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Combating Child Chronic Malnutrition and Anemia in Peru: Simulations based on the Achievement of Sustainable Development Goals

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Abstract

Chronic child malnutrition and anemia are among the main risk factors for child development across the developing world. In Peru, 14.7% of children under 5 years of age are chronically malnourished and 36.4% of children between 6 and 36 months of age show some degree of anemia. In this paper, we estimate the improvements that can be expected in child malnutrition and anemia in Peru, if Sustainable Development Goals (SDGs) are achieved for a set of health determinants. The study contributes to the literature in two ways. First, it is the first study to offer improvement scenarios for SDG-related health outcomes based on shifts produced in other SDG-related variables. This can be informative to policy if some of these SDG-related determinants have a direct connection to policy action. Second, we use the insights of a simple economic model describing families' behavior to choose the empirical strategy less prone to biases and interpret the improvement scenarios. Our results indicate that important reductions of 8.9 and 15.7 percentage points can be achieved in child chronic malnutrition and anemia, respectively, if all their SDG-related determinants reach their targets. Importantly, at least half of these reductions can be produced by closing gaps in access to observable inputs that have a direct influence on health and that can be directly influenced by policy.

JEL Classification: I18, I12, C25
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1. Introduction

Chronic child malnutrition and anemia are among the main risk factors for child development across the developing world (Walker et al., 2007). Childhood anemia is associated with serious consequences that include growth retardation, impaired motor and cognitive development, and increased morbidity and mortality (Grantham-McGregor et al., 2001; Ramakrishnan, 2008). Children with malnutrition problems are nine times more likely to die than those who do not suffer this condition (Black, el al. 2013).

In Peru, 14% of children between 0 and 36 months of age are chronically malnourished and 36% of children between 6 and 36 months of age show some degree of anemia (INEI, 2015). There are also significant disparities according to their geographical domain. While the prevalence of chronic malnutrition in urban areas is 9%, in rural areas this figure reaches 27%. In addition, 44% of children in rural areas suffer anemia compared to 34% in urban areas.

Chronic child malnutrition and anemia are related to families' access to adequate food, basic public services and, more in general, to their socioeconomic status (Haddad and Smith, 2000; Gwatkin et al., 2007; Kanjilal et al., 2010). A relevant policy question concerns which improvements can be expected in child malnutrition and anemia if shifts in these determinants are produced.

It is now fairly common for policymakers to commit to certain targets in terms of social indicators and make these targets public. Some of these commitments have even an international scope. A good example of this are the Sustainable Development Goals (SDGs) adopted by the United Nations and its member states in September 2015. SDGs comprise 17 goals, 169 targets and 232 indicators. Several of these indicators are health-related in the sense that they refer to health outcomes or determinants with well-established causal links with health outcomes. For example, the second SDG makes explicit reference to child chronic malnutrition while the third SDG comprises granting universal access to health services.

Efforts have been made to measure levels and progress in achieving health-related SDGs and project their attainment by 2030 (González-Pier et al., 2016; Fullman et al., 2017 WHO, 2017, World Bank, 2017). These contributions have focused on expanding the array of indicators available across countries and on estimating improvement scenarios for individual indicators based on their historic trends. In this regard, it is worth noticing that SDGs comprise outcome indicators but also variables that can directly or indirectly influence these outcomes. Therefore, achieving some of the goals can cause improvements in other SDG-related indicators. Despite several SDGs are related to each other, to the best of our knowledge, no previous study has estimated improvement scenarios for an SDG health outcome based on achieving improvements in other SDG-related variables that can function as its determinants.

This type of exercise can be more informative for a policymaker committed to achieving all the SDGs than an assessment based on historic trends. Historic trends can indicate how likely it is to achieve a certain target if policy action remains as usual. They will not reveal how improvements achieved in policy variables translate into improvements in health outcomes. This insight is relevant within the SDG framework because some of the SDG-related health determinants can be directly linked to policy action (e.g. they refer to access to a basic public service). Outcome variables such as child malnutrition and anemia have a direct connection with children's and families' wellbeing but cannot be directly determined by policy. By linking progress in health outcomes to improvements in their SDG-related determinants, the policymaker will have a better idea of what to expect in terms of improved wellbeing and the achievement of SDG-related outcomes if she fulfills her commitments in terms of variables that have a more direct connection with policy.

In this paper we seek to estimate the improvements that can be expected in child malnutrition and anemia in Peru if their SDG-related determinants reach a set of target values consistent with the targets proposed for the Sustainable Development Goals. This research contributes to the literature in two ways. First, it is the first study to offer improvement scenarios for SDG-related health outcomes based on shifts produced in other SDG-related variables. This accounts for the potential synergies between SDGs and, as explained above, can be more informative for a policymaker committed to achieving these goals than an analysis solely based on historic trends.

The second contribution is related to the methodology employed to estimate the improvement scenarios for chronic child malnutrition and anemia. SDG-related health determinants comprise both health inputs and health input determinants. Inputs are variables that have a direct effect on the outcome (e.g. food intake). Input determinants have an indirect effect as they are mediated by inputs (e.g. maternal education). Inputs and input determinants cannot be treated the same way in empirical work. Failure to recognize this distinction can lead to a misinterpretation of the improvement scenarios and to a biased assessment of the consequences of shifting SDG-related health determinants.

For example, consider a regression of child health on inputs (e.g. food intake) and input determinants (e.g. maternal education). In this specification, the input determinants control for unobserved inputs. This means that shifts introduced in maternal education will be mediated through the unobserved inputs. Therefore, it would not be appropriate to use this regression to estimate the expected improvement in child health if maternal education reaches a certain target level. In fact, this regression will provide the expected improvement in child health if the unobserved inputs reach a level consistent with maternal education reaching a certain target value. If one seeks to estimate the improvement in child health produced by a shift in maternal education, one has to consider the results of a regression of child health on input determinants only.

In the analysis that follows, we will distinguish between three different types of empirical specifications. The first one is a production function and will include only health inputs. The second specification is a demand function and will include only health input determinants. The third is a hybrid production function and will include both health inputs and input determinants. Each specification requires particular assumptions to produce the expected improvement in the health outcome (chronic child malnutrition or anemia) after SDG-related determinants reach their target values. We will use the insights of a simple economic model describing how families' decisions translate into particular levels of health inputs to explain these assumptions and choose the empirical specification less prone to biases. We believe this framework could be used in future efforts seeking to estimate improvement scenarios in SDG-related outcomes produced by shifts in SDG-related determinants.

Consistent with the SDGs and based on the information available in the Peruvian National Health and Demographic Survey (DHS 2015), the input variables considered reflect adequate food intake (related to SDG 2, target 2.1), adequate dwelling conditions

(SDG 6, targets 6.1, 6.2; SDG 7, target 7.1; SDG 11, target 11.1), and access to health services (SDG 3, target 3.8). Target values are set to reflect universal access to these basic goods and services. SDG-related input determinants correspond to household wealth (related to SDG1, target 1.2) and maternal education (SDG 4, target 4.3). Household wealth was measured using the DHS 2015 wealth index. Its target was defined to reflect a shift in the wealth distribution such that all households have an index equal or greater than the third quintile cut-off value. This is consistent with reducing the incidence of national poverty from 22% to 8%. The target value for maternal education was defined considering the average proportion of women with tertiary education in the OECD member countries.

Our main findings can be summarized as follows. We can expect a significant reduction of 9 percentage points (from 14.7% to 5.7%) in chronic child malnutrition in Peru if all the SDG-related determinants reach their targets. Around 63% of this improvement (5.6 percentage points) is achieved through the effect of observable inputs that have a direct influence on health and that can be directly influenced by policy. The remaining 3.4 percentage points can be attributed to the shift in unobservable inputs produced by input determinants reaching their targets. The potential for improvement is much more significant in the rural domain. Simulations reveal that we can expect a reduction of 21.6 percentage points (from 27.4% to 5.8%) in chronic child malnutrition in rural Peru if all the SDG-related determinants reach their targets. Around half of this improvement (11.2 percentage points) is produced by the shift in observable inputs.

If all SDG-related health determinants reach their targets, we can also expect an important reduction of 15.7 percentage points in childhood anemia in Peru (from 36.4% to 20.6%). Around 65% of this reduction can be achieved through the effect of observable inputs with a direct influence on health and a direct connection to policy action. As in the case of malnutrition, rural areas show a greater potential for improvement. In particular, we can expect a reduction of 21.5 percentage points (from 43.4% down to 21.9%) in childhood anemia in rural Peru if all the SDG-related determinants reach their targets. More than half (55%) of this improvement is produced by observable inputs.

The rest of the paper is organized as follows. Section 2 presents the analytical framework and, based on this, describes the simulation scenarios and their assumptions.

Section 3 discusses the data sources, indicators, target values and the empirical specifications. Section 4 presents the simulation results. Section 5 closes with some concluding remarks.

2. Analytical framework

In this section, we describe the analytical framework linking health outcome determinants to families' decisions. The model is based on Glewwe and Miguel (2008). We use this framework to distinguish between three different types of empirical specification and interpret the improvement scenarios that can be produced by each one.

Assume that the health status of child i (H_i) can be expressed as a function of variables that have a direct effect on his/her wellbeing as well as the child's innate healthiness (μ_i). The function relating health outcomes to these direct influences is called a *production function*. Some of these direct influences can be affected by families' decisions (such as the child's food intake, the physical conditions surrounding him/her and his/her access to health care services) while others will be assumed as predetermined (such as the child's innate healthiness, age or sex). Direct influences determined by families' decisions will be called health inputs. Assume, also, that some of these inputs are observed (I_i; i.e. they can be accounted for with the available data) while others remain unobserved to the econometrician (U_i). The production function can be written as:

$$H_i = H^p(I_i, U_i, E_i, \mu_i; \beta^p) \tag{1}$$

Where E_i are predetermined direct influences and β^p are the parameters of the production function. The presence of unobserved inputs complicates the estimation of these parameters because unobserved inputs are likely correlated with the inputs one can observe. This is because inputs are jointly determined through families' decisions. To illustrate this and to present other relationships of interest besides the production function, consider the following simple model.

Assume that the child's a family cares for consumption of an aggregate good (C_i) and the child's health status. This family maximizes the following utility function:

$$W_i = W(C_i, H_i; \tau) \tag{2}$$

Where parameter τ expresses parental preferences for child health. The family also faces the following budget constraint:

$$Y_i = p_C C_i + p_I I_i + p_U U_i \tag{3}$$

Where Y_i is family income (assumed to be exogenously determined) and p_C, p_I and p_U are the prices of the consumption good, the observed health inputs and the unobserved health inputs, respectively.

Optimizing the utility given in (2) subject to the constraints given in (1) and (3) produces the demand functions for the inputs. Demand functions are expressed in terms of family resources and preferences, prices and predetermined direct influences. In particular:

$$I_i = I^d(Y_i, \tau, p_C, p_I, p_U, E_i, \varepsilon_i; \alpha) \tag{4}$$

$$U_i = U^d(Y_i, \tau, p_C, p_I, p_U, E_i, \omega_i; \gamma) \tag{5}$$

Where α and γ are the paramters of the demand functions of observed and unobserved inputs, respectively, and ε_i and ω_i are shocks affecting these demand functions. To ease the exposition, allow vector z_i to contain the arguments of the input demand functions except predetermined direct influences; i.e. $z_i = (Y_i\ \tau\ p_C\ p_I\ p_U)$.

This model allows one to express the relation between health outcomes and their determinants in three different ways. The first one is the production function given in (1). It accounts for the direct effect of health inputs on health outcomes. The second one is a *demand function* and it represents the relationship between health outcomes and input determinants. Formally, if we replace the input demand functions given in (4) and (5) in the production function, we obtain the following demand function for health:

$$H_i = H^p(I^d(z_i, E_i, \varepsilon_i; \alpha), U^d(z_i, E_i, \omega_i; \gamma), E_i, \mu_i; \beta^p) = H^d\left(z_i, E_i, \mu_{i,}\varepsilon_i, \omega_i; \beta^d\right) \tag{6}$$

Where β^d are the parameters of the health demand function.

The third specification is known as a *hybrid production function* and combines health inputs and input determinants (see Todd and Wolpin (2007) for an application based on the production function of cognitive skill). According to the previous model, input determinants (z_i) should not be considered in a production function if all health inputs have been accounted for. This, however, is not always possible due to data limitations. A hybrid production function is based on the implicit exercise of replacing unobserved inputs by their respective demand functions. Thus, we obtain:

$$H_i = H^p(I_i, U^d(z_i, E_i, \omega_i; \gamma), E_i, \mu_i; \beta^p) = H^h\left(I_i, E_i, z_i, \mu_{i,}, \omega_i; \beta^h\right) \tag{7}$$

Where β^h are the parameters of the hybrid production function of health. In a hybrid production function the health outcome is expressed in terms of observed inputs and input determinants.

The above analysis should serve to clarify that there are three different specifications that one could use to relate a health outcome to its determinants. As explained below, each one relies on different assumptions to identify the expected improvement in a health outcome produced after inputs and input determinants reach certain target values.

To see this, consider a set of target values for the observed health inputs (I^T) and the input determinants (z^T). Assume one is interested in estimating the expected improvement in H_i if these inputs and input determinants reach these target values.

Notice that if input determinants reach their target levels this will produce a shift in inputs. We can express the value attained by the inputs using their demand functions: $I^{DT} = I^d(z^T, \bar{E}, ; \alpha)$, $U^{DT} = U^d(z^T, \bar{E}, ; \gamma)$, where $\bar{E}$ is the average value of the predetermined direct influences. The level attained by the inputs when $z_i = z^T$can be smaller, equal to or greater than their respective targets. Whether $I^T \geq I^{DT}$ or $I^T \leq I^{DT}$ has important consequences for the interpretation of the improvement scenarios provided by the production function, the demand function and the hybrid production function. This is explained below.

If we estimate a production function we have to regress the health outcome on its predetermined direct influences and health inputs only and this can only be done considering the observed inputs. Based on the estimated value of the parameters $\left(\hat{\beta}^p\right)$ and the functional form assumed for the production function $\left(H^p(.)\right)$, one can predict a new value for the health outcome using: $\widehat{H}_p = H^p\left(I^T, \bar{E}; \hat{\beta}^p\right)$. $\widehat{H}_p$ provides the improvement in the health outcome if the observed inputs reach their targets, that is, when $I_i = I^T$. Notice that for $\hat{H}_p$ to provide the expected improvement in H_i when $I_i = I^T$ and $z_i = z^T$, we have to assume that any indirect effect caused by the shift in z_i is already accounted for by setting $I_i = I^T$. This means we have to assume that there are no unobserved inputs (so there is no effect of shifting z_i operating through U^{DT}) and that $I^T \geq I^{DT}$ (so the effect of shifting z_i that operates through I^{DT} is already incorporated by setting $I_i = I^T$).

To estimate a demand function we have to regress the health outcome on the input determinants only. Based on the estimated value of its parameters $\left(\hat{\beta}^d\right)$ and the functional form assumed for the demand function $\left(H^d(.)\right)$, one can predict a new value for the health outcome using: $\hat{H}_d = H^d\left(z^T, \bar{E}; \hat{\beta}^d\right)$. $\hat{H}_d$ provides the improvement in the health outcome if the inputs (observed and unobserved) reach a level consistent with input determinants reaching their targets. In other words, $\hat{H}_d$ provides the improvement in the health outcome when $I_i = I^{DT}$ and $U_i = U^{DT}$. For this to coincide with the expected improvement in H_i when $I_i = I^T$ and $z_i = z^T$, we have to assume that $I^T \leq I^{DT}$ so that the effect of setting observed inputs to their targets is already incorporated in the shift caused by setting input determinants to their targets.

Finally, to estimate a hybrid production function we have to regress the health outcome on its observed inputs and the input determinants. Using the estimated value of its parameters and the function form assumed for the hybrid production function, one can predict a new value for the health outcome using: $\hat{H}_h = H^h\left(I^T, z^T, \bar{E}; \hat{\beta}^h\right)$. $\hat{H}_h$ provides the improvement in the health outcome if the observed inputs reach their targets $(I_i = I^T)$ and the unobserved inputs reach a level consistent with input determinants reaching their targets $(U_i = U^{DT})$. This will coincide with the expected improvement in H_i when $I_i = I^T$ and $z_i = z^T$ if we assume that $I^T \geq I^{DT}$ so any indirect effect of z_i that operates through the observed inputs is already accounted for by setting them to their target level.

Recall that the empirical objective of this exercise is to estimate the improvement in two health outcomes (chronic child malnutrition or anemia) after their SDG-related determinants reach certain target values. These determinants can comprise both inputs and input determinants. For this, we will consider the results provided by the following simulations:

(i) We will set observed inputs and input determinants to their target levels using the estimates of the hybrid production function $(\widehat{H}_h)$.

(ii) We will set input determinants to their target levels using the estimates of the demand function $(\widehat{H}_d)$.

(iii) We will set observed inputs to their target levels using the estimates of the hybrid production function ($\widehat{H}'_h = H^h(I^T, \bar{z}, \bar{E}; \hat{\beta}^h)$, where $\bar{z}$ is the average value of the input determinants).

There are three important issues to consider regarding these simulations. First, notice that we will not use the results provided by the production function (H^p). This is because to use H^p to estimate the improvement in the health outcome when SDG-related inputs and input determinants reach their targets, one has to assume that there are no unobserved inputs. This is a strong assumption as health outcomes depend of numerous influences and it is unlikely that all of them have been fully accounted for in a health survey.[1]

In addition, even if one is interested in the expected improvement produced by setting only the observed inputs to their targets, the estimates provided by the hybrid production function are more reliable. This is because in the hybrid specification, potential confounders affecting the estimates of the parameters of observed inputs are, at least, partially controlled for through the demand function of unobserved inputs. In fact, we will rely on the hybrid specification to estimate the improvement produced by shifting only observed inputs (see $\widehat{H}'_h$ above).

Second, notice that whether $\widehat{H}_h$ or $\widehat{H}_d$ corresponds to the expected improvement in the health outcome when SDG-related inputs and input determinants reach their targets depends on whether $I^T \geq I^{DT}$ or $I^T \leq I^{DT}$. To test this, we will rely on the difference $\widehat{H}_h - \widehat{H}_d$. Recall that $\widehat{H}_h$ provides the expected value of the outcome when the observed inputs reach their targets $(I_i = I^T)$ and the unobserved inputs reach a level consistent with input determinants reaching their targets $(U_i = U^{DT})$. $\widehat{H}_d$ provides the expected value of the health outcome when both $I_i = I^{DT}$ and $U_i = U^{DT}$. Therefore, the difference $\widehat{H}_h - \widehat{H}_d$ estimates the marginal gain in terms of the health outcome of setting $I_i = I^T$ instead of $I_i = I^{DT}$. A positive difference is evidence in favor of

[1] In the analysis that follows we will provide evidence that does not support this assumption.

$I^T > I^{DT}$ and, therefore, $\widehat{H}_h$ is the best estimate of the improvement in the health outcome when its SDG-related determinants reach their targets.

Finally, notice that the difference $\widehat{H}_h - \widehat{H}'_h = H^h(I^T, z^T, \bar{E}; \hat{\beta}^h) - H^h(I^T, \bar{z}, \bar{E}; \hat{\beta}^h)$ estimates the marginal gain in terms of the health outcome of shifting the unobservable inputs to $U_i = U^{DT}$. A positive difference, thus, constitutes evidence in favor of the presence of unobserved inputs. As explained above, the presence of omitted inputs rules out the use of the production function and renders the hybrid function as the preferred specification to provide an unbiased estimate, even if one is interested in the effect of shifting the observed inputs only.

3. Data and estimation

3.1 Data

This analysis is based on the information contained in the 2015 National Demographic and Health Survey (DHS). This survey provides information on socioeconomic conditions, access to health services and the nutritional and health status of Peruvian children under the age of 3, their mothers and families.[2]

As explained in the previous section, our estimations will consider three types of variables: health outcomes, inputs and input determinants. The outcomes correspond to the incidence of chronic child malnutrition and childhood anemia. Children between 0 and 36 months of age suffering from chronic malnutrition are those that report a height two standard deviations or more below the benchmark established by the World Health Organization. The DHS classifies children between 6 and 36 months of age as having mild, moderate or severe anemia based on the concentration of hemoglobin in their blood. Based on this, our outcome variable is built as the proportion of children that report some degree of anemia. Table 1 reports the basic descriptive statistics for these two health outcomes.

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[2] The survey was conducted on a sample of 35,850 families, involving 25,257 children. Complete information on health outcomes and health determinants is available for 13,370 children in the case of anemia, and 13,228 children in the case of malnutrition.

Table 1
Outcome variables

Outcome variable	Description	Mean/1		
		Peru	Urban	Rural
Chronic child malnutrition (0-36 months)	1 If the child has a height 2 standard deviations or more below the WHO standard 0 Otherwise	0.14	0.09	0.27
Childhood anemia (6-36 months)	1 If the child suffers from mild, moderate or severe anemia 0 Otherwise	0.36	0.34	0.44

Source: DHS, 2015.
/1 Means were calculated using the sample of children with complete information on health outcomes and health determinants (n=13,228 for malnutrition and n=13,370 for anemia).

Health outcomes depend on a vast array of direct influences (Haddad and Smith, 2000; Gwatkin et al., 2007; Kanjilal et al., 2010). As discussed in the previous section, we will distinguish between those direct influences that can be contemporaneously affected by families' decision (inputs) and those that can be regarded as predetermined. Inputs, in turn, will be grouped into three categories: (i) food intake; (ii) dwelling conditions; and (iii) access to health services. These input categories are broad enough to account for all the external influences that are in direct contact with the child and can affect her health status. Table 2 presents the variables considered in each category. Notice that our ability to characterize each input category is limited by the information contained in the DHS. Recall, however, that our analysis allows for the presence of omitted inputs and that is why we will consider the inclusion of input determinants in our regressions and simulations.

Table 2
Available inputs and predetermined direct influences for chronic malnutrition and anemia

Direct influences	Variables	Mean[/5]		
		All	Urban	Rural
Inputs	**Food intake** Between 0 and 5 months 1 If the child breastfeeds exclusively or consumes formula milk[/1] or refrigerated breast milk 0 Otherwise Between 6 and 36 months 1 If the child consumes more than 4 out of 6 food groups daily [/2] 0 Otherwise	0.22	0.22	0.21
	Dwelling conditions 1 If the household has an appropriate water source and sanitation service, uses adequate cooking fuel and treatment for drinkable water, has appropriate flooring material[/3] and the child's mother washes her hands before preparing food and after using the toilet. 0 Otherwise	0.26	0.33	0.04
	Access to health services 1 If the child's mother does not report any problem to access health services[/4]. 0 Otherwise	0.16	0.20	0.06
Pre-determined	Birth weight (kg.)	3.27	3.30	3.17
	Child's sex d (1=male)	0.51	0.51	0.51
	Child's age (months)	29.72	29.90	29.20

Source: DHS, 2015.

/1 The use of formula milk is recommended only in certain cases depending on the mother's or the child's health status. The DHS does not indicate the reason why the child is consuming formula milk. Its incidence, however, is small (18%) so we assume its consumption is medically justified.

/2 The food groups considered are: (i) dairy products; (ii) cereals and tubers; (iii) fruits and vegetables; (iv) chicken and red meat; (v) eggs; (vi) legumes.

/3 An appropriate source of water considers access to a public network (either inside or outside the house) or if the household consumes bottled water. Adequate cooking fuel considers electricity or gas. Adequate treatment for drinkable water includes: boiling, chlorine, filtering, solar water disinfection or if the household consumes bottled water. An appropriate sanitation service considers access to a public network or septic tank and improved latrines for rural areas. Adequate flooring material comprises: (i) wood; (ii) parquet; (iii) asphalt tiles/vinyl; (iv) granite, ceramic tiles; or (v) cement.

/4 Mothers were asked whether any of the following represents a problem to access health services in the case of illness: do not know where to go, cannot get permission to go, do not have enough money for treatment, distance to medical services, no transportation available, lack of health personnel, lack of medical supplies.

/5 Means were calculated using the sample of children with complete information on health determinants (n= 22,024).

Input determinants are presented in Table 4. These correspond to family and background characteristics that influence the demand for inputs. Based on the information contained in the DHS, the input determinants considered in this analysis comprise family wealth, the mother tongue and educational attainment of the child's mother, and the altitude and geographical domain where the household resides to account for differences in input prices and availability.

At this point is worth highlighting that it is not the intention of our empirical exercise to estimate the effect of a particular input (e.g. potable water) or of a particular manner to deliver an input (e.g. a program to expand access to potable water). As explained above, the empirical objective of this analysis is to estimate the improvement in child chronic malnutrition and anemia that can be expected if their SDG-related determinants reach a set of proposed targets. Based on this, our main simulations will rely on shifting aggregate groups of variables and not on shifting a particular input. The exercise proposed here, thus, is less prone to biases that one seeking to identify the effect of a specific input using observational data such as the DHS.[3]

It is also not our intention to estimate the effect of a particular input determinant (e.g. maternal education). We include input determinants because some of these are related to an SDG and to control for potentially omitted inputs. As in the case of inputs, our main simulations will introduce shifts in all the SDG-related input determinants and not in a particular one.

[3] As discussed in Castro and Rolleston (2018), estimation of the effect of a particular input requires absence of unobserved influences correlated with the input of interest. Consistent estimation of the contribution of a group or category of inputs, however, is still possible despite the presence of such unobservables as long as they exhibit partial correlation only with the inputs that belong to their same category or group. In other words, the presence of unobserved inputs does not necessarily pose a threat for the identification of the contribution of a group of inputs if their effect is captured by observed inputs that belong to their same category.

Table 3
Available input determinants for child chronic malnutrition and anemia

Input determinants	Variables	Mean/2		
		All	Urban	Rural
Mother tongue (child's mother)	1 Spanish 0 Otherwise	0.94	0.99	0.81
Child's mother educational attainment (primary education)	1 If primary education is the highest educational attainment 0 Otherwise	0.21	0.13	0.46
Child's mother educational attainment (secondary education)	1 If secondary education is the highest educational attainment 0 Otherwise	0.65	0.71	0.48
Child's mother educational attainment (higher education)	1 If higher education is the highest educational attainment 0 Otherwise	0.13	0.16	0.02
Household wealth index/1	1 If the household has an index equal or greater than the third quintile cut-off value of the wealth index distribution 0 Otherwise	0.56	0.73	0.06
Altitude	Meters above sea level	1,047	718	2,038
Geographical domain	1 if urban 0 if rural	0.75	1	0

Source: DHS, 2015.

/1 The DHS includes a wealth index at the household level based on the consumption of durable goods and dwelling characteristics.

/2 Means were calculated using the sample of children with complete information on health determinants (n= 22,024).

3.2 Estimation using a probabilistic model

The estimation will be based on a probabilistic model because both outcome variables are binary indicators. In other words, we will directly estimate the probability that an individual exhibits the health condition on the basis of a set of covariates or regressors.

The set of covariates considered will determine the type of function to be estimated. For the hybrid production function the covariates will comprise all observed inputs and input determinants. For the demand function, the covariates will consider the input determinants only. The estimations will be based on a probit model. In this model, the parameters are estimated by Maximum Likelihood under the assumption of normality.

Define as h_i the observed health condition for individual i. In the case of chronic malnutrition, $h_i = 1$ if the child is malnourished and $h_i = 0$ if he or she is not. In the case of anemia, $h_i = 1$ if the child reports some degree of anemia and $h_i = 0$ if he or she does not. The incidence of the health condition in a given population can be estimated using the probability than an average person of the population exhibits the condition. Therefore, the estimated parameters of the probit model $(\hat{\beta})$ can be used to calculate the incidence of the health condition using:

$$\Pr(h_i = 1 | x_i = \bar{x}) = \Phi(\bar{x}'\hat{\beta}) \tag{8}$$

Where x_i is a vector containing the covariate values for individual i, $\bar{x}$ contains the average value of these covariates, and $\Phi(\cdot)$ corresponds to the cumulative density function of the standard normal distribution.

Simulations will be based on shifting the values of certain covariates to the targets described below. As indicated in Section 2, the main simulations will comprise:
(i) shifting observed inputs to their target levels using the estimates of the hybrid production function; (ii) shifting observed input determinants to their targets using the estimates of the demand function; and (iii) shifting observed inputs and input determinants to their targets using the estimates of the hybrid production function.

Let vectors x_I and x_Z contain the covariates corresponding to inputs and input determinants, respectively (for simplicity, we have dropped subscript i). Their sample mean values are given by $\bar{x}_I$ and $\bar{x}_Z$, and their target values by x_I^T and x_Z^T, respectively. Also, let $\hat{\beta}_I^h$ and $\hat{\beta}_Z^h$ denote the parameter estimates provided by the probit model of the hybrid production function for the inputs and input determinants, respectively. Vector $\hat{\beta}_Z^d$ contains the parameter estimates for the input determinants provided by the probit model of the demand function (recall that the demand function does not include health inputs). Finally, allow h_B denote the baseline incidence of the health condition. Based on this notation, Table 4 presents the relations that will provide the results of the three main simulations. The terms in brackets in Table 4 provide the expected reduction in the incidence of the health condition under analysis.

Table 4
Simulations and their corresponding expected incidence of the health condition

Simulation	Expected incidence
Observed inputs reach their targets	$h_B - \left[\Phi\left(\bar{x}_I{}'\hat{\beta}_I^h + \bar{x}_Z{}'\hat{\beta}_Z^h\right) - \Phi\left(x_I^T{}'\hat{\beta}_I^h + \bar{x}_Z{}'\hat{\beta}_Z^h\right)\right]$
Observed input determinants reach their targets	$h_B - \left[\Phi\left(\bar{x}_Z{}'\hat{\beta}_Z^d\right) - \Phi\left(x_Z^T{}'\hat{\beta}_Z^d\right)\right]$
Observed inputs and input determinants reach their targets	$h_B - \left[\Phi\left(\bar{x}_I{}'\hat{\beta}_I^h + \bar{x}_Z{}'\hat{\beta}_Z^h\right) - \Phi\left(x_I^T{}'\hat{\beta}_I^h + x_Z^T{}'\hat{\beta}_Z^h\right)\right]$

3.3 Target values for simulations

Simulations will rely on shifting the observed inputs and input determinants that are related to an SDG. Table 5 presents the target values for these inputs and input determinants. Targets were proposed based on the SDG targets and the nature of the variable under analysis.

Target values for all three input categories were defined considering the goal of achieving universal access to adequate food, dwelling conditions and health services. This implies shifting baseline figures to 100%. The target for maternal education was defined considering the average educational attainment in OECD countries as a reasonable benchmark. In particular, the average proportion of women between 25 and 64 years of age that have tertiary education as their highest educational attainment in OECD countries is 46% (OECD, 2010). For our simulations, we set this as a target and assumed that the remaining 54% have secondary education as their highest educational attainment.

Finally, the target for household wealth was defined to reflect a shift in the DHS 2015 wealth index distribution such that all households have an index equal or greater than the third quintile cut-off value. According to the 2015 National Household Survey, this corresponds to a reduction in the incidence of national poverty from 22% to 8%.[4] This, in turn, is consistent with target 1.2 of SDG 1 which requires reducing at least by half the proportion of the population living in poverty.

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[4] The National Household Survey is the official source of information for calculating the incidence of poverty each year. According to this source, the incidence of national poverty in 2015 was 22%. The DHS does not include an income or poverty indicator. To translate the proposed shift in the DHS wealth distribution into a shift in national poverty, we built the DHS wealth index using the 2015 National Household Survey and estimated the incidence of poverty among households with a wealth index equal or greater than the third quintile cut-off value of the wealth distribution. The result was a poverty incidence of 8%.

Table 5
Target values for inputs and input determinants and their corresponding SDGs

Variable category	Variable	Baseline (DHS 2015)	Proposed target	Related SDGs and targets
Inputs	Food intake (% children with adequate food intake)	0.22	1.00	**SDG 2. Target 2.1**: End hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round.
	Dwelling conditions (% children living in a dwelling with appropriate basic services)	0.26	1.00	**SDG 6. Target 6.1**: Achieve universal and equitable access to safe and affordable drinking water for all. **SDG 6. Target 6.2**: Achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations. **SDG 7. Target 7.1**: Ensure universal access to affordable, reliable and modern energy services. SDG 11. Target 11.1: Ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums.
	Access to health services (% children whose mother does not report any restriction to access health services)	0.16	1.00	**SDG 3. Target 3.8**: Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all.
Input determinants	Child's mother educational attainment (% children whose mothers' highest educational attainment is primary education)	0.21	0.00	**SDG 4. Target 4.3**: Ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university.
	Child's mother educational attainment (% children whose mothers' highest educational attainment is secondary education)	0.65	0.54	
	Child's mother educational attainment (% children whose mothers' highest educational attainment is higher education)	0.13	0.46	
	Household wealth (% children living in a household with a wealth index equal or greater than the third quintile cut-off value)	0.56	1.00	**SDG1. Target 1.2**: Reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions.

Source: DHS, 2015; United Nations, 2017.

4. Results

This section presents simulation results for the three scenarios discussed in Section 2. In particular, we consider the results of: (i) setting observed inputs to their target levels using the estimates of the hybrid production function $\left(\widehat{H}_h'\right)$; (ii) setting input determinants to their target levels using the estimates of the demand function $\left(\widehat{H}_d\right)$; and (iii) setting observed inputs and input determinants to their target levels using the estimates of the hybrid production function $\left(\widehat{H}_h\right)$. In addition to these results, we will also consider the improvements produced by shifting each type of input category separately. Results obtained when simulating changes in individual input categories, however, should be taken with caution as they are more prone to biases that those obtained for the aggregate simulations. In Appendix 1 we present the regression results for the three specifications.

Recall that it is possible to test for omitted inputs by evaluating the difference $\widehat{H}_h - \widehat{H}_h'$. A positive difference means that there is a gain in shifting unobservable inputs to a level consistent with input determinants reaching their targets $(U_i = U^{DT})$. Thus, a positive difference is evidence of the existence of unobserved inputs. In the results that follow we estimate and evaluate the significance of $\widehat{H}_h - \widehat{H}_h'$. Notice that because the outcomes of interest are chronic malnutrition and anemia, gains are interpreted as reductions in these indicators. Therefore, the presence of unobservable inputs should translate into a negative difference when evaluating $\widehat{H}_h - \widehat{H}_h'$.

In addition, recall that if there is evidence of omitted inputs and $I^T \geq I^{DT}$, $\widehat{H}_h$ will provide the best estimate for the expected improvement in health outcomes when SDG-related inputs and input determinants reach their targets. We can test if $I^T \geq I^{DT}$ by evaluating the difference $\widehat{H}_h - \widehat{H}_d$. In particular, a positive difference (negative if gains are interpreted as reductions) is evidence that $I^T > I^{DT}$. We also estimate and evaluate the significance of $\widehat{H}_h - \widehat{H}_d$ in the results that follow.

Figures 1 and 2 present the simulation results for child chronic malnutrition. Figure 1 presents results for the national average and Figure 2 presents results for the urban and rural domain. Each figure is divided into four sections. The first section indicates the 2015 (baseline) value of the health outcome. The second section presents the expected value of the outcome after each input type reaches its target value separately and after all observed inputs reach their targets using the hybrid production function $(\widehat{H}_h')$. The third section presents the result of shifting all input determinants to their target values using the estimates of the demand function $(\widehat{H}_d)$. Finally, the fourth section presents the expected value of the health outcome after all observed inputs and input determinants reach their targets using the estimates of the hybrid production function $(\widehat{H}_h)$. Below the figure, we provide the point estimate for each scenario and its difference with respect to the baseline value. We also present the results for the differences $\widehat{H}_h - \widehat{H}_h'$ and $\widehat{H}_h - \widehat{H}_d$. Figures 3 and 4 have a similar structure and show the simulation results for anemia considering the national average and comparing the urban and rural domains, respectively.

Results presented in Figure 1 provide evidence of the existence of omitted inputs (the difference $\widehat{H}_h - \widehat{H}_h'$ is negative and statistically significant) and in favor of $I^T > I^{DT}$ (the difference $\widehat{H}_h - \widehat{H}_d$ is also negative and statistically significant). Recall that if the target values for the inputs exceed the values that they would attain if their determinants reach their targets ($I^T > I^{DT}$), the hybrid production function is the preferred specification to provide an estimate of the gain produced after all the SDG-related determinants reach their targets. We will, therefore, use $\widehat{H}_h$ to estimate this gain.

The results presented in Figure 1 indicate that we can expect a significant reduction of 9 percentage points (from 14.7% to 5.7%) in chronic child malnutrition in Peru if all the SDG-related determinants reach their targets. Results obtained for $\widehat{H}_h'$ reveal that around 63% of this improvement (5.6 percentage points) is achieved through the effect of observable inputs. The remaining 37% of the improvement can be related to shifts in unobservable inputs produced when input determinants such as maternal education and household income reach their proposed target values. If evaluated separately, the input category related to dwelling conditions appears to make a larger contribution (3 percentage points) to the overall reduction in chronic malnutrition. The remaining input categories (food intake and health services) exhibit a similar contribution ranging between 1.5 and 1.8 percentage points.

Results presented in Figure 2 show that the potential for improvement is much more significant in the rural domain. In particular, we can expect a reduction of 21.6

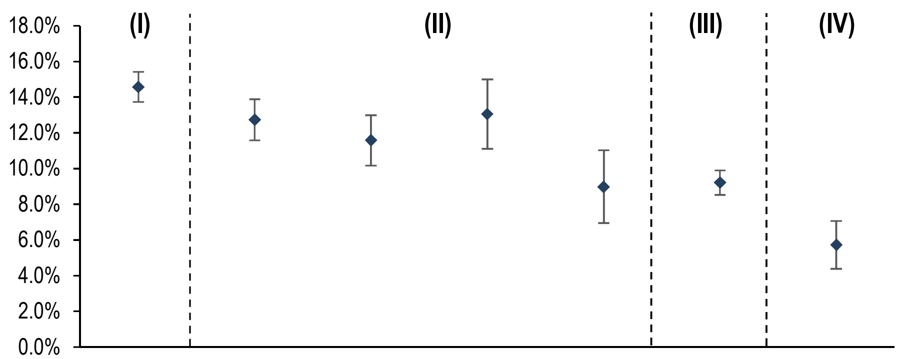
percentage points (from 27.4% to 5.8%) in the incidence of chronic child malnutrition in rural Peru if all the SDG-related determinants reach their proposed targets. Around half of this improvement (11.2 percentage points) is produced by the shift in observable inputs (see the results for $\widehat{H}_h'$ in Figure 2). As for the aggregate indicator, the input category related to dwelling conditions appears to make the largest individual contribution to this reduction (6.4 percentage points). Expected improvements in the urban domain are smaller but remain statistically significant. In particular, simulations reveal that if all SDG-related determinants reach their target, we can expect a reduction of 6 percentage points in chronic malnutrition in this domain. Interestingly, a larger proportion of this reduction (70%) can be attributed to shifts in observable inputs. If evaluated individually, all three input categories exhibit a similar contribution (between 1.2 and 1.5 percentage points) to the overall reduction.

Figure 3 presents the results for anemia at the national level. We also find evidence of omitted inputs (the difference $\widehat{H}_h - \widehat{H}_h'$ is negative and statistically significant) and that the target values for the inputs exceed the values that they would attain if their determinants reach their targets (the difference $\widehat{H}_h - \widehat{H}_d$ is also negative and statistically significant). Therefore, we will rely on $\widehat{H}_h$ to estimate the improvement produced if all the SDG-related determinants of anemia reach their targets.

Figure 3 shows that one can expect a reduction of 15.7 percentage points (from 36.4% to 20.6%) in the incidence of anemia in Peru if all its SDG-related determinants reach their targets. Nearly 65% of this improvement (10.2 percentage points) can be related to the shift in observable inputs. Among these, the input category related to food intake is the only that makes a significant contribution. Inputs related to dwelling conditions and access to health services, do not exhibit significant results.

As in the case of chronic malnutrition, the rural domain exhibits a larger potential for improvement (see Figure 4). In particular, one can expect to cut by half the incidence of anemia in the rural domain (from 43.4% down to 21.9%) if all its SDG-related determinants reach their proposed targets. In urban areas, the expected reduction amounts to 13.9 percentage points (from 33.7% to 19.9%). A significant part of this reduction (53% in the rural domain and up to 70% in urban areas) can be related to improvements in observable inputs, especially those related to food intake.

Figure 1
Simulation results for child chronic malnutrition (national average)

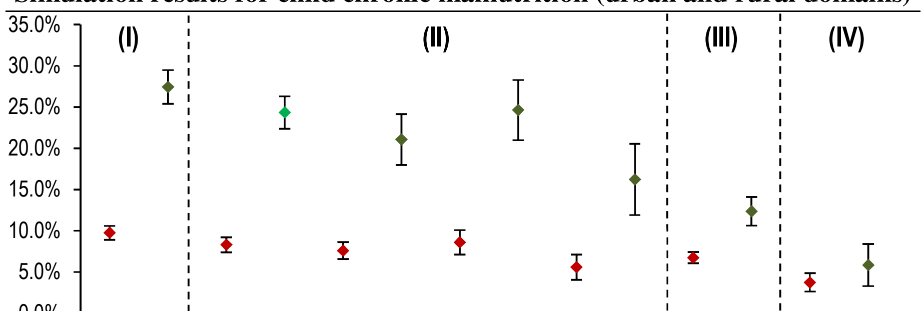


	Baseline 2015	Food intake	Dwelling conditions	Access to health services	All inputs ($\hat{H}'_h$)	All input determinants ($\hat{H}_d$)	All inputs and determinants ($\hat{H}_h$)
	14.7%	**12.7%**	**11.6%**	**13.1%**	**8.9%**	**9.2%**	**5.7%**
		-2.0*** (0.690)	-3.1*** (0.807)	-1.6 (1.081)	-5.7*** (1.033)	-5.5*** (0.294)	-9.0*** (0.749)

$\hat{H}_h - \hat{H}_d$= -3.5*** (1.422); $\hat{H}_h - \hat{H}'_h$= -3.3*** (0.580)

Robust standard error in parentheses, rescaled to match percentage points. *** p < 0.01, ** p < 0.05, * p < 0.10

Figure 2
Simulation results for child chronic malnutrition (urban and rural domains)



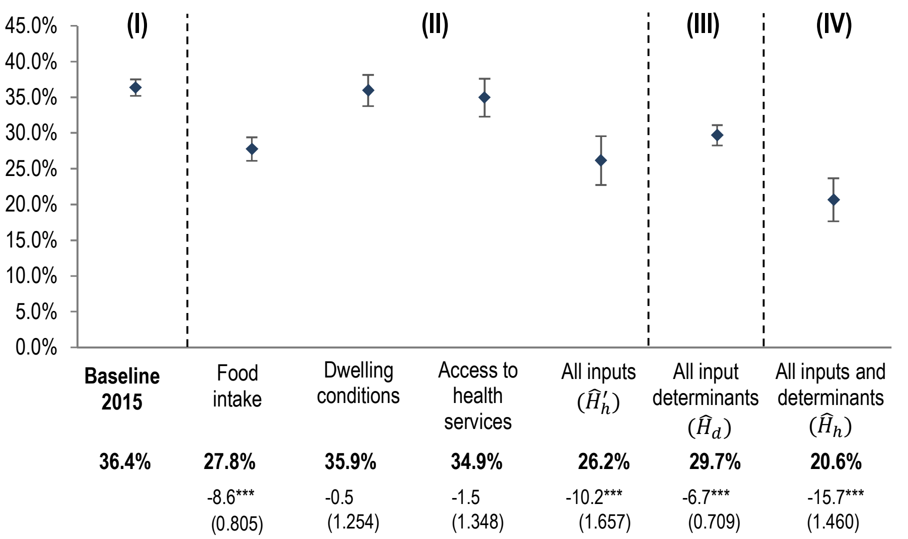
	Baseline 2015	Food intake	Dwelling conditions	Access to health services	All inputs ($\hat{H}'_h$)	All input determinants ($\hat{H}_d$)	All inputs and determinants ($\hat{H}_h$)
◆ Rural	**27.4%**	**24.3%** -3.1*** (1.025)	**21.1%** -6.3*** (1.604)	**24.6%** -2.8 (1.863)	**16.2%** -11.2*** (2.248)	**12.4%** -15.0*** (0.872)	**5.8%** -21.6*** (1.303)
◆ Urban	**9.7%**	**8.3%** -1.4*** (0.462)	**7.6%** -2.1*** (0.517)	**8.6%** -1.1 (0.775)	**5.6%** -4.1*** (0.798)	**6.7%** -3.0*** (0.225)	**3.7%** -6.0*** (0.599)

Rural: $\hat{H}_h - \hat{H}_d$= -6.5*** (1.855); $\hat{H}_h - \hat{H}'_h$= -10.4*** (1.530)

Urban: $\hat{H}_h - \hat{H}_d$= -3.0*** (0.012); $\hat{H}_h - \hat{H}'_h$= -1.9*** (0.364)

Robust standard error in parentheses, rescaled to match percentage points. *** p < 0.01, ** p < 0.05, * p < 0.10

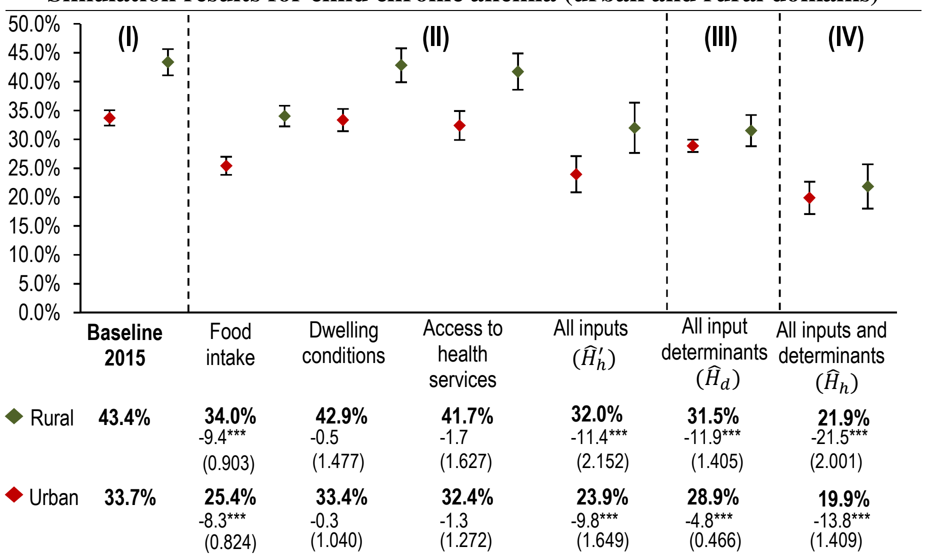
Figure 3
Simulation results for child chronic anemia (national average)



$\widehat{H}_h - \widehat{H}_d$= -9.0*** (2.871); $\widehat{H}_h - \widehat{H}'_h$= -5.5*** (0.728)

Robust standard error in parentheses, rescaled to match percentage points. *** p < 0.01, ** p < 0.05, * p < 0.10

Figure 4
Simulation results for child chronic anemia (urban and rural domains)



Rural: $\widehat{H}_h - \widehat{H}_d$= -9.7*** (3.206); $\widehat{H}_h - \widehat{H}'_h$= -10.2*** (1.265)

Urban: $\widehat{H}_h - \widehat{H}_d$= -9.0*** (2.370); $\widehat{H}_h - \widehat{H}'_h$= -4.1*** (0.528)

Robust standard error in parentheses, rescaled to match percentage points. *** p < 0.01, ** p < 0.05, * p < 0.10

One of the intended contributions of this study is related to its methodology. In particular, we estimate and interpret our scenarios on the basis of the insights of a simple economic model that distinguishes between health inputs (arguments in the production function of health) and health input determinants (arguments in the demand function of inputs). This allowed us to choose between a demand function and a hybrid production function after testing for omitted inputs and verifying if the gain for setting inputs to their own targets is already accounted for by setting input determinants to their targets.

To better illustrate this, in Table 6 we estimate the gain related to setting observable inputs to their own targets if these targets are reduced by 50%. In other words, we no longer set access to adequate food intake, dwelling conditions and health services to 100% but to 50%. As expected, the shift in malnutrition and anemia after setting inputs and input determinants to their targets is smaller than in our main simulation (compare columns 3 and 5 in Table 6). In addition, it is no longer obvious that the hybrid production function should be the preferred specification. Comparison of columns 4 and 6 in Table 6 reveals that the gain for setting observable inputs to their own targets is now considerably smaller and even non-significant in the case of malnutrition. This means that the improvement produced by setting observable inputs to their targets is already accounted for by shifting input determinants. In other words, we have evidence that $I^T = I^{DT}$ and, therefore, results obtained using the demand function or the hybrid production function are statistically equivalent.

Table 6
Simulations when input targets at reduced by 50%

			Input targets = 100%		Input targets = 50%	
	(1)	(2)	(3)	(4)	(5)	(6)
	Baseline (2015) (H_0)	Expected outcome if input dets. reach their targets ($\widehat{H}_d$)	Expected outcome if inputs and input dets. reach their targets ($\widehat{H}_h$)	Gain for setting observable inputs to their own targets ($\widehat{H}_h - \widehat{H}_d$)	Expected outcome if inputs and input dets. reach their targets ($\widehat{H}_{h,50}$)	Gain for setting observable inputs to their own targets ($\widehat{H}_{h,50} - \widehat{H}_d$)
CM	14.7%	9.2% (0.003)	5.7% (0.007)	3.5*** (0.014)	7.8% (0.005)	1.4 (0.009)
Anemia	36.4%	29.7% (0.007)	20.6% (0.015)	9.1*** (0.029)	26.3% (0.009)	3.4* (0.017)

Robust standard error in parentheses.
p < 0.01, ** p < 0.05, * p < 0.10
Columns 4 and 6 show differences with reversed signs.

5. Concluding remarks

We have estimated the improvement in two relevant health outcomes for Peru (child chronic malnutrition and anemia) if their SDG-related determinants reach a set of target values. We used the insights of a simple economic model relating health inputs to families' decisions, to clarify the assumptions required by different empirical specifications to identify this expected improvement. Based on the specification less prone to bias according to this framework, we found that important reductions of 9 and 15.7 percentage points can be achieved in child chronic malnutrition and anemia, respectively, if all their SDG-related determinants reach their targets. Our results also show that the potential for improvement is much more significant in the rural domain, where reductions are around 22 percentage points.

Importantly, our simulations also reveal that the majority (around 65%) of the reductions produced in the national indicators can be related to improvements in observable inputs reflecting children's access to an adequate food intake, adequate dwelling conditions and access to health services. The remaining improvement is related to changes in unobservable influences caused by a shift in input determinants. This result is especially relevant for policy because the inputs considered not only have a direct effect on health outcomes but also show a more direct link to policy action than input determinants. Among these observable inputs, access to adequate dwelling conditions appears to make the most significant contribution.

This analysis complements the studies carried out so far in which the achievement of health-related SDGs has been assessed on the basis of historic trends, as if policy action remained as usual. In particular, this analysis serves to inform the policymaker about the expected gain in terms of health outcomes if she achieves the goals proposed for SDG-related health determinants. Our study has revealed that important improvements can be produced in health outcomes if SDGs are achieved for observable health inputs that can be directly linked to policy. Moreover, it is worth noticing that these SDG-related inputs have been obtained from a nationally representative health and demographic survey so they correspond to indicators that can be readily built and monitored by policymakers.

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Appendix 1

Coefficient estimates for the three specifications (probit model estimations)

VARIABLES	(1) Hybrid - Anemia	(2) Prod. Fn - Anemia	(3) Dem. Fn - Anemia	(4) Hybrid - CM	(5) Prod. Fn - CM	(6) Dem. Fn. - CM
Food intake	-0.3093***	-0.3110***		-0.1208***	-0.1439***	
	(0.032)	(0.031)		(0.041)	(0.039)	
Dwelling conditions	-0.0144	-0.1481***		-0.2141***	-0.5443***	
	(0.040)	(0.037)		(0.057)	(0.051)	
Access to health services	-0.0450	-0.1716***		-0.0918	-0.3009***	
	(0.044)	(0.042)		(0.063)	(0.059)	
Weight at birth	-0.0055	-0.0434	-0.0140	-0.6671***	-0.6946***	-0.6656***
	(0.027)	(0.027)	(0.027)	(0.041)	(0.040)	(0.040)
Sex	0.1324***	0.1376***	0.1393***	0.2330***	0.2285***	0.2366***
	(0.029)	(0.029)	(0.029)	(0.038)	(0.036)	(0.037)
Age	-0.0011	-0.0010	-0.0007	0.0111***	0.0114***	0.0112***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Mother tongue	-0.1309**		-0.1323**	-0.1467**		-0.1508***
	(0.052)		(0.052)	(0.057)		(0.057)
Primary education	0.1828*		0.1613	-0.2117*		-0.2181*
	(0.107)		(0.106)	(0.116)		(0.117)
Secondary education	0.2244**		0.1981*	-0.5424***		-0.5648***
	(0.106)		(0.105)	(0.116)		(0.117)
Higher education	-0.0543		-0.0825	-0.8339***		-0.8746***
	(0.116)		(0.115)	(0.138)		(0.138)
Household wealth	-0.2258***		-0.2355***	-0.2987***		-0.3579***
	(0.039)		(0.037)	(0.052)		(0.050)
Altitude	0.0001***		0.0001***	0.0001***		0.0001***
	(0.000)		(0.000)	(0.000)		(0.000)
Urban area	0.0722*		0.0659*	-0.1027**		-0.1228**
	(0.039)		(0.039)	(0.049)		(0.049)
Constant	-0.3637**	-0.1054	-0.4219***	1.5054***	0.9527***	1.4666***
	(0.144)	(0.092)	(0.142)	(0.185)	(0.134)	(0.182)
Observations	13,370	13,370	13,503	13,228	13,228	13,357
Pseudo R-squared	0.0355	0.0161	0.0266	0.161	0.109	0.158
Log likelihood	-4039	-4120	-4127	-2114	-2246	-2139

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1