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Economic mobility along the business cycle. The case of Peru

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Abstract

The performance of Latin American countries in reducing poverty and expanding the middle class has been remarkable. By taking a close look at the Peruvian experience, we explore how this aggregate behavior relates to business cycle conditions and if it is shared by population groups with different characteristics. We find social mobility to be cyclical, with recessions followed by a rise in downward mobility and strong economic growth driving boosts in upward mobility. Furthermore, the reduction in poverty appears to be the result of a sustained increase in the poverty exit rate, shared similarly among heterogenous groups, together with a prolonged decrease in the poverty entry rate, especially for households regarded as initially disadvantaged.

JEL Classification : C23, C53, I32, O15, O54
Keywords : Poverty dynamics, pro-poor growth, pseudopanel data, Latin America.

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1 Introduction

Since the turn of the millennium, the performance of Latin American countries in reducing poverty and boosting the expansion of a middle class has been remarkable. Cord et al. (2015) and Stampini et al. (2016) show that not only the share of the population living on less than US$ 4 a day dropped from more than 45 percent in 2000 to less than 30 percent in 2013, but this trend has also been accompanied by a significant reduction in income inequality (see also Ferreira et al., 2013). Such positive results have also fed the academic debate; in particular, the observation that the high economic growth rates sustained in the region were the main driver of poverty reduction provides categorical evidence about the pro-poor nature of economic growth. Furthermore, the conventional wisdom that economic growth alone is not sufficient is also reinforced, as important gaps among different subgroups persist (see, *inter alia*, Vakis et al., 2016; Morley, 2017)

In this paper, we take a closer look at the Peruvian experience of economic mobility in the 20-year period between 1997 and 2016. In comparative studies, such as Ferreira et al. (2013) or Cord et al. (2015), the Peruvian case is regarded as one of the most successful in the region and even worldwide. According to our computations, the poverty rate decreased from a historical high of 55 percent in 2005, to a record minimum of 19 percent in 2016, more than 3 percentage points a year, whereas extreme poverty dropped from more than 23 percent in 2002 to 3 percent in 2016. Despite this, the Peruvian economy shares several similarities with other Latin American and, more generally, developing countries; thus, we reckon that our study can help drawing important lessons for the design of social policies in developing countries.

Our analysis makes three contributions to the literature on economic mobility. Firstly, we implement the methodology advanced in Dang and Lanjouw (2013) and Dang et al. (2014) to study poverty transitions in the absence of panel data, i.e., by using the information of repeated surveys with different, but similar, households. The technique has been used in, among many others, Ferreira et al. (2013), Cruces et al. (2015) and Stampini et al. (2016), with a focus on the joint probability of, say, being poor in two different periods. Our interest is not on this joint probability but on the derived conditional probability of being poor given a previous poverty state, which connects more naturally to the large and well developed literature on economic mobility (e.g., Jarvis and Jenkins, 1998; Fields, 2010; Jantti and Jenkins, 2015).

Secondly, most of the previous studies on the Peruvian case, such as Genoni and Salazar (2015), Cruces et al. (2015) and Morley (2017), center on the episode of economic expansion and poverty reduction that began in the mid 2000s. Our sample begins in the late 1990s and includes a complete macroeconomic cycle, featuring an initial economic downturn, a short period of stagnation and then the aforementioned economic expansion, see Figure 1(a).[1] By considering an expanded window we are able to better grasp how economic mobility respond to cyclical macroeconomic conditions. Figure 1(b) shows that the poverty rate was initially 43 percent in 1998, increased to more than 50 percent by 2005 and then began to drop sustainedly. In contrast, the share of population whose per capita expenditure is greater than thrice the poverty line (i.e., the upper class) was 9 percent in 1998, dropped to 5 percent in 2005 and then increased gradually to 16 percent in 2016. Thus, we find that poverty and mobility are also cyclical and, moreover, identify a turning point in 2004, which cannot be unveiled in previous studies.

Finally, previous studies such as Dang and Lanjouw (2013), Dang et al. (2014), Genoni and Salazar (2015) and Stampini et al. (2016) highlight the differences in transitions rates among population groups with different characteristics (geographical location, urban versus rural, educated versus uneducated household head, among others). The analysis enables us to better characterize the nature of such differences. In particular, we find the cyclical behavior of mobility indicators to be pervasive, as they appear to have the same evolution for different population groups. Furthermore, the observed reduction in poverty is the confluence of a sustained increase of the poverty exit rate (the probability of a poor household to escape poverty) and a prolonged

[1] In 1998 the Peruvian economy was struck by two important shocks, namely the Russian financial crisis and a strong El Niño weather phenomenon, that led the economy into a long recession. The recovery was interrupted by political instability in the years 2000 and 2001. Later, by the mid 2000s and after deepening important reforms to promote stability and growth, the country benefited from extraordinarily favorable external conditions (high term of terms and low interest rates), briefly interrupted by the global financial crisis in 2008/2009. See Rossini and Santos (2015) for a comprehensive narrative of the Peruvian experience.

decrease in the entry rate (the probability of a non-poor household to become poor). The differences in the exit rate among various population groups are essentially constant throughout the sample period, which suggests that such differences are related to structural factors insensitive to the state of the economy. In contrast, the decrease in the entry rate is significantly higher for more disadvantaged groups (e.g., rural households, households with uneducated heads, among others), so the associated gaps were partially bridged during the booming period.

The rest of the paper is organized as follows. Section 2 presents the econometric framework for measuring economic mobility with repeated cross-sections (i.e., pseudopanel data). Section 3 describes the data used in our empirical work and presents the main results of our investigation. In particular, we explore the cyclical behavior of various measures of economic mobility, and disentangle the poverty rate into entry and exit rates for various population groups. Section 4 concludes and gives some avenues for future research.

2 Methodological discussion

In most developing countries, there is a lack of panel data where the same households are followed over time. Even when genuine panel data are available, the samples may suffer from serious non-random attrition problems or lack of representativeness, especially when studying persistent phenomena whose effects may take several periods to manifest. Nonetheless, as pointed out by Deaton (1985), representative independent cross-sections are often available, and the use of pseudopanel data methods, which focus on the comparison over time of different households but with the same observable characteristics rather than on the evolution of a given household, is called for. Importantly, several models that seemingly require the availability of panel data can also be identified with repeated surveys under appropriate conditions. Antman and McKenzie (2007) and, more recently, Pencavel (2006) explore the applicability of these methods for the case of economic mobility.

Dang and Lanjouw (2013) and Dang et al. (2014) develop a methodology that we adopt to study the population transitions from one income group to another in the absence of panel data. In the tradition of the pseudopanel literature, this is a projection method that implicitly groups households according to their observable, time-invariant or predictable characteristics. Not only is the technique elegant and relatively easy to replicate, but also allows us to make inferences about the economic mobility of specific subgroups, an extraordinarily demanding task with panel data. Furthermore, the methodology has been successfully put to a test in, *inter alia*, Ferreira et al. (2013) and Cruces et al. (2015), which show that the qualitative, and most of the quantitative, conclusions reached with a genuine panel data analysis (when applicable), can be obtained with the pseudopanel.

2.1 Poverty dynamics from pseudopanel data

Consider two household surveys from different periods, where $t = 0$ denotes an initial period and $t = 1$ denotes a final period. Even though the surveys are drawn anew each time so individual households cannot be traced over time, they contain enough information of "similar" households. Since the households are different from one period to the other, to avoid cluttering the notation we do not introduce a household subscript. Following Dang et al. (2014), we first discuss the case where the population is divided into two income classes, poor and non-poor, and describe the method to study the transitions between these groups. We allow for more income classes later.

Let y_t be the logarithm of the per capita income (or expenditure) of a typical household in period (survey) t, and define $\boldsymbol{x}_t$ as a vector that contains observable characteristics from that household. Consider the linear projection of y_t on $\boldsymbol{x}_t$:

$$y_t = \boldsymbol{x}_t{}'\boldsymbol{\beta}_t + e_t \, , \tag{1}$$

where, by construction, the error term e_t is uncorrelated with $\boldsymbol{x}_t$. In general, $\boldsymbol{x}_t$ contains fixed effects or variables that can be retrospectively determined with accuracy, so the dependance of t is due to sampling error. Yet, the fact that we allow the linear projection coefficients $\boldsymbol{\beta}_t$ to be time-varying turns out to be the main source of time-variation in this framework.

It is worth emphasizing that equation (1) is simply a predictive device. We do not attempt to interpret it as a behavioral or structural equation aimed to identify causal links from $\boldsymbol{x}_t$ to y_t. Thus, the least squares estimator of the reduced-form coefficients $\boldsymbol{\beta}_t$ and of the standard deviation of the error term σ_t are consistent and the textbook framework for inference based on these estimators is completely valid. All these quantities can be estimated exclusively using "marginal" information from survey t.

Let z_t be the relevant observable income threshold (e.g., the logarithm of the poverty line) such that the household is poor in period t if $y_t < z_t$ and non-poor if $y_t > z_t$. The purpose is to infer about joint events such as $\{y_0 < z_0, y_1 < z_1\}$ when y_0 and y_1 cannot be observed simultaneously. To this end, we use the following assumptions:

(i) Both surveys represent the same population.

(ii) The vector of household characteristics in period 0, $\boldsymbol{x}_0$, is either observable or can be backcasted with arbitrary accuracy.

(iii) Given $\boldsymbol{x}_0$ and $\boldsymbol{x}_1$, (e_0, e_1) have a bivariate normal distribution with non-negative correlation coefficient ρ and standard deviations, respectively, σ_0 and σ_1.

The first two assumptions are required for identification. Even though these are not necessarily testable, several decisions on the samples used and the very specification of the regression model (1) are made to render their validity uncontroversial. On the other hand, assumption (iii), which is testable, is made mainly for algebraic convenience. Besides this parametric approach, Dang et al. (2014) also develop a non-parametric framework where the normality assumption can be dropped, at the cost of wider bounds for the transition probabilities of interest. In our application, however, this assumption did not appear to be restrictive while providing important gains in terms of the precision of the estimates.

From equation (1), the joint probability that a poor household in period 0 remains poor in period 1 equals:

$$\Pr\left(y_0 < z_0, y_1 < z_1\right) = \Pr\left(e_0 < z_0 - \boldsymbol{x}_0{}'\boldsymbol{\beta}_0, e_1 < z_1 - \boldsymbol{x}_1{}'\boldsymbol{\beta}_1\right) \ . \tag{2}$$

Since $\boldsymbol{x}_0$ is available under assumption (ii), the unobservable y_0 can be predicted by:

$$y_{0|1} = \boldsymbol{x}_0\boldsymbol{\beta}_0 + e_{0|1} \ . \tag{3}$$

An implication of assumption (i) is that $e_{0|1}$ comes from the same distribution as e_0 and e_1, and therefore y_0 can be replaced by $y_{0|1}$ in the definition of the joint probability in (2).

Finally, the interest is on conditional probabilities which can be determined from joint and marginal probabilities. Under the normality assumption (iii):

$$\Pr\left(y_1 < z_1 \,|\, y_0 < z_0\right) = \frac{\Pr\left(y_0 < z_0, y_1 < z_1\right)}{\Pr\left(y_0 < z_0\right)} = \frac{\Phi_2\left(\dfrac{z_0 - \boldsymbol{x}_0{}'\boldsymbol{\beta}_0}{\sigma_0}, \dfrac{z_1 - \boldsymbol{x}_1{}'\boldsymbol{\beta}_1}{\sigma_1}; \rho\right)}{\Phi\left(\dfrac{z_0 - \boldsymbol{x}_0{}'\boldsymbol{\beta}_0}{\sigma_0}\right)} \ , \tag{4}$$

where $\Phi_2(\cdot,\cdot;\rho)$ stands for the standard bivariate normal cumulative distribution function with correlation ρ and $\Phi(\cdot)$ denotes the standard normal cumulative distribution function. The evaluation of the denominator of (4), which is a marginal event, does not require knowledge about the correlation ρ, but that of the numerator, being a joint event, does. Dang and Lanjouw (2013) provide a detailed discussion on the estimation of ρ with pseudopanel data. Alternatively, Dang et al. (2014) show that the bivariate normal probabilities are monotonic functions of ρ, so bounds of these probabilities can be obtained by evaluating (4) at two different values of $\rho_L < \rho_U$, which is specially useful when there is a strong belief that the true value of ρ is such that $\rho \in (\rho_L, \rho_U)$. The belief may be obtained from previous studies or from ancilliary estimations using limited genuine panel data.

Equation (4) provides the basis for the estimation of the conditional probability of interest. The expression is to be evaluated for each household in period 1, using the consistent estimators of $\boldsymbol{\beta}_0$, σ_0, $\boldsymbol{\beta}_1$ and σ_1, and a calibration of ρ, and then averaged across all households. Dang and Lanjouw (2013) show that such an estimator is consistent and asymptotically normal. Furthermore, by simply averaging over household with specific characteristics (say, rural households or households whose head in uneducated) it is possible to obtain consistent estimators for group-specific conditional probabilities, under asymptotic sequences where the number of observations in the group tends to infinity (which, in turn, can be understood as a sequence where the number of groups is fixed and the total number of observations increase).

Needless to say, upon minor redefinitions, this framework applies to determine any conditional probability of interest, such as the poverty "exit rate", i.e., the probability of escaping poverty $\Pr(y_1 > z_1 \mid y_0 < z_0)$, or the poverty "entry rate", i.e., the probability of becoming poor $\Pr(y_1 < z_1 \mid y_0 > z_0)$. We describe such redefinitions next.

2.2 More income groups

As in Dang and Lanjouw (2013), the above framework can be extended to separate the population into an arbitrary number of n income classes, and to compute the corresponding n^2 transition probabilities. Consider $n-1$ thresholds $\{z_{1t}, z_{2t}, \ldots, z_{(n-1)t}\}$, sorted increasingly, and the conventions that $z_{0t} \to -\infty$ and $z_{nt} \to \infty$ for all t, such that a household belongs to income class i in period t if $z_{(i-1)t} < y_t < z_{it}$.

Analogously to (2), define:

$$F(i,j) = \Pr(y_0 < z_{i0}, y_1 < z_{j1}) = \Phi_2\left(\frac{z_{i0} - \boldsymbol{x}_0{}'\boldsymbol{\beta}_0}{\sigma_0}, \frac{z_{j1} - \boldsymbol{x}_1{}'\boldsymbol{\beta}_1}{\sigma_1}; \rho\right), \tag{5}$$

for all $(i,j) = 1, 2, \ldots, n-1$. Note that since $z_{0t} \to -\infty$, then $F(i,0) = F(0,i) = 0$ for all $i = 1, 2, \ldots, n$. In addition, since $z_{nt} \to \infty$:

$$F(i,n) = \Pr(y_0 < z_{i0}) = \Phi\left(\frac{z_{i0} - \boldsymbol{x}_0{}'\boldsymbol{\beta}_0}{\sigma_0}\right), \qquad F(n,i) = \Pr(y_1 < z_{i1}) = \Phi\left(\frac{z_{i1} - \boldsymbol{x}_1{}'\boldsymbol{\beta}_1}{\sigma_1}\right), \tag{6}$$

are marginal probabilities for all $i = 1, 2, \ldots, n-1$. Finally, $F(n,n) = 1$.

With these definitions, it is simple to verify that the joint probability that a household belongs to income class i in period 0, and to income class j in period 1 is equal to:

$$\begin{aligned} P(i,j) &= \Pr(z_{(j-1)0} < y_0 < z_{j0}, z_{(i-1)1} < y_1 < z_{i1}) \\ &= F(i,j) - F(i,j-1) - [F(i-1,j) - F(i-1,j-1)], \end{aligned} \tag{7}$$

so the corresponding conditional probability that a household belongs to income class j in period 1 given that it belonged to income class i in period 0 is, analogously to (4):

$$p_{ij} = \frac{P(i,j)}{F(i,n) - F(i-1,n)}. \tag{8}$$

2.3 Measuring mobility

For a large number of households, p_{ij} can be read as the proportion of households in income class i who moves to income class j. The conditional probabilities p_{ii} represent stayers, whereas the terms p_{ij} for $i \neq j$ represent movers. When the population is divided into n income class, an established measure of social mobility is the so-called "average jump" index (see Jantti and Jenkins, 2015, for a comprehensive survey):

$$B = \frac{1}{n} \sum_{i=1}^{n} \sum_{j=1}^{n} |i - j| p_{ij} \, , \tag{9}$$

which equals the expected number of income class boundaries crossed by a household. Clearly, B is a weighted average of all transition probabilities which are multiplied by the distance between the two classes. Thus, it weights transitions by the number of classes the individual traverses in the income movement. In the complete immobility case (where $p_{ii} = 1$ for all i and $p_{ij} = 0$ for all $i \neq j$) it takes the value zero and the higher its value, the higher the level of mobility.

A drawback of this index is that it does not distinguish between upward and downward mobility. However, it can be decomposed into two pieces $B = B_U + B_D$ such that:

$$B_U = \frac{1}{n} \sum_{i=1}^{n} \sum_{j>i}^{n} |i - j| p_{ij} \qquad \text{and} \qquad B_D = \frac{1}{n} \sum_{i=1}^{n} \sum_{j<i}^{n} |i - j| p_{ij} \, , \tag{10}$$

where B_U is a weighted average of moves to higher income classes ($i < j$), whereas B_D is a weighted average of moves to lower income classes ($i > j$). Finally, in a two-class setup, $B_U = p_{12}$ is the poverty exit rate, whereas $B_D = p_{21}$ is the poverty entry rate.

3 Empirical analysis

This section presents the main results of the paper. We first describe the data used in our empirical work. Then, we present estimation results of a number of expenditure equations. The equations have a very good fit and their residual diagnostics are quite satisfactory. Then, we compute and describe the transition probabilities and mobility measures behind the widespread reduction in poverty. Social mobility has followed a cyclical pattern, lead by the macroeconomy, such that since 2004 the poverty exit rate has increased and the entry rate has decreased sustainedly. Finally, we discuss the similarities and differences of this aggregate behaviour with population groups featuring different observable characteristics.

3.1 Data

We use the publicly available household surveys ENAHO, from 1997 to 2016, developed by the Peruvian Statistics Bureau (INEI, for its name in Spanish). Various waves of this survey have been used in other explorations such as Dang and Lanjouw (2013), Ferreira et al. (2013), Dang et al. (2014), Cruces et al. (2015), Stampini et al. (2016) and Morley (2017), which enhances the comparability of our results to those of the previous literature.

The ENAHO is a nationally representative survey aimed to measure the poverty rate and general living conditions. It contains detailed information on education, employment, income and expenditure, housing and perceptions, all subdivided by departments (25 administrative divisions) and geographical regions. The scope and complexity of the survey has evolved through time, with the number of interviewed households steadily increasing, from about 5,000 in the earliest periods to more than 30,000 in the latest rounds. Also, the survey features information about the household head's parents since 2001, and various proxies of ethnicity since 2004. Finally, the ENAHO includes the official poverty and extreme poverty lines by geographic area, updated using consumer inflation at the department level, together with the summary measure of per capita expenditure that is used to determine the poverty rates. The dependent variable in the expenditure equations (1) is the logarithm of this summary measure.

The ENAHO has experienced a number of methodological changes throughout the years; the most important being that before 2004 the survey was carried out quarterly, with the fourth quarter module dedicated to household spending and poverty, whereas since 2004 the ENAHO is carried out continuously over the year.

Despite this and minor refinements in the measurement of some expenditures and imputations, the general methods to compute poverty and classify the population into income groups have changed little.

Finally, ENAHO also contains some genuine panel data. However, the households in the panel are irregularly sampled (for instance, no panel information is provided for various years, the latest being 2007), it is heavily unbalanced, the attrition and rotation rates are high, it is not always representative even at a national level, among other design problems. See Herrera and Cozzubo (2016) for a detailed description. Given these limitations, we decide to use the panel information in a very limited fashion, and based our main inferences on the full repeated surveys instead.

3.2 Expenditure equations

The soundness of our methods depends on the validity of the assumptions listed in section 2.1 for our data. Thus, the empirical exploration follows a series of decisions regarding sample and variable selection such that these assumptions are satisfied. First, assumption (i) requires the underlying populations of the initial and final surveys to be the same. In a context of volatile economic growth and social mobility, we follow Stampini et al. (2016) and describe the dynamics over the 20-year period as the collection of 19 transitions between consecutive years since, in the absence of sudden migration waves, the population in, say, 2003 is essentially the same as in 2004.

Moreover, as in previous studies like Ferreira et al. (2013) and Cruces et al. (2015), we find it convenient to restrict the samples to avoid life cycle effects which can invalidate the population invariance assumption. In particular, the expenditure equation (1) is estimated for households whose head is between 25 and 65 years of age in the initial period ($t = 0$), and consequently for households whose head is between 26 and 66 years old in the final period ($t = 1$). For this reason, the results are based on the output of 38 estimated equations: for each year between and including 1998 and 2015, the equation is estimated twice, first treating a given year as the initial period (say, 2004 in the 2004/2005 transition) and then treating the same year as the final period (2004 in the 2003/2004 transition). This amounts to 36 equations that are complemented with a regression for 1997 as the initial period of the 1997/1998 transition, and a regression for 2016 as the final period of the 2015/2016 transition.

On the other hand, the selection of variables onto which the logarithm of per capita household expenditure is projected (about 50) is mainly dictated by assumption (ii), i.e., variables that can be backcasted with accuracy, and a minimum requirement of statistical significance (see Annex 1). Vector $\boldsymbol{x}_t$ contains geographical controls (rural and regional effects), time-invariant attributes of the household head (sex, the main language learned as a child and the education level of their parents), and functions of their age which evolve deterministically. Also, since we access the date of birth and retrospective data of all household members, several explanatory variables relate to the household composition (the number of children, members of working age and the elders, all of them differentiated by sex), dependency ratios and the average household age. Finally, we also include a number of regressors that although may be time-varying, are persistent and quite unlikely to change from one year to the other. These include the head's education level and its main occupation (measured in broad categories such as a white or blue collar workers), access to basic services and measures of housing quality. The latter variables are indicators of whether the house is built with rudimentary materials. This is so because if, say, the walls are rudimentary now it is very likely that they were also rudimentary the previous year, which is not necessarily the case with improved materials as housing standards are expected to improve with income.[2]

The estimated expenditure equations are shown in Annex Table 1. A remarkable result is the high fit obtained for these equations, with the adjusted R^2 ranging between 0.6 and 0.7 (see also panel (a) of Figure 2). This follows from the fact that the regressors, which are somehow standard income covariates, are known to be

[2] Cruces et al. (2015) also use data on the ownership of various assets available in ENAHO, which also contain some retrospective information. In a preliminary examination, we found the accuracy of the backcasts of these regressors to be much lower than what is obtained for the variables included in our regressions (e.g., household composition). Yet, we believe this is an interesting extension for future work.

closely related to poverty profiling and mapping (see, *inter alia*, Bane and Ellwood, 1986; Chaudhuri and Ravallion, 1994; Genoni and Salazar, 2015; Morley, 2017). The fit is admittedly higher to what is reported in previous studying using Peruvian data (see, *inter alia*, Dang and Lanjouw, 2013; Ferreira et al., 2013; Dang et al., 2014; Cruces et al., 2015), which may be driven by the inclusion of a large quantity of additional highly significant regressors.

At this stage some inferences about the value of ρ, the correlation between the error terms of two consecutive expenditure equations, can be pursued. For each year, we compute estimates of ρ from the predicted residuals of the expenditure equations, after identifying the households that belong to ENAHO's panel. Figure 2(a) shows the point estimates along with their 95% confidence intervals. Even though we notice some time variation in the estimates of ρ, they are mostly stable, ranging within a narrow interval bounded by $\rho_L = 0.4$ and $\rho_U = 0.6$.[3] In the results to follow we compute bounds based on these values of ρ, and set $\rho = 0.55$ to compute point estimates.

Finally, we explore the suitability of assumption (iii), the normality of the error terms in the expenditure equations. It has been widely documented that the per capita income or expenditure distributions tend to behave like log-normals in the middle of the distribution, but feature much heavier tails (see, for instance, Lubrano and Ndoye, 2016; Ibragimov and Ibragimov, 2017). Hence, if the regressors in (1) contain variables that can explain part of the tail behavior in y_t, it may be the case that e_t is normally distributed even if y_t is not. This seems to be the case in our application, as the regressors include several indicators that separate the poorest (for instance, the usage of rudimentary materials in the house) or the richest (notably, the education level and the parent's education) households from those in the middle of the distribution.

Figure 2(b) shows the box plots of the standardized residuals e_t/σ_t over the entire sample period. As usual, the limits of the boxes are the first (Q_1) and third (Q_3) quartiles, whereas the whiskers are given by the lowest datum that is higher than $Q_1 - 1.5(Q_3 - Q_1)$, and the highest datum that is lower than $Q_3 + 1.5(Q_3 - Q_1)$. For normally distributed data, the box limits are ± 0.6745 and the whiskers are ± 2.698; these theoretical values are also displayed in 2(b), and correspond quite closely to the empirical distributions of the standardized residuals. In the normal case, the probability mass within the whiskers amounts to more than 0.997, and a similar figure can be obtained for the standardized residuals. All in all, there is a rather strong indication of error normality in our results. Even if the normality assumption was wrong, the non-normal behavior would be explained by outliers that occur with an extremely low probability, making assumption (iii) not overly restrictive for the purpose of computing transition probabilities of non-extreme households.

3.3 Results on economic mobility

The output of our analysis is abundant, all of it available upon request, and to save space we report two sets of results. The first contains point estimates of the transition probabilities of the whole population among five income classes, along with the derived mobility measures. The second shows point estimates of transition probabilities, as well as their bounds, in a two-class setup for various groups sharing similar characteristics.

Figure 3 shows results in a setup that divides households into five per capita expenditure categories, as in Stampini et al. (2016). If z_t denotes the poverty line and z_{1t} denotes the extreme poverty line (as computed by the INEI), then the per capita expenditure thresholds are $\{z_{1t}, z_{2t} = z_t, z_{3t} = 2z_t, z_{4t} = 3z_t\}$, the corresponding categories being: (A) extreme poverty, $y_t \leq z_{1t}$; (B) poverty, $z_{1t} < y_t \leq z_t$; (C) non-poor at risk, $z_t < y_t \leq 2z_t$; (D) middle class, $2z_t < y_t \leq 3z_t$; and (E) upper class, $y_t > 3z_t$. It is worth mentioning that although the thresholds are set arbitrarily, they are conveniently linked to the time-varying and region-specific poverty lines.

Figure 3(a) shows the mobility measures for households that move downwards and upwards from their initial

[3] These values tend to be slightly smaller than those reported in the literature: about 0.6 in Dang and Lanjouw (2013), 0.58 in Dang et al. (2014) and 0.57 in Cruces et al. (2015). The reason is that the error terms can be rationalized as $e_t = \alpha + v_t$, where α captures the neglected time-invariant heterogeneity and v_t is an independent noise; then, given the higher fit of our equations, the contribution of α (which is the source of correlation between e_0 and e_1) is likely to be less important in our results.

class, i.e., respectively B_D and B_U, and unveils a cyclical pattern in mobility with a clear turning point in 2004. From 1998 to 2004, following the initial recession and stagnation, downward mobility increased steadily as upward mobility declined, a trend that reversed markedly from 2005 onward as economic growth consolidated. The year 2002 can be regarded as a turning point in trend growth as well as other growth-related indicators at the macroeconomic level, such as the capital formation to GDP ratio, see Figure 1(a). Thus, the evidence suggests a two-year lead from the macroeconomic context to economic mobility.

Since 2007, the upward mobility of an average household has been more likely that downward mobility. It is interesting to note that the global financial crisis, whose effects manifested mostly in 2009, did not have a noticeable effect on mobility. This seems to be the case because the crisis had a short-lived negative effect on the Peruvian economy, and effects that pass-through to mobility are more likely to be persistent. The post-crisis trend growth is decreasing albeit still high, whereas the capital formation to GDP ratio produces another turning point (a peak) in 2013. The prevalence of these trends suggests that social mobility would tend to stabilize and possibly form another turning point shortly after the last period of our sample.

Figure 3(b) takes a closer look at households' mobility dynamics. It presents the probabilities of a household belonging to a particular category in a selected year given its initial category in the previous year. The results coincide with the trends of Figure 3(a), and in particular it can be observed that the probability of a household belonging to a higher class in the next year substantially increases from 2010 to 2015, regardless of the initial category.

On the other hand, Figure 4 shows related results for a two-class setup and for different groups. In particular, it shows the evolution of the bounds of the poverty exit and entry rates. At first glance, the 2004 turning point is confirmed in all cases: the poverty exit rate tends to be decreasing up to 2004 and then it turns increasing, whereas the entry rate displays the opposite behavior. What is remarkable is that this pattern is pervasive across several households characteristics such as location, the education level of the head, the language that the head learned as a child and the head's occupation. Other characteristics displayed similar dynamics, as they are somehow related with these attributes. For instance, the education of the head's parents (either the father or the mother) correlate strongly with the education of the head herself, and thus their transition probabilities resemble those shown in Figures 4(e) and 4(f).

Another interesting finding is that the disparities in the poverty exit rates among households with different characteristics remain relatively stable through time, especially during the expansionary phase. For instance, the difference between the poverty exit rate between urban and rural households, Figure 4(a), is 0.29 (0.40 vs 0.11) in 2004 and 0.32 (0.76 vs 0.43) in 2016. Also, in 2004 the probability of escaping poverty for a household whose head has tertiary education is 0.45 higher than for a household whose head is uneducated (0.59 vs 0.13), Figure 4(e); in 2016, the difference is 0.41 (0.87 vs 0.46). Likewise, the gaps in the poverty exit rate among households with heads of different occupations are, to a large extent, constant: the difference between a household whose head has a white-collar occupation and one whose head is occupied in primary rural activities (i.e., farmers or fishermen) passes from 0.50 (0.60 vs 0.10) in 2004 to 0.47 (0.90 vs 0.43) in 2016, Figure 4(g). In sum, the probability of exiting poverty has increased for every group by roughly the same magnitude.

In contrast, all households experienced a decrease in the conditional probability of falling into poverty since the turning point in 2004, but the reduction seems higher for initially disadvantaged households; hence, the difference in the poverty entry rates lessens. For instance, the difference between the poverty entry rate between rural and urban households, Figure 4(b), reduces from 0.38 (0.65 vs 0.27) in 2004 to 0.19 (0.24 vs 0.05) in 2016. In addition, the difference in the probability of becoming poor between a household whose head has no education and one whose head has tertiary education is 0.49 (0.61 vs 0.12) in 2004, and reduces to 0.21 (0.23 vs 0.02) by 2016, Figure 4(f). The same is true for the gap between a household headed by a farmer and one headed by a white-collar worker, which passes from 0.55 (0.67 vs 0.12) in 2004 to 0.24 (0.25 vs 0.01) in 2016, Figure 4(h). The convergence is quite notorious: in 2004, 7 out of 10 non-poor farmers and 1 out of 10 white-collar workers were expected to fall into poverty the following year; in 2016, while virtually no non-poor white-collar worker would fall into poverty, only 2 out of 10 farmers were expected to become poor. The long-run convergence to a state of low probability of falling into poverty suggests a sustained and widespread reduction in household vulnerability.

All in all, the significant poverty rate decline from 2004 onwards is driven by two complementary dynamics: a sustained increase in the probability of escaping poverty, which is homogenous among households with different characteristics, along with a reduction in the probability of falling into poverty, which is especially conspicuous among initially disadvantaged households.

4 Concluding remarks

We have taken a close look at the Peruvian experience of economic mobility, regarded as one of the most successful case among developing countries, during the 20-year period between 1997 and 2016. Our exploration unveils a cyclical pattern in economic mobility, led by the business cycle in approximately two years: following a recession at the turn of the century, downward mobility increased as upward mobility declined; then, trend growth began accelerating in 2002, followed by a clear turning point in households' economic mobility in 2004. From that year onwards, upward mobility shows a consistent positive trend.

Similarly, the poverty exit rate tends to decrease up to 2004 and then starts increasing, whereas the entry rate to poverty displays the opposite behavior. Remarkably, the pattern is widespread across households with different characteristics such as location, education level of the household head and the head's occupation. Interestingly, the differences in the poverty exit rates among households with different characteristics remain stable, suggesting that the probability of escaping poverty have increased for every group by roughly the same amount, whereas the decline in the entry rate is more pronounced for initially disadvantaged households. In sum, the significant poverty rate decline from 2004 to 2016 is due to an increase in the probability of escaping poverty, together with a marked reduction in the probability of disadvantaged households falling into poverty.

Even though these results are specific to the Peruvian case, they are likely to share similarities with other emerging economies, just as recent macroeconomic experiences do. We reckon that an interesting avenue for future research is to replicate our empirical approach to other developing countries. Also, as our analysis is mostly descriptive, there is still much room to explore the role that targeted social policies, such as conditional cash transfer programs, may have had in both the increase of the poverty exit rate and the decrease in the entry rate. This can be of use for the design of policies oriented to reduce vulnerability and strength the safety nets available to the newly non-poor, a fascinating topic that is part of our research agenda.

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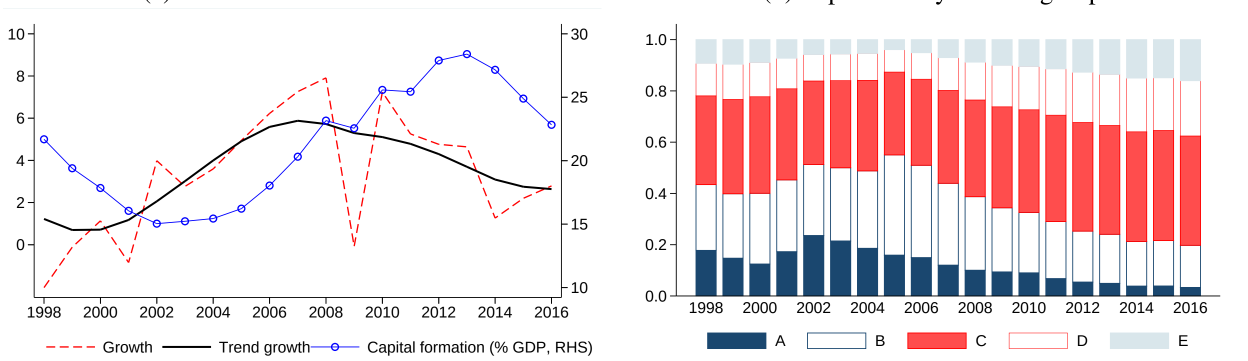
Figure 1. *Economic growth and poverty*

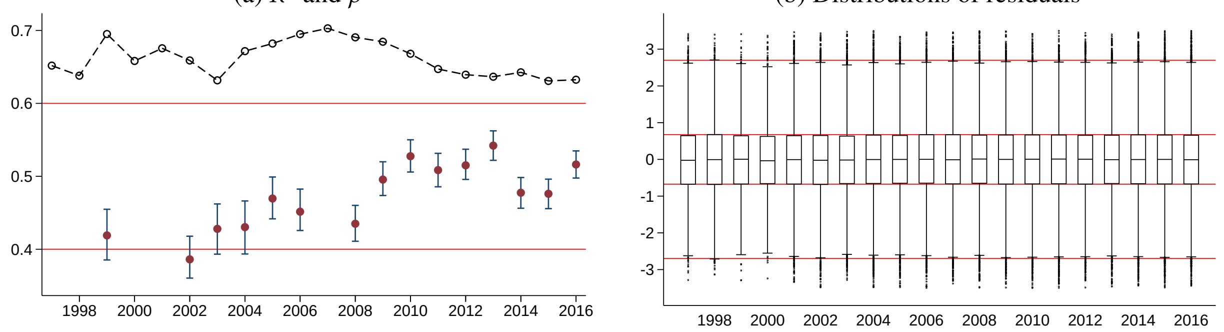
(a) Macroeconomic indicators (b) Population by income group



Sources: Central Reserve Bank of Peru and ENAHO, 1997 to 2016. Own elaboration.
Notes: In panel (a), the dashed line is the growth rate of real GDP per capita; the solid line, the growth rate of its Hodrick-Prescott trend (with a smoothing constant of 6.25, suitable for annual data); the connected line is the ratio of gross fixed investment to GDP. If z denotes the poverty line, panel (b) shows the marginal probabilities (see section 2.2) that the per capita expenditure is (A) less than the extreme poverty line; (B) between the extreme poverty line and z; (C) between z and $2z$; (D) between $2z$ and $3z$; and (D) greater than $3z$.

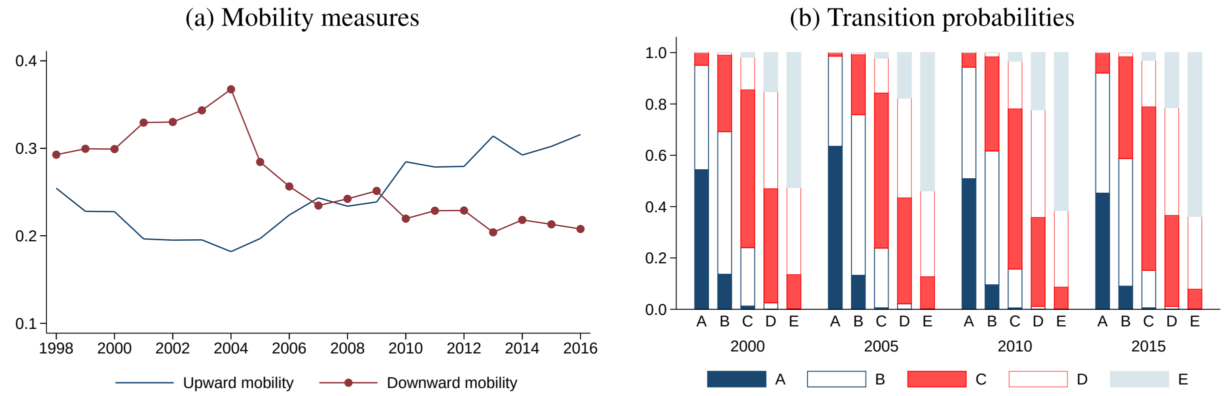
Figure 2. *Regression results*

(a) R^2 and ρ (b) Distributions of residuals



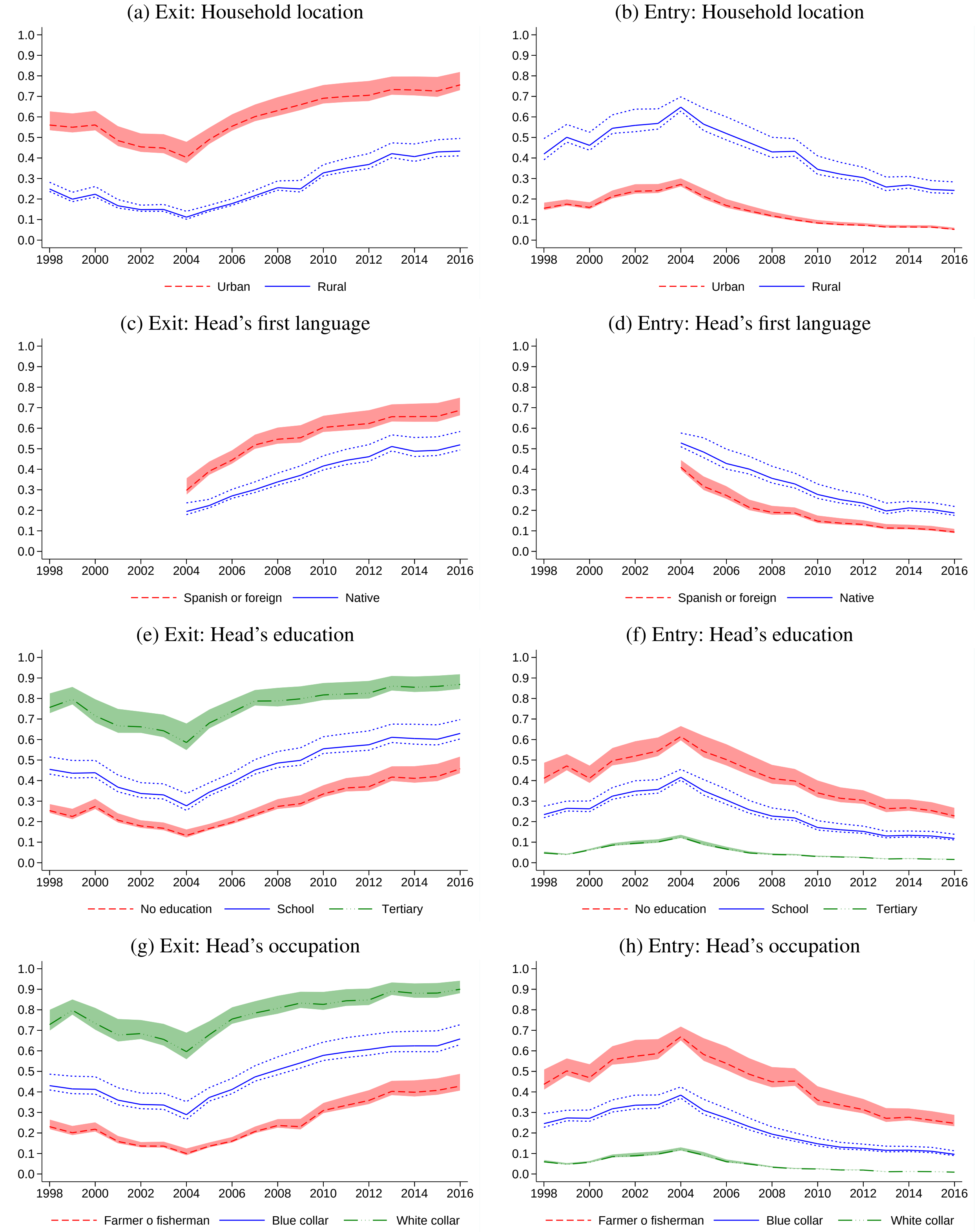
Source: ENAHO, 1997 to 2016. Own elaboration.
Notes: In panel (a), the dashed line connecting hollow circles is the adjusted R^2 of the expenditure equations in Annex 1; the filled circles are the point estimates of ρ using the available panel data, within their 95% confidence intervals. Panel (b) shows box plots of the standardized residuals of the expenditure equations, along with references lines that correspond to data normally distributed (± 0.6745 and ± 2.698).

Figure 3. *Economic mobility*



Source: ENAHO, 1997 to 2016. Own elaboration.
Notes: Panel (a) shows the mobility measures in equation (10) for $n = 5$ expenditure classes: (A) $y \leq$ extreme poverty line; (B) $y \in$ (extreme poverty line, z]; (C) $y \in (z, 2z]$; (D) $y \in (2z, 3z]$; and (D) $y > 3z$, where z is the poverty line. Panel (b) shows transition probabilities among these groups for selected years. These are the probabilities of a household belonging to a class in period 1 (color-coded), given that it belonged, in period 0, to the class indicated on the horizontal axis.

Figure 4. *Poverty exit and entry rates*



Source: ENAHO, 1997 to 2016. Own elaboration.
Notes: In all graphs, the areas are limited by the estimates of lower and upper bounds of the corresponding conditional probability, using $\rho_L = 0.4$ and $\rho_U = 0.6$. The lines inside the areas are the point estimates with $\rho = 0.55$.

Annex 1: Expenditure equations

Next, we present the estimates of the 38 expenditure equations used in the analysis. As mentioned, the dependent variable is the logarithm of per capita household expenditure. Most of the regressors are dummy variables, known to be important income covariates that implicity classify the population into several groups:

Household location

- Rural household. The missing category is the urban area.
- Indicators that divide the country into the so-called three natural regions (Costa, Sierra or highlands, and the Amazon region), interacted with longitude (North, Center and South). The missing category is Metropolitan Lima, which is the richest region of the country.

Household head characteristics

- Head is a female. The missing category is male.
- The main language spoken by the head as a child was native (quechua, aymara or others). The missing category is Spanish or foreign languages. Available from 2004 onwards.
- Indicators of age groups with a 5-year interval each. The missing category is that the head is between 40 and 44 year old (roughly, the average age).
- Education level achieved by the head: Primary, Secondary or Tertiary. Until 2000, the Tertiary category included both undergraduate and postgraduate studies; from 2001 onwards, it can be separated intro undergraduate studies (Tertiary) and Postgraduate. The missing category is no formal education.
- Main occupation of the head: white collar worker, blue collar worker (mostly for the urban population), farmer or fisherman (mostly for the rural population), and whether the main economic sector of employment is financial services.
- Education level achieved by the head's parents (father or mother): Primary, Secondary or Tertiary, with no education as the missing category. These variables are available from 2001 onwards.

Household characteristics

- Single-parent household. The missing category is a two-parent household.
- Number of children (below working age), working age members (from 14 to 65 years old) and elder (above working age), also separated by sex. The sum of these variables gives the number of household members.
- Child dependency ratio (the number of children divided by the number of members of working age).
- Female to male ratio (the number of girls plus women divided by the number of boys plus men).
- Average age of all household members.

House characteristics

- Rudimentary roofs, walls or floors. These variables equal one if the main material used is at the lowest categories of a list provided by INEI. The missing category is the usage of noble, improved materials. The information for roofs is available since 2001.
- The house does not have tap water, a proper sewer system or toilets indoors. The missing category is that the house do have these facilities. The indoor toilet indicator is available since 2000.
- The house does not have electricity, or phone (including mobile phones). The missing category is that the house do have these facilities.
- Number of rooms in the house divided by the number of household members.
- An indicator, computed by the INEI, of whether the house is considered overcrowded. The missing category is that the house size is considered appropriate. Available since 2000.

Annex Table 1. *Expenditure equations (1997 - 2001)*

	1997	1998	1998	1999	1999	2000	2000	2001
Rural household	−0.068***	−0.023	−0.023	−0.021	−0.014	−0.070**	−0.073***	−0.125***
North Costa	−0.105***	−0.157***	−0.160***	−0.196***	−0.193***	−0.064**	−0.069**	−0.185***
Center Costa	−0.081***	0.023	0.020	0.007	0.009	−0.003	0.005	−0.145***
South Costa	−0.072***	−0.183***	−0.188***	−0.164***	−0.158***	−0.075**	−0.074**	−0.089***
North Sierra	−0.315***	−0.261***	−0.261***	−0.249***	−0.248***	−0.124***	−0.126***	−0.314***
Center Sierra	−0.347***	−0.288***	−0.291***	−0.317***	−0.308***	−0.146***	−0.131***	−0.268***
South Sierra	−0.299***	−0.258***	−0.259***	−0.322***	−0.320***	−0.263***	−0.251***	−0.332***
Amazon	−0.096***	−0.098***	−0.101***	−0.146***	−0.138***	−0.077***	−0.079***	−0.238***
Head is female	−0.077**	−0.005	−0.011	0.008	−0.003	−0.019	−0.010	−0.075***
Head speaks a native language								
Head is younger than 30	0.047	0.036	0.012	−0.062	−0.054	0.105**	0.103**	0.014
Head is between 30 and 34	0.035	0.032	0.030	0.011	0.012	0.065*	0.069**	0.045***
Head is between 35 and 39	−0.023	−0.020	−0.021	−0.020	−0.020	0.106***	0.106***	0.016
Head is between 45 and 49	−0.015	−0.046**	−0.046**	−0.000	0.000	0.047	0.042	−0.038***
Head is between 50 and 54	−0.031	−0.053**	−0.052**	−0.019	−0.020	0.014	0.009	−0.064***
Head is between 55 and 59	−0.061**	−0.077***	−0.075***	−0.029	−0.031	0.032	0.021	−0.039**
Head is 60 or older	−0.067**	−0.093***	−0.094***	−0.024	−0.032	0.035	0.010	−0.066***
Head's education: Primary	0.164***	0.126***	0.126***	0.127***	0.123***	0.093***	0.087***	0.077***
Head's education: Secondary	0.325***	0.251***	0.252***	0.248***	0.248***	0.188***	0.184***	0.202***
Head's education: Tertiary	0.427***	0.381***	0.386***	0.371***	0.369***	0.253***	0.248***	0.301***
Head's education: Postgraduate								
White collar worker	0.080***	0.022	0.019	0.073*	0.076*	0.074*	0.081**	0.092***
Blue collar worker	−0.061***	−0.060***	−0.060***	−0.043**	−0.041*	−0.065***	−0.063***	−0.074***
Farmer or fisherman	−0.046**	−0.120***	−0.122***	−0.113***	−0.110***	−0.117***	−0.113***	−0.173***
Financial services	0.058	0.031	0.054	0.192**	0.193**	0.534**	0.529**	0.187***
Head's father education: Primary								
Head's father education: Secondary								
Head's father education: Tertiary								
Head's mother education: Primary								
Head's mother education: Secondary								
Head's mother education: Tertiary								
Monoparental family	−0.030	−0.007	−0.012	−0.020	−0.038	−0.045	−0.045	−0.071***
Number of boys	−0.088***	−0.058***	−0.059***	−0.081***	−0.079***	−0.067***	−0.068***	−0.075***
Number of working age men	−0.047***	−0.030**	−0.032***	−0.047***	−0.048***	−0.070***	−0.071***	−0.073***
Number of aged men	−0.080	−0.084**	−0.113**	−0.105**	−0.127**	−0.097**	−0.184***	−0.143***
Number of girls	−0.075***	−0.060***	−0.061***	−0.069***	−0.070***	−0.043**	−0.040**	−0.046***
Number of working age women	−0.040***	−0.044***	−0.046***	−0.048***	−0.051***	−0.043***	−0.042***	−0.016*
Number of aged women	−0.169***	−0.119***	−0.118***	−0.147***	−0.159***	−0.068*	−0.082**	−0.097***
Child dependency ratio	−0.034	−0.071**	−0.075**	−0.070**	−0.073**	−0.123***	−0.113***	−0.088***
Females to males ratio	−0.014	−0.000	0.001	−0.019	−0.018	−0.023	−0.027*	−0.046***
Average age	0.016***	0.020***	0.020***	0.007	0.007	0.020***	0.021***	0.017***
Average age squared / 1000	−0.156***	−0.203***	−0.197***	−0.094	−0.083	−0.270***	−0.272***	−0.186***
Rudimentary flooring	−0.103***	−0.154***	−0.152***	−0.192***	−0.199***	−0.163***	−0.165***	−0.117***
Rudimentary walls	−0.131***	−0.110***	−0.108***	−0.100***	−0.101***	−0.093***	−0.096***	−0.127***
Rudimentary roof								
House without tap water	−0.040**	−0.087***	−0.085***	−0.013	−0.008	−0.029	−0.025	−0.060***
House without sewer system	−0.141***	−0.108***	−0.109***	−0.164***	−0.167***	−0.164***	−0.133***	−0.075***
House without indoor toilet							−0.087***	−0.043***
House without electricity	−0.211***	−0.192***	−0.196***	−0.150***	−0.162***	−0.142***	−0.136***	−0.146***
House without phone	−0.290***	−0.276***	−0.275***	−0.334***	−0.342***	−0.317***	−0.324***	−0.306***
Number of rooms per person	0.222***	0.193***	0.186***	0.225***	0.211***	0.188***	0.171***	0.168***
Overcrowded house							−0.032	−0.029**
Constant	8.270***	8.269***	8.294***	8.646***	8.685***	8.436***	8.436***	8.557***
Number of observations	4,597	4,979	4,985	2,505	2,488	2,549	2,524	11,533
Adjusted R^2	0.651	0.638	0.638	0.694	0.696	0.655	0.661	0.673
Root mean squared error (σ)	0.429	0.417	0.418	0.399	0.399	0.383	0.382	0.413
$\hat{\rho}$ lower limit				0.382	0.385			
$\hat{\rho}$ upper limit				0.452	0.455			

Notes: Ordinary least squares estimations. * [**] {***} indicates statistical significance at a 10% [5%] {1%} confidence level (robust standard errors).

Annex Table 1 (continued). *Expenditure equations (2001 - 2005)*

	2001	2002	2002	2003	2003	2004	2004	2005
Rural household	−0.118***	−0.104***	−0.106***	−0.044***	−0.047***	−0.085***	−0.083***	−0.093***
North Costa	−0.179***	−0.158***	−0.156***	−0.070***	−0.068***	−0.021	−0.028**	0.011
Center Costa	−0.139***	−0.072***	−0.073***	−0.019	−0.017	−0.041***	−0.044***	0.012
South Costa	−0.082***	−0.117***	−0.114***	−0.130***	−0.131***	−0.122***	−0.117***	−0.077***
North Sierra	−0.308***	−0.175***	−0.169***	−0.177***	−0.172***	−0.198***	−0.204***	−0.169***
Center Sierra	−0.259***	−0.177***	−0.177***	−0.194***	−0.194***	−0.211***	−0.205***	−0.227***
South Sierra	−0.326***	−0.195***	−0.193***	−0.139***	−0.140***	−0.220***	−0.209***	−0.165***
Amazon	−0.232***	−0.112***	−0.111***	−0.047***	−0.044***	−0.064***	−0.066***	−0.080***
Head is female	−0.076***	−0.046***	−0.045***	−0.026	−0.026	−0.035**	−0.033**	−0.027*
Head speaks a native language							−0.050***	−0.049***
Head is younger than 30	0.013	0.076***	0.075***	0.019	0.014	0.024	0.037**	0.001
Head is between 30 and 34	0.041***	0.067***	0.070***	0.031*	0.035**	0.044***	0.046***	0.010
Head is between 35 and 39	0.014	0.042***	0.043***	0.015	0.017	0.030**	0.031**	0.015
Head is between 45 and 49	−0.041***	−0.014	−0.015	−0.037**	−0.038**	0.009	0.008	−0.006
Head is between 50 and 54	−0.067***	−0.026*	−0.029*	−0.029*	−0.031*	−0.016	−0.017	−0.033**
Head is between 55 and 59	−0.040**	−0.030*	−0.036**	−0.023	−0.027	−0.001	−0.004	−0.030**
Head is 60 or older	−0.073***	−0.009	−0.025	−0.033	−0.052**	−0.031*	−0.041**	−0.037**
Head's education: Primary	0.080***	0.074***	0.074***	0.127***	0.129***	0.089***	0.083***	0.071***
Head's education: Secondary	0.190***	0.175***	0.178***	0.227***	0.227***	0.170***	0.162***	0.169***
Head's education: Tertiary	0.293***	0.268***	0.270***	0.319***	0.317***	0.265***	0.256***	0.282***
Head's education: Postgraduate	0.515***	0.339***	0.343***	0.508***	0.508***	0.485***	0.472***	0.491***
White collar worker	0.049**	0.100***	0.100***	0.078***	0.077***	0.051***	0.055***	0.060***
Blue collar worker	−0.067***	−0.055***	−0.057***	−0.044***	−0.049***	−0.070***	−0.069***	−0.028***
Farmer or fisherman	−0.172***	−0.165***	−0.169***	−0.152***	−0.159***	−0.213***	−0.217***	−0.171***
Financial services	0.155**	0.153**	0.149**	0.322***	0.338***	0.113**	0.105*	0.205***
Head's father education: Primary	0.051***	0.031***	0.033***	0.044***	0.043***	0.060***	0.057***	0.065***
Head's father education: Secondary	0.118***	0.082***	0.081***	0.117***	0.113***	0.089***	0.083***	0.096***
Head's father education: Tertiary	0.133***	0.151***	0.147***	0.110***	0.104***	0.154***	0.148***	0.090***
Head's mother education: Primary	0.030**	0.048***	0.042***	0.048***	0.050***	0.068***	0.068***	0.036***
Head's mother education: Secondary	0.038*	0.105***	0.105***	0.087***	0.095***	0.107***	0.106***	0.053**
Head's mother education: Tertiary	0.011	0.162***	0.159***	0.160***	0.157***	0.097***	0.105***	0.130***
Monoparental family	−0.082***	−0.081***	−0.084***	−0.080***	−0.080***	−0.047***	−0.045***	−0.038***
Number of boys	−0.076***	−0.058***	−0.058***	−0.063***	−0.061***	−0.070***	−0.066***	−0.060***
Number of working age men	−0.069***	−0.061***	−0.059***	−0.053***	−0.048***	−0.062***	−0.063***	−0.044***
Number of aged men	−0.188***	−0.149***	−0.184***	−0.135***	−0.191***	−0.083***	−0.116***	−0.092***
Number of girls	−0.046***	−0.041***	−0.040***	−0.047***	−0.048***	−0.044***	−0.041***	−0.050***
Number of working age women	−0.013	−0.031***	−0.030***	−0.031***	−0.035***	−0.036***	−0.037***	−0.049***
Number of aged women	−0.102***	−0.116***	−0.133***	−0.112***	−0.131***	−0.128***	−0.133***	−0.130***
Child dependency ratio	−0.082***	−0.084***	−0.083***	−0.083***	−0.084***	−0.079***	−0.085***	−0.071***
Females to males ratio	−0.046***	−0.033***	−0.032***	−0.029***	−0.024**	−0.026***	−0.027***	−0.014*
Average age	0.018***	0.026***	0.026***	0.019***	0.020***	0.017***	0.018***	0.018***
Average age squared / 1000	−0.198***	−0.286***	−0.283***	−0.188***	−0.193***	−0.180***	−0.184***	−0.189***
Rudimentary flooring	−0.100***	−0.131***	−0.126***	−0.136***	−0.133***	−0.123***	−0.123***	−0.120***
Rudimentary walls	−0.123***	−0.109***	−0.111***	−0.072***	−0.073***	−0.092***	−0.092***	−0.085***
Rudimentary roof	−0.010	−0.017*	−0.019**	−0.009	−0.008	0.001	−0.001	−0.002
House without tap water	−0.057***	−0.040***	−0.039***	−0.022*	−0.023*	−0.042***	−0.040***	−0.050***
House without sewer system	−0.069***	−0.065***	−0.063***	−0.080***	−0.078***	−0.071***	−0.070***	−0.081***
House without indoor toilet	−0.037***	−0.040***	−0.041***	−0.036***	−0.036***	−0.057***	−0.057***	−0.056***
House without electricity	−0.141***	−0.160***	−0.157***	−0.123***	−0.122***	−0.150***	−0.150***	−0.136***
House without phone	−0.281***	−0.301***	−0.302***	−0.259***	−0.260***	−0.273***	−0.273***	−0.302***
Number of rooms per person	0.161***	0.159***	0.157***	0.148***	0.146***	0.137***	0.137***	0.133***
Overcrowded house	−0.031***	−0.029***	−0.029***	−0.020	−0.019	−0.022**	−0.025**	−0.060***
Constant	8.458***	8.230***	8.212***	8.248***	8.218***	8.302***	8.302***	8.271***
Number of observations	11,572	13,143	13,155	8,827	8,844	13,640	13,630	13,798
Adjusted R^2	0.678	0.658	0.659	0.630	0.633	0.671	0.673	0.681
Root mean squared error (σ)	0.410	0.409	0.409	0.393	0.392	0.394	0.393	0.396
$\hat{\rho}$ lower limit		0.360	0.353	0.393	0.393	0.394	0.393	0.442
$\hat{\rho}$ upper limit		0.418	0.411	0.462	0.462	0.466	0.466	0.499

Notes: Ordinary least squares estimations. * [**] {***} indicates statistical significance at a 10% [5%] {1%} confidence level (robust standard errors).

Annex Table 1 (continued). *Expenditure equations (2005 - 2009)*

	2005	2006	2006	2007	2007	2008	2008	2009
Rural household	−0.097***	−0.120***	−0.118***	−0.114***	−0.114***	−0.080***	−0.081***	−0.108***
North Costa	0.010	−0.106***	−0.104***	−0.093***	−0.092***	−0.096***	−0.098***	−0.137***
Center Costa	0.009	−0.035**	−0.035**	−0.089***	−0.087***	−0.066***	−0.065***	−0.120***
South Costa	−0.080***	−0.195***	−0.201***	−0.115***	−0.114***	−0.152***	−0.156***	−0.132***
North Sierra	−0.165***	−0.246***	−0.246***	−0.242***	−0.240***	−0.253***	−0.251***	−0.300***
Center Sierra	−0.231***	−0.294***	−0.290***	−0.276***	−0.275***	−0.246***	−0.246***	−0.265***
South Sierra	−0.167***	−0.246***	−0.244***	−0.233***	−0.232***	−0.263***	−0.266***	−0.276***
Amazon	−0.082***	−0.144***	−0.142***	−0.078***	−0.077***	−0.065***	−0.066***	−0.137***
Head is female	−0.025*	−0.011	−0.008	−0.057***	−0.058***	−0.035***	−0.035***	−0.032**
Head speaks a native language	−0.045***	−0.029***	−0.031***	−0.061***	−0.060***	−0.052***	−0.050***	−0.024***
Head is younger than 30	0.009	−0.005	0.002	−0.001	0.003	−0.036**	−0.040**	−0.035*
Head is between 30 and 34	0.013	−0.002	0.003	0.028**	0.029**	0.003	0.004	−0.011
Head is between 35 and 39	0.016	0.023*	0.025**	0.019*	0.019*	−0.017	−0.017	−0.012
Head is between 45 and 49	−0.008	−0.007	−0.008	−0.015	−0.016	−0.012	−0.013	−0.006
Head is between 50 and 54	−0.037***	−0.041***	−0.044***	−0.017	−0.018	−0.036***	−0.038***	−0.013
Head is between 55 and 59	−0.036**	−0.043***	−0.048***	−0.046***	−0.048***	−0.047***	−0.050***	−0.046***
Head is 60 or older	−0.055***	−0.035**	−0.051***	−0.018	−0.029*	−0.038**	−0.049***	−0.055***
Head's education: Primary	0.071***	0.096***	0.097***	0.086***	0.085***	0.074***	0.076***	0.060***
Head's education: Secondary	0.173***	0.180***	0.180***	0.182***	0.184***	0.166***	0.170***	0.151***
Head's education: Tertiary	0.283***	0.280***	0.276***	0.313***	0.313***	0.272***	0.274***	0.247***
Head's education: Postgraduate	0.496***	0.440***	0.438***	0.516***	0.516***	0.438***	0.444***	0.438***
White collar worker	0.063***	0.068***	0.074***	0.028*	0.030*	0.016	0.016	0.047***
Blue collar worker	−0.030***	−0.081***	−0.078***	−0.066***	−0.066***	−0.089***	−0.089***	−0.078***
Farmer or fisherman	−0.173***	−0.207***	−0.204***	−0.184***	−0.186***	−0.214***	−0.215***	−0.235***
Financial services	0.205***	0.127***	0.138***	0.172**	0.173***	0.154**	0.147**	0.179***
Head's father education: Primary	0.067***	0.047***	0.047***	0.041***	0.039***	0.055***	0.057***	0.039***
Head's father education: Secondary	0.098***	0.088***	0.086***	0.056***	0.053***	0.063***	0.063***	0.054***
Head's father education: Tertiary	0.093***	0.115***	0.119***	0.098***	0.096***	0.152***	0.148***	0.072***
Head's mother education: Primary	0.035***	0.063***	0.058***	0.060***	0.060***	0.050***	0.049***	0.076***
Head's mother education: Secondary	0.059***	0.088***	0.094***	0.101***	0.106***	0.075***	0.077***	0.141***
Head's mother education: Tertiary	0.125***	0.109***	0.104***	0.160***	0.162***	0.165***	0.177***	0.194***
Monoparental family	−0.040***	−0.056***	−0.056***	−0.072***	−0.075***	−0.056***	−0.054***	−0.047***
Number of boys	−0.060***	−0.059***	−0.057***	−0.054***	−0.054***	−0.065***	−0.065***	−0.063***
Number of working age men	−0.042***	−0.054***	−0.053***	−0.051***	−0.050***	−0.057***	−0.057***	−0.046***
Number of aged men	−0.154***	−0.161***	−0.219***	−0.151***	−0.187***	−0.118***	−0.132***	−0.114***
Number of girls	−0.049***	−0.052***	−0.050***	−0.044***	−0.045***	−0.041***	−0.041***	−0.054***
Number of working age women	−0.047***	−0.042***	−0.042***	−0.035***	−0.034***	−0.034***	−0.033***	−0.033***
Number of aged women	−0.143***	−0.154***	−0.161***	−0.168***	−0.173***	−0.134***	−0.147***	−0.137***
Child dependency ratio	−0.064***	−0.059***	−0.058***	−0.074***	−0.069***	−0.088***	−0.087***	−0.067***
Females to males ratio	−0.014*	−0.017**	−0.017**	−0.018**	−0.018**	−0.030***	−0.030***	−0.014*
Average age	0.019***	0.021***	0.023***	0.024***	0.025***	0.018***	0.018***	0.018***
Average age squared / 1000	−0.198***	−0.219***	−0.236***	−0.257***	−0.261***	−0.202***	−0.198***	−0.181***
Rudimentary flooring	−0.119***	−0.113***	−0.113***	−0.147***	−0.147***	−0.129***	−0.130***	−0.153***
Rudimentary walls	−0.085***	−0.099***	−0.101***	−0.128***	−0.127***	−0.145***	−0.143***	−0.159***
Rudimentary roof	−0.002	−0.015*	−0.017**	−0.008	−0.010	−0.028***	−0.027***	−0.026***
House without tap water	−0.049***	−0.035***	−0.034***	−0.015*	−0.014	−0.032***	−0.033***	−0.020**
House without sewer system	−0.079***	−0.082***	−0.084***	−0.078***	−0.074***	−0.063***	−0.060***	−0.074***
House without indoor toilet	−0.057***	−0.042***	−0.044***	−0.050***	−0.048***	−0.043***	−0.043***	−0.030***
House without electricity	−0.133***	−0.102***	−0.104***	−0.076***	−0.080***	−0.090***	−0.089***	−0.106***
House without phone	−0.302***	−0.277***	−0.277***	−0.291***	−0.291***	−0.293***	−0.294***	−0.251***
Number of rooms per person	0.131***	0.136***	0.134***	0.125***	0.123***	0.136***	0.132***	0.121***
Overcrowded house	−0.065***	−0.034***	−0.033***	−0.053***	−0.052***	−0.049***	−0.047***	−0.059***
Constant	8.231***	8.332***	8.295***	8.357***	8.346***	8.619***	8.610***	8.627***
Number of observations	13,771	14,242	14,190	15,252	15,254	14,819	14,762	14,989
Adjusted R^2	0.683	0.694	0.695	0.703	0.703	0.691	0.690	0.685
Root mean squared error (σ)	0.395	0.393	0.392	0.388	0.388	0.390	0.390	0.388
$\hat{\rho}$ lower limit	0.439	0.426	0.419			0.409	0.411	0.474
$\hat{\rho}$ upper limit	0.497	0.482	0.477			0.458	0.460	0.520

Notes: Ordinary least squares estimations. * [**] {***} indicates statistical significance at a 10% [5%] {1%} confidence level (robust standard errors).

Annex Table 1 (continued). *Expenditure equations (2009 - 2013)*

	2009	2010	2010	2011	2011	2012	2012	2013
Rural household	−0.105***	−0.090***	−0.091***	−0.110***	−0.108***	−0.107***	−0.107***	−0.090***
North Costa	−0.136***	−0.123***	−0.125***	−0.079***	−0.082***	−0.104***	−0.105***	−0.146***
Center Costa	−0.120***	−0.081***	−0.080***	−0.041***	−0.043***	−0.074***	−0.076***	−0.101***
South Costa	−0.132***	−0.092***	−0.093***	−0.062***	−0.066***	−0.067***	−0.073***	−0.109***
North Sierra	−0.299***	−0.275***	−0.275***	−0.280***	−0.286***	−0.322***	−0.329***	−0.366***
Center Sierra	−0.265***	−0.229***	−0.232***	−0.246***	−0.249***	−0.268***	−0.272***	−0.274***
South Sierra	−0.274***	−0.256***	−0.255***	−0.181***	−0.184***	−0.201***	−0.205***	−0.172***
Amazon	−0.134***	−0.095***	−0.096***	−0.038***	−0.041***	−0.065***	−0.067***	−0.101***
Head is female	−0.031**	−0.023*	−0.018	−0.042***	−0.041***	−0.018	−0.016	−0.009
Head speaks a native language	−0.023**	−0.036***	−0.036***	−0.040***	−0.041***	−0.028***	−0.027***	−0.028***
Head is younger than 30	−0.027	0.061***	0.065***	0.007	0.011	−0.012	−0.002	0.018
Head is between 30 and 34	−0.007	0.027**	0.029**	0.017	0.017	−0.005	−0.002	0.013
Head is between 35 and 39	−0.010	0.029**	0.030**	−0.009	−0.009	−0.014	−0.012	0.008
Head is between 45 and 49	−0.007	−0.008	−0.009	−0.021**	−0.021**	−0.010	−0.011	0.001
Head is between 50 and 54	−0.016	−0.012	−0.014	−0.023**	−0.024**	−0.005	−0.008	−0.011
Head is between 55 and 59	−0.051***	−0.012	−0.016	−0.030**	−0.032**	−0.034***	−0.039***	−0.027**
Head is 60 or older	−0.070***	−0.024	−0.038**	−0.021	−0.026*	−0.034**	−0.049***	−0.051***
Head's education: Primary	0.061***	0.072***	0.073***	0.084***	0.083***	0.073***	0.075***	0.074***
Head's education: Secondary	0.153***	0.179***	0.180***	0.169***	0.169***	0.176***	0.175***	0.169***
Head's education: Tertiary	0.248***	0.266***	0.267***	0.268***	0.267***	0.273***	0.274***	0.261***
Head's education: Postgraduate	0.442***	0.437***	0.440***	0.425***	0.418***	0.413***	0.412***	0.416***
White collar worker	0.048***	0.007	0.008	−0.006	−0.003	0.012	0.013	0.028**
Blue collar worker	−0.078***	−0.077***	−0.076***	−0.096***	−0.096***	−0.067***	−0.067***	−0.096***
Farmer or fisherman	−0.238***	−0.222***	−0.219***	−0.236***	−0.235***	−0.188***	−0.190***	−0.212***
Financial services	0.189***	0.130***	0.140***	0.144***	0.144***	0.170***	0.180***	0.232***
Head's father education: Primary	0.037***	0.029***	0.028***	0.029***	0.028***	0.065***	0.065***	0.047***
Head's father education: Secondary	0.052***	0.070***	0.066***	0.084***	0.084***	0.091***	0.091***	0.069***
Head's father education: Tertiary	0.069***	0.094***	0.092***	0.120***	0.119***	0.134***	0.142***	0.117***
Head's mother education: Primary	0.074***	0.083***	0.085***	0.056***	0.056***	0.057***	0.055***	0.061***
Head's mother education: Secondary	0.145***	0.136***	0.143***	0.069***	0.072***	0.081***	0.079***	0.094***
Head's mother education: Tertiary	0.197***	0.171***	0.176***	0.141***	0.145***	0.143***	0.142***	0.145***
Monoparental family	−0.053***	−0.068***	−0.067***	−0.068***	−0.067***	−0.056***	−0.057***	−0.046***
Number of boys	−0.061***	−0.068***	−0.066***	−0.062***	−0.061***	−0.078***	−0.075***	−0.061***
Number of working age men	−0.046***	−0.037***	−0.036***	−0.038***	−0.038***	−0.032***	−0.030***	−0.041***
Number of aged men	−0.171***	−0.149***	−0.191***	−0.132***	−0.140***	−0.123***	−0.162***	−0.154***
Number of girls	−0.052***	−0.051***	−0.048***	−0.048***	−0.048***	−0.062***	−0.062***	−0.038***
Number of working age women	−0.032***	−0.019**	−0.019***	−0.035***	−0.035***	−0.026***	−0.027***	−0.029***
Number of aged women	−0.143***	−0.155***	−0.163***	−0.109***	−0.117***	−0.131***	−0.139***	−0.118***
Child dependency ratio	−0.066***	−0.031	−0.036*	−0.088***	−0.091***	−0.033*	−0.034*	−0.066***
Females to males ratio	−0.014*	−0.026***	−0.026***	−0.017**	−0.017**	−0.016**	−0.015**	−0.021***
Average age	0.019***	0.021***	0.022***	0.017***	0.017***	0.017***	0.018***	0.020***
Average age squared / 1000	−0.189***	−0.216***	−0.217***	−0.190***	−0.188***	−0.196***	−0.200***	−0.205***
Rudimentary flooring	−0.152***	−0.133***	−0.131***	−0.140***	−0.139***	−0.134***	−0.133***	−0.128***
Rudimentary walls	−0.158***	−0.170***	−0.171***	−0.140***	−0.139***	−0.150***	−0.147***	−0.144***
Rudimentary roof	−0.026***	−0.025***	−0.025***	−0.027***	−0.028***	−0.031***	−0.030***	−0.052***
House without tap water	−0.019**	−0.035***	−0.036***	−0.036***	−0.035***	0.003	−0.002	−0.012
House without sewer system	−0.072***	−0.079***	−0.077***	−0.080***	−0.079***	−0.099***	−0.097***	−0.102***
House without indoor toilet	−0.033***	0.004	0.001	−0.008	−0.005	−0.031***	−0.031***	−0.024**
House without electricity	−0.108***	−0.090***	−0.089***	−0.058***	−0.058***	−0.054***	−0.052***	−0.034***
House without phone	−0.248***	−0.237***	−0.235***	−0.212***	−0.213***	−0.223***	−0.223***	−0.221***
Number of rooms per person	0.118***	0.128***	0.127***	0.134***	0.133***	0.164***	0.159***	0.150***
Overcrowded house	−0.063***	−0.041***	−0.041***	−0.049***	−0.051***	0.006	0.005	−0.017
Constant	8.603***	8.508***	8.494***	8.703***	8.705***	8.662***	8.644***	8.699***
Number of observations	14,921	14,696	14,625	16,742	16,598	16,756	16,620	20,248
Adjusted R^2	0.685	0.668	0.668	0.647	0.647	0.639	0.639	0.637
Root mean squared error (σ)	0.387	0.385	0.385	0.382	0.382	0.383	0.383	0.380
$\hat{\rho}$ lower limit	0.470	0.504	0.506	0.486	0.485	0.492	0.496	0.521
$\hat{\rho}$ upper limit	0.517	0.548	0.550	0.531	0.531	0.534	0.537	0.562

Notes: Ordinary least squares estimations. * [**] {***} indicates statistical significance at a 10% [5%] {1%} confidence level (robust standard errors).

Annex Table 1 (continued). *Expenditure equations (2013 - 2016)*

	2013	2014	2014	2015	2015	2016
Rural household	−0.093***	−0.143***	−0.144***	−0.122***	−0.121***	−0.145***
North Costa	−0.146***	−0.159***	−0.158***	−0.143***	−0.143***	−0.127***
Center Costa	−0.103***	−0.096***	−0.094***	−0.100***	−0.100***	−0.111***
South Costa	−0.109***	−0.067***	−0.065***	−0.089***	−0.086***	−0.116***
North Sierra	−0.367***	−0.375***	−0.370***	−0.347***	−0.348***	−0.330***
Center Sierra	−0.274***	−0.259***	−0.257***	−0.247***	−0.247***	−0.258***
South Sierra	−0.174***	−0.157***	−0.155***	−0.193***	−0.193***	−0.205***
Amazon	−0.101***	−0.101***	−0.099***	−0.120***	−0.119***	−0.136***
Head is female	−0.006	−0.041***	−0.038***	−0.037***	−0.037***	−0.029***
Head speaks a native language	−0.028***	−0.061***	−0.060***	−0.062***	−0.061***	−0.057***
Head is younger than 30	0.022	0.038**	0.043***	0.040**	0.036**	−0.001
Head is between 30 and 34	0.016	−0.003	−0.002	0.031***	0.031***	−0.002
Head is between 35 and 39	0.009	0.011	0.012	0.015	0.015	−0.005
Head is between 45 and 49	−0.000	0.005	0.004	0.004	0.004	−0.001
Head is between 50 and 54	−0.014	−0.011	−0.013	−0.015	−0.016	−0.008
Head is between 55 and 59	−0.032***	−0.015	−0.017	−0.003	−0.006	−0.022**
Head is 60 or older	−0.065***	−0.020	−0.024*	−0.029**	−0.037***	−0.025**
Head's education: Primary	0.073***	0.066***	0.063***	0.083***	0.083***	0.063***
Head's education: Secondary	0.168***	0.160***	0.157***	0.179***	0.178***	0.161***
Head's education: Tertiary	0.260***	0.259***	0.255***	0.303***	0.303***	0.271***
Head's education: Postgraduate	0.418***	0.427***	0.423***	0.455***	0.450***	0.424***
White collar worker	0.028**	0.038***	0.039***	0.024*	0.025*	0.044***
Blue collar worker	−0.097***	−0.082***	−0.082***	−0.080***	−0.080***	−0.079***
Farmer or fisherman	−0.215***	−0.192***	−0.194***	−0.204***	−0.205***	−0.204***
Financial services	0.226***	0.139***	0.133***	0.208***	0.209***	0.184***
Head's father education: Primary	0.046***	0.056***	0.055***	0.024***	0.022***	0.036***
Head's father education: Secondary	0.070***	0.088***	0.089***	0.069***	0.067***	0.054***
Head's father education: Tertiary	0.117***	0.116***	0.120***	0.108***	0.106***	0.075***
Head's mother education: Primary	0.060***	0.059***	0.060***	0.053***	0.056***	0.063***
Head's mother education: Secondary	0.092***	0.119***	0.121***	0.095***	0.098***	0.131***
Head's mother education: Tertiary	0.141***	0.161***	0.159***	0.147***	0.151***	0.178***
Monoparental family	−0.047***	−0.067***	−0.066***	−0.082***	−0.084***	−0.074***
Number of boys	−0.061***	−0.082***	−0.083***	−0.069***	−0.073***	−0.065***
Number of working age men	−0.039***	−0.044***	−0.045***	−0.040***	−0.039***	−0.043***
Number of aged men	−0.197***	−0.113***	−0.131***	−0.121***	−0.149***	−0.117***
Number of girls	−0.038***	−0.053***	−0.052***	−0.054***	−0.056***	−0.061***
Number of working age women	−0.028***	−0.016**	−0.013*	−0.026***	−0.023***	−0.034***
Number of aged women	−0.122***	−0.142***	−0.141***	−0.144***	−0.149***	−0.131***
Child dependency ratio	−0.062***	−0.035*	−0.030	−0.036**	−0.026	−0.057***
Females to males ratio	−0.020***	−0.032***	−0.035***	−0.021***	−0.022***	−0.016**
Average age	0.020***	0.016***	0.017***	0.020***	0.021***	0.016***
Average age squared / 1000	−0.206***	−0.158***	−0.167***	−0.207***	−0.208***	−0.168***
Rudimentary flooring	−0.128***	−0.149***	−0.149***	−0.147***	−0.147***	−0.140***
Rudimentary walls	−0.139***	−0.129***	−0.128***	−0.126***	−0.124***	−0.113***
Rudimentary roof	−0.053***	−0.055***	−0.054***	−0.063***	−0.065***	−0.062***
House without tap water	−0.012	0.009	0.009	−0.007	−0.007	0.020**
House without sewer system	−0.100***	−0.079***	−0.078***	−0.072***	−0.072***	−0.082***
House without indoor toilet	−0.024**	−0.013	−0.012	−0.042***	−0.042***	−0.022**
House without electricity	−0.033***	−0.039***	−0.040***	−0.022*	−0.024**	−0.041***
House without phone	−0.220***	−0.195***	−0.192***	−0.189***	−0.186***	−0.174***
Number of rooms per person	0.149***	0.149***	0.148***	0.145***	0.143***	0.152***
Overcrowded house	−0.017	−0.036***	−0.037***	−0.026**	−0.025**	−0.027***
Constant	8.682***	8.837***	8.818***	8.778***	8.771***	8.952***
Number of observations	20,101	20,237	20,019	21,257	21,128	23,445
Adjusted R^2	0.636	0.642	0.643	0.630	0.631	0.632
Root mean squared error (σ)	0.380	0.377	0.376	0.379	0.379	0.370
$\hat{\rho}$ lower limit	0.522	0.456	0.456	0.456	0.456	0.498
$\hat{\rho}$ upper limit	0.562	0.498	0.498	0.496	0.496	0.535

Notes: Ordinary least squares estimations. * [**] {***} indicates statistical significance at a 10% [5%] {1%} confidence level (robust standard errors).