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Rural structural change, poverty and income distribution: evidence from Peru

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Abstract Some rural regions of Peru showed remarkable rates of poverty reduction and inequality reduction between 2004 and 2012, while others lagged behind. Using microsimulation-based decompositions, we analyse the driving forces behind these trends, finding that rural poverty and inequality reductions are mainly attributable to increasing labour incomes in Peru's agricultural sector and, to a smaller extent, increasing public transfers. In earlier years, higher returns to experience drive these results, while in later years, increasing staple-crop yields and prices are of key importance. Further, remuneration of working hours increases in reaction to labour-supply shortages in rural areas. The accompanying rising incomes and non-agricultural job creation is less pro-poor than would be ideal, as they benefit more highly skilled workers. Further, shrinking farm sizes hampers poverty reduction and income-inequality reduction. Policies should target the participation of the

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poor in high-value (non-)agricultural activities, especially if positive trends in commodity prices are only transitory.

Keywords Agriculture · Income distribution · Microsimulation-based decomposition · Peru · Rural poverty · Rural labour markets

Abbreviations

ENAHO	Encuesta Nacional de Hogares
INEI	National Institute of Statistics and Informatics
OLS	Ordinary Least Squares
PEN	Peruvian Nuevo Sol

1 Introduction

Peru's economy grew at an average annual rate of 7.2 per cent between 2004 and 2008. During the global economic crisis in 2009, growth dropped to 1.1 per cent, but the economy managed to recover quickly to an average growth rate of 6.9 per cent between 2010 and 2012 (WDI 2015). Country-wide, this growth translated into poverty reduction and was accompanied by decreasing income inequality. And yet poverty is still widespread and inequality remains high in Peru's rural areas. In 2012, about one-quarter of the population lived in rural areas, where people remain vulnerable with a poverty rate of 56 per cent. This rate, however, is down from 87 per cent in 2004 and 72 per cent in 2008. During the same time span, extreme poverty declined even more, from 45 per cent (2004) to 34 per cent (2008) to 21 per cent (2012).

While country-wide inequality in Peru decreased, the distribution of rural income worsened with the Gini index increasing from 40.5 in 2004 to 43.9 in 2008, and improved again slightly to 42.2 in 2012. Rural inequality is partly driven by large disparities between regions, and poverty and distributional change also differs between them. The rural coastal regions, hereafter referred to as 'Costa', experienced considerable poverty reduction and decreasing income inequality. In the highland regions, hereafter referred to as 'Sierra', poverty reduction is lagging behind the national trend, but has been more successful in tackling extreme poverty than moderate poverty. The humid rainforest region ('Selva'), although still poorer than the rural Costa, showed a remarkable reduction in rates of extreme and moderate poverty between 2004 and 2012. During the same time frame, income inequality worsened in the Sierra and the Selva, strongest between 2004 and 2008.

These poverty and inequality trends remain poorly understood, as neither the underlying determinants of income nor the poverty dynamics[1] in rural areas in Peru have been thoroughly investigated. This study's objective is thus to identify the drivers of rural poverty and income inequality changes in Peru between 2004 and 2012. We also analyse dynamics between two sub-periods – 2004 to 2008 and 2008 to 2012 – to capture changes over time.

[1] We use the term 'dynamics' despite the absence of panel data. This is because the structural changes that drive poverty and distributional change are important features of rural growth dynamics. The microsimulation technique – albeit estimated from cross-sectional data – tries to mimic this process, in particular by simulating the changing occupational choices over time.

While the earlier sub-period is characterised by stronger economic growth and the expansion of public transfers, the latter sub-period shows a slight decline in economic growth – at least at the national level – but increasing private transfers. Our analysis considers both agricultural and non-agricultural income dynamics in the assessment of structural drivers of change, such as occupational shifts into non-agricultural sectors or production shifts towards higher-value crops. We also take into account non-labour income sources, such as the role of public transfers and remittances. The period of investigation falls into a phase characterised by increasing global market integration – especially in the earlier sub-period – and by important commodity price movements. The early 2000s saw relatively low (agricultural) commodity prices before reaching peaks in 2007/2008 and 2011/2012 (OECD/FAO 2015). This makes our period of analysis exceptionally interesting for studying rural areas. Understanding rural income dynamics is of crucial importance beyond the case study of Peru, because some trends of rural structural change, such as increased market integration and an increasing role of non-agricultural employment, can be observed throughout the rural areas of the developing world that are often characterised by persistent and deep poverty (Dercon 2009; Losch et al. 2012).

The literature identifies several potentially important determinants of rural income dynamics. Some authors suggest that engaging in non-agricultural activities provides a key pathway for rural households to income growth and poverty reduction (Elbers and Lanjouw 2001; Escobal 2001; Lanjouw 2001). For the case of Peru, Morley (2017) argues that the rural population benefited from both a move into non-agricultural activities, in particular by better-educated individuals, and a rise in wages across industrial activities and services. Despite this occupational shift, the largest section of the Peruvian rural work force is still employed in agriculture. Income growth in this sector, and thus changes in rural inequality and poverty, can result from various factors: First, increases in real agricultural prices can explain growing agricultural profits. Second, as a reaction to more open markets, Peru has shifted agricultural production to certain high-value export products for which it has comparative advantages (Niemeyer and Garrido 2011; Velazco and Velazco 2012). Entering high-value export-oriented value chains can generate higher profits for farmers and new employment opportunities for agricultural wage-workers (Weinberger and Lumpkin 2007; Maertens et al. 2012). Third, higher agricultural productivity has been shown to raise the income level of the poorest rural households (Datt and Ravallion 1998; Fan et al. 2004; Klasen et al. 2013).

Based on a microsimulation that models the rural income-generation process, we decompose poverty and distributional change into the mentioned underlying causes of rural income change in Peru. The methodology was developed by Bourguignon and Ferreira (2005) and builds on the earlier work of Almeida dos Reis and Paes de Barros (1991) and of Juhn et al. (1993). The advantage is that it decomposes changes in the entire income distribution into their various driving forces, including but not limited to changes in the distribution of rural assets and personal characteristics in the population, changes in the returns to those assets and characteristics, and changes in people's occupational choices.

To the best of our knowledge, our study is the first that adapts this methodology to examine distributional effects of structural change in a rural setting, segmented along different agricultural and non-agricultural sub-sectors. This is especially pertinent considering the continuing relevance of agriculture for livelihoods in rural areas of developing countries. Our paper complements and integrates other studies that focus on the role of different public and private services (Escobal and Torero 2005), infrastructure investments (Chong et al. 2009), rural-to-urban migration (Morley 2017) or emerging rural non-agricultural employment opportunities (Escobal 2001; Jonasson 2008).[2]

The remainder of this article is organised as follows. Section 2 outlines the methodology used for the empirical analysis and delineates the data used. Section 3 highlights the main descriptive results and presents selected results of the multivariate analyses. It follows a discussion in Section 4 highlighting the most relevant opportunities and challenges for rural poverty and income inequality reduction. The article ends by summarising the main findings and drawing key conclusions.

2 Methodology and data

2.1 Methodology

Several approaches have been proposed to model distributional and welfare effects of changes in policy and the macroeconomic environment in developing and transition countries. In this paper, to disentangle the underlying causes of poverty and inequality changes, we use a microsimulation-based decomposition technique following Bourguignon and Ferreira (2005) and Lay (2010) (for an overview of different scopes of microsimulation models see e.g. Bourguignon and Spadaro 2006; Figari et al. 2015). Similar to Labeaga et al. (2008), our approach captures changes in the full distribution of income – meaning we use a full sample of rural households, and take into account their full income portfolio. This approach has a clear advantage over standard macroeconomic approaches that focus on changes between representative household groups and thus cannot adequately capture within-group inequality and individual or household heterogeneity.

In contrast to applications of this approach from developed economies, which frequently focus on labour-supply responses to tax and transfer changes (see e.g. Blundell et al. 2000), the behavioural model presented here emphasises occupational choices and the earnings changes resulting from structural change as key drivers of distributional change (see Online Supplementary Material A).

Specifically, we use repeated waves of cross-sectional household survey data to estimate the effects on the joint distribution of income that can be associated with the following changes between two points in time: (a) changes in the socio-demographic structure of the population, as characterised by area of residence, level of education, years of experience or ownership of physical assets (collectively referred to as the 'endowment effect'); (b) changes in returns to factors of production, including land and labour and the various components of human capital, such as education and experience ('price effect'); (c) changes in the occupational structure of the population ('occupational choice effect'); (d) changes in unobservables ('residual effect'); and (e) changes in non-labour income sources ('effect of non-labour income sources'). This decomposition can be done either for all returns, endowments and occupational choices simultaneously or for certain selected parameters. For details on the decomposition technique being applied, see Online Supplementary Material B and Bourguignon and Ferreira (2005).

To separate the observed changes in the distribution of income into the key forces just described ((a) to (e)), our microsimulation model mimics the income-generation process of household hh, with total net household income Y_{hh} being derived from both labour and

[2] Loayza and Rigolini (2016) study the effect of mining activities on socioeconomic outcomes in rural Peru.

non-labour income sources. Labour income is thus broadly defined to include agricultural and non-agricultural income from wage and self-employment.[3]

Each member i of household hh can choose to be inactive, to work non-remunerated or to engage in one of seven employment options: (i) agricultural wage employment; (ii) non-agricultural wage employment; agricultural self-employment in (iii) maize farming, (iv) potato farming, (v) coffee farming or (vi) 'other' farming; and (vii) non-agricultural self-employment. The dummy variables W_i^{ag} and W_i^{nonag} identify the household members engaged in wage employment in agriculture and non-agriculture, and the wages earned in the respective sector are denoted by ω_i^{ag} and ω_i^{nonag}. The dummy variables P_i^s identify the household members engaged in self-employed activities in sector s, where the set S comprises four agricultural sub-sectors (maize, potato, coffee, 'other') and one aggregate non-agricultural sector. The sectoral self-employed profits are denoted by π_i^s. Equation 1 describes the household income-generation model (all variables refer to a particular year but, in the interest of simplifying notation, are not time-indexed).

$$Y_{hh} = \frac{1}{n}\left[\sum_{i=1}^{n} \omega_i^{ag} W_i^{ag} + \sum_{i=1}^{n} \omega_i^{nonag} W_i^{nonag} + \sum_{i=1}^{n} \sum_{S} \pi_i^s P_i^s + \bar{y}_{hh}\right] \tag{1}$$

Equation 1 is not estimated directly, but it aggregates information from (i) two Mincerian wage equations, one for agriculture and one for non-agriculture, (ii) five sectoral profit functions, (i) and (ii) both being OLS,[4] (iii) an occupational choice model, and (iv) the household income from non-labour income sources, $\bar{y}_{hh}$. All income components are expressed in real values (constant 2009 Peruvian Nuevo Sol, PEN). Per capita income is obtained by dividing total household income by the household size n.[5]

Wages and profits include monetary income as well as payments in kind or production for self-consumption. Each individual can be active only in one economic activity. This activity is determined by the first employment activity given in the survey. In addition to the income earned in this main activity, income earned from any secondary or further employment is added. Thus, the outcome variable is the logarithmised total individual labour income that includes all work income from primary, secondary or further employment.

The explanatory variables for the sectoral Mincerian wage equations include two dummies for the level of education completed (primary, secondary or higher) and a variable capturing work experience, defined as age minus years of education. Other covariates include gender, working hours and geographical location. In addition to these, the profit equations include physical capital and, in the case of agriculture, land. The non-agricultural wage and profit equations further control for different industries. A detailed model description is provided in Online Supplementary Material A.1.

The occupational choice model is estimated using a multinomial logit discrete choice model. Household heads, spouses and other household members are treated differently,

[3] Strictly speaking, self-employment not only generates labour income, but also capital income (plus land rents in the case of agriculture).

[4] When estimating the model, we checked for selection biases related to self-selection into alternative occupations by performing a correction method as described by Bourguignon et al. (2007) for the estimates, based on the methodology first introduced by Dubin and McFadden (1984). However, the bias correction terms of the seven labour-market equations turn out to be insignificant. One exception is a slight upward bias of the OLS estimate of the non-agricultural wage equation due to self-selection into this occupational category of individuals that hold superior endowments. We decided to ignore this bias, because the deviations from OLS coefficients were marginal. The results of these regressions can be obtained from the authors upon request.

[5] We also used household size calculated in adult equivalent, which did not significantly alter our results.

meaning that we assume a sequential choice with the household head deciding first. The utility of being unemployed or inactive is arbitrarily set to zero. The utilities of the other employment options (non-remunerated work, wage versus self-employment in one of the four agricultural sub-sectors or in non-agriculture) for household heads depend on education, age, gender, the number of household members in different working-age groups (population above the age of 13), and geographic location. For spouses and other household members, occupational choices depend on the same variables plus the number of children under age 14 living in the household and an employment choice dummy of the household head. Individuals will choose the activity that leads to the highest utility. A detailed model description providing all relevant equations is provided in Online Supplementary Material A.2, which also provides information on how the residuals are simulated for incomes that cannot be observed initially (simulated change in occupational choice) and for the occupational choice model. Note that because of their limited importance in the Peruvian rural context, taxes are explicitly not modelled.

The non-labour incomes, $\bar{y}_{hh}$, include incomes from private and public transfers, (imputed) rents from property, in-kind donations and other extraordinary (non-)monetary incomes. During the time under study, two important social-transfer schemes were introduced: The first is 'Juntos' ('Together'), a large-scale conditional cash-transfer programme implemented gradually since 2005. The second is Pensión 65, a social pension scheme gradually introduced since 2012. For both programmes, transfer receipts are modelled using a two-step procedure that attempts to mimic the official eligibility criteria. A detailed description is provided in Online Supplementary Material A.3. Growth in the other non-labour income sources is assumed to be exogenous. That is, we use the growth rate in mean (non-zero) incomes from the respective source as a scaling factor. As the descriptive evidence, provided in Online Supplementary Material E, suggests that there may be crowding out of private by public transfers, we also present a simulation that assumes that households that become eligible for either Juntos or Pensión 65 in return lose their remittance income (results are presented separately with and without this assumption). Admittedly, the approach is not without limitations. A detailed discussion of the critical assumptions of the non-labour income simulations can be found in the discussion section.

2.2 Data

We use data from the nationally and regionally representative Peruvian household survey Encuesta Nacional de Hogares (ENAHO) collected by the National Institute of Statistics and Informatics (INEI) between 2004 and 2012. The ENAHO data is collected annually from a sample of about 80,000 persons corresponding to 20,000 households in urban and rural areas of all regions. We restrict our analysis to rural areas, defined as those towns and villages with a population of less than 2,000 (see Table C.1 in Online Supplementary Material C). The survey provides detailed information on the demographics, employment, education and other population characteristics, as well as income and consumption of households and their individual members. Furthermore, the survey gives information on production quantities and values and the number of labour-employed for those households in which at least one member was active in self-employment. If the household engages in agricultural self-employment, the survey provides information on total agricultural land endowments per farm, as well as on availability of irrigation technologies. Unfortunately, information on land allocation to different crops is missing, which blurs the evidence on productivity. We categorise farmers either as maize, potato or coffee farmers depending on which product makes up the highest share of total production value per farm. Those three products were chosen because, according to the IV National Agricultural Census, coffee, maize and potatoes are the three most important crops in terms of cultivated area, adding up to almost 25 per cent of total agricultural area in the country in 2012 (INEI 2013b). Furthermore, for more than 70 per cent of all Peruvian farmers maize and potatoes comprised a very important source of income in 2004 and 2012. Coffee was chosen because it is the most important cash crop for export; with between 11 and 14 per cent of farmers fall into this category.[6] 'Other' farmers make up the rest, and comprise those producing both low-value and high-value products. Although non-traditional export products – such as fruits and vegetables – have been gaining in importance in Peru, singling out these farmers is not useful due to limited distributional relevance.

We simulate changes in household income to explain changes in household welfare outcomes over time.[7] Given that official poverty measures by the INEI are based on consumption-based poverty lines,[8] we need to translate the simulated income dynamics to the consumption space. In doing so, we assume that the ratio of total household income to total household consumption is both household-specific and time-specific. In order to evaluate each household's poverty status based on its income position, we therefore rescale the official region-specific poverty lines (based on consumption baskets) using for each household the income-to-consumption ratio as a scaling factor.

Since we are interested in the dynamics of poverty, it would be useful to have panel data. ENAHO provides repeated cross-sectional data for the years between 2004 and 2012, but the number of rural panel households (surveyed in 2004, 2008 and 2012) is too low. Therefore we use cross-sectional data from all years for the descriptive analysis and the two cross-sections of 2004 and 2012 for the microsimulation described above. To take into account possible intra-period dynamics relevant for evaluating income changes over time, we also consider two sub-periods, from 2004 to 2008 and from 2008 to 2012. The period of investigation falls within a phase of change in (agricultural) commodity price trends that needs to be taken into account when interpreting the obtained results.

[6]Note that farmers usually do not produce only one crop – maize, potatoes or coffee – but produce a combination of crops. Over the period of investigation, between 8 per cent and 10.7 per cent of those producers categorised as maize producers also generated a substantial fraction of their profits from potato production (second-most dominant crop equals at least 70 per cent of the profits of the first dominant crop). Vice versa, between 7.1 per cent and 9.2 per cent of farmers categorised as potato farmers also generated a high profit share from maize production. To a lesser extent (between 2 per cent and 4 per cent), coffee farmers also produced maize, especially in the Costa and Sierra in 2004. This sometimes makes a clear distinction of farming categories difficult, but it is necessary for modelling occupational choices. Thus, we conducted a sensitivity analysis by categorising farmers by their secondary farming choices (if second-most dominant crop equals at least 70 per cent of the profits of the first dominant crop) to ensure the validity of our results. This is presented in the Online Supplementary Material D, showing that these production overlaps hardly alter the results.

[7]Consumption measures have proven to be the better long-term welfare measure as compared to income, because households tend to smooth their consumption over time while income shows more volatility. However, since our focus is on the labour-market story behind welfare changes, we use income as a welfare measure.

[8]There are different poverty lines based on consumption baskets for different geographic domains considering region-specific median prices in major cities in each region. The value of each moderate poverty line is equal to the household's per capita cost of a basic basket of food and of non-food consumption. The value of each extreme poverty line represents the expenditure necessary to purchase a basic basket of food items only. For details on how poverty lines were constructed, see INEI (2013a).

3 Results

3.1 Descriptive analysis

Rural areas in Peru have seen some important macroeconomic and sectoral trends in the twenty-first century – ones with an important regional dimension. While a copious discussion of the major trends can be found in Online Supplementary Material E, we want to highlight a few major developments of the Peruvian rural labour market and non-labour income sources between 2004 and 2012. First, there was an important increase in non-agricultural wage employment and a corresponding decline in non-remunerated work across all regions – this was accompanied by increasing wages in real terms, especially among women during the second half of the period of investigation. Second, in agricultural self-employment, yields and real prices of staple crops like maize and potato increased – leading to higher incomes for many rural households. Third, agricultural production shifted towards the traditional export crop coffee – a sector experiencing increasing real prices. Fourth, in the Costa and the Selva, agricultural wage employment gained importance – probably due to new employment opportunities in the rising horticulture sector. And, fifth, growing public-transfer schemes and non-monetary incomes contributed substantially to increasing household incomes in rural areas. Below, we quantitatively examine to what extent these developments contributed to changes in poverty and income inequality in different regions in Peru.

3.2 Poverty and distributional change and simulation results

Moderate poverty drops by 15 percentage points between 2004 and 2008 and another 16 percentage points between 2008 and 2012, while extreme poverty falls by 11 percentage points during the earlier period and another 13 percentage points in the latter period. In rural Peru, the GINI index increases by 3.3 points between 2004 and 2008 and falls slightly, by -1.7 points, between 2008 and 2012. However, there are noteworthy regional differences: in the Costa, moderate poverty is substantially reduced, by 36 percentage points, and extreme poverty is almost eradicated, dropping from 22 per cent to 6 per cent over the entire period of investigation. This drop in poverty is accompanied by a steadily improving GINI index, falling more than six points from 2004 to 2012. The Selva shows large drops in moderate poverty (-37 percentage points) and extreme poverty (-20 percentage points), but income inequality worsens dramatically in the earlier sub-period (+7.5 points GINI index by 2008) and only slightly recovers between 2008 and 2012 (-1.3 points). In the Sierra, moderate poverty remains very high with rates above 60 per cent in 2012, but extreme poverty drops by 26 percentage points – this is accompanied by a more unequal distribution of income (+ 2.5 points GINI index), also worsening between 2004 and 2008 and thereafter slightly recovering.

Our microsimulations decompose[9] these observed changes in poverty and income-inequality indices between 2004 and 2012, as well as between 2004 and 2008 and between 2008 and 2012 into the above-described driving forces (see Section 2.1: (a) 'endowment effects', (b) 'price effects , (c) 'occupational choice effect', (d) the 'residual effect' and (e) the 'effect of non-labour income sources'). We limit the discussion to those aspects that

[9]For simplicity, in the following, we present the decomposition results only for the poverty headcount indices (P(0)) of extreme and moderate poverty and for the GINI index. The full information about the decomposition of all three Foster–Greer–Thorbecke poverty measures and the generalised entropy class of inequality indices can be obtained from the authors upon request.

appear most relevant for explaining changes in poverty and inequality changes. Also, we focus on the decomposition results of the entire period between 2004 and 2012, but selectively present sub-periods if there are important dynamics within the sub-periods to show. All of the following decomposition results are based on the estimated income-generation model. The labour income equation estimations as well as the results of the occupational choice models are presented in Online Supplementary Material F and G.

To give a preliminary impression about which effects are most dominant in explaining changes in poverty and inequality levels, Table 1 below shows the aggregate endowment, price and occupational choice effects as well as the effects of changes in residuals and in non-labour income sources. The upper rows report the single effects without interaction effects, while the bottom rows report all effects with successive interaction effects. We find that price effects followed by increasing non-labour income sources cause large decreases in extreme and moderate poverty. Price effects alone explain 81 per cent of total poverty reduction and increasing non-labour income adds another 18 per cent of total poverty reduction. The dominance of these two effects is consistent across sub-periods and regions. Changes in occupations[10] between 2004 and 2012 also reduce extreme and moderate poverty; however, the effect is not very pronounced. These poverty-decreasing effects are partly offset by endowment effects. If only population endowments had changed, ceteris paribus, extreme poverty would have increased over time. This is because especially the rural population at the lower end of the income distribution have lower endowments of important assets such as agricultural land, and working hours lessen across sectors in 2012 as compared to 2008 and 2004. If price and endowment effects are interacted (see row f), the joint poverty-reducing effect is lower than the sum of the single endowment effect (see row a) and the single price effect (see row b). This means that endowments are lower in particular for those whose returns grow the strongest. Interacting occupational choice changes with price and endowment changes (see row g) somewhat mitigates the occupational choice effect (see row c) by deteriorating population endowments, despite moving into sectors with positive price effects. Table 1 also demonstrates that poverty reduction does not always go hand in hand with a reduction in income inequality. While the aggregate occupational choice effect and effects from increasing non-labour income sources reduce income inequality, the aggregate price effect, aggregate endowment effect and residual effect increase income inequality between 2004 and 2012. However, both effects are not constant over time: the aggregate residual effect and aggregate endowment effect strongly increase income inequality between 2004 and 2008, while both effects reduce income inequality between 2008 and 2012. This is mainly explained by improvements in education and paid labour endowments (see below for more details). While during the first sub-period the non-poor benefit relatively more, the poor also benefit from these trends later on.

These aggregate effects capture a variety of different – and partly counteracting – influences. Decomposing the price effect – aggregated across occupations (see upper rows of Table 2 below) – over the entire period reveals that the main poverty-reducing effect is ascribed to an increase in the sectoral base income and higher returns to working hours. This holds across all regions. The increased premium on working hours is likely to reflect the increasing labour-supply shortage due to urban migration (compare Morley (2017)). Female income gaps remain high in all sectors (see Table E2 in the Online Supplementary

[10]The occupational choice effect only captures income effects induced by occupational shifts between sectors, and assuming static average incomes in different sectors. This means that varying developments in average income across different sectors between 2004, 2008 and 2012 are not taken into account.

Table 1 Poverty and distributional effects of aggregate changes in endowments, prices, occupational shifts and non-labour income sources in rural Peru by subperiod (in percentage points, region: total rural Peru)

Scenario	Change 2004 – 2012			Change 2004 – 2008			Change 2008 – 2012		
	GINI	P(0) extreme poverty	P(0) moderate poverty	GINI	P(0) extreme poverty	P(0) moderate poverty	GINI	P(0) extreme poverty	P(0) moderate poverty
Observed poverty and inequality year 1	40.6	44.7%	86.7%	40.6	44.7%	86.7%	43.9	34.3%	71.6%
Observed poverty and inequality year 2	42.2	20.9%	55.6%	43.9	34.3%	71.6%	42.2	20.9%	55.6%
Observed change	**+1.6**	**−23.8**	**−31.1**	**+3.3**	**−10.4**	**−15.1**	**−1.7**	**−13.4**	**−16.0**
(a) Total endowment effects	+1.7	+9.1	+1.3	+3.2	+7.5	−0.3	−1.5	+3.5	+3.0
(b) Total price effects	+1.4	−26.0	−25.4	+1.1	−13.4	−10.8	+0.5	−13.1	−15.7
(c) Total occupational choice effects	−0.7	−2.4	−2.1	−0.6	−1.4	−1.4	−0.1	−1.0	−0.8
(d) Residual effect	+1.0	−0.7	−0.9	+1.1	−0.3	−0.7	−0.2	−0.2	−0.1
(e) Effect of non-labour income sources	−1.6	−8.8	−5.5	−0.8	−3.9	−1.9	−1.0	−4.8	−3.4
(f) a) + b)	+3.2	−12.0	−21.0	+3.5	−4.2	−10.6	n.e.	−7.9	−10.0
(g) a) + b) + c)	+2.5	−13.5	−23.2	+3.0	−5.8	−12.2	−0.3	−8.3	−1.6
(h) a) + b) + c)+ d)	+3.5	−13.9	−24.1	+4.1	−6.2	−13.2	−0.5	−8.3	−10.5
(i) a) + b) + c) + d) + e)	+1.6	−23.7	−31.1	+3.4	−10.4	−15.2	−1.7	−13.2	−15.9

Note: P(0) = poverty headcount; GINI = GINI coefficient as an indicator for income inequality; n.e. = no effect

The upper rows of the table report observed levels of poverty and income inequality in all periods (poverty in per cent and GINI as an index) and the respective changes over time (in (percentage) points). The bottom rows of the table report the changes in poverty and income inequality (in (percentage) points) based on each counterfactual scenario

Source: Authors' elaborations based on regression results and ENAHO data

The bold data indicates the observed changes

Table 2 Disaggregated price and endowment effects across all sectors in rural Peru by subperiod (in percentage points, region: total rural Peru)

Scenario	Change 2004 – 2012			Change 2004 – 2008			Change 2008 – 2012		
	GINI	P(0) extreme poverty	P(0) moderate poverty	GINI	P(0) extreme poverty	P(0) moderate poverty	GINI	P(0) extreme poverty	P(0) moderate poverty
Observed poverty and inequality year 1	40.6	44.7%	86.7%	40.6	44.7%	86.7%	43.9	34.3%	71.6%
Observed poverty and inequality year 2	42.2	20.9%	55.6%	43.9	34.3%	71.6%	42.2	20.9%	55.6%
Observed change	**+1.6**	**−23.8**	**−31.1**	**+3.3**	**−10.4**	**−15.1**	**−1.7**	**−13.4**	**−16.0**
Total price effect all sectors aggregated	**+1.4**	**−26.1**	**−25.4**	**+1.1**	**−13.4**	**−10.8**	**+0.5**	**−13.1**	**−15.7**
Education	−0.4	+0.4	+1.0	+0.8	+0.1	−0.5	−1.1	+0.6	+1.7
Experience	−0.4	−1.1	−0.1	+0.8	−7.1	−5.6	−1.0	+5.2	+7.0
Female income gap	n.e.	n.e.	+0.1	n.e.	+0.2	+0.2	−0.1	−0.2	−0.1
Working hours	+1.7	−7.8	−8.5	+1.5	−5.8	−5.4	+0.3	−2.5	−3.0
Regional income gap	−0.5	−0.6	−0.3	−0.2	−0.5	−0.1	−0.4	−0.2	n.e.
Sectoral income gap	−0.2	−0.2	n.e.	−0.1	+0.1	+0.3	n.e.	−0.3	−0.4
Paid labour	+0.4	−1.8	−1.4	+0.3	−1.7	−0.9	+0.4	−0.1	−0.4
Non-remunerated labour	n.e.	−0.3	−0.1	+0.3	+0.6	+0.4	−0.2	−1.0	−0.8
Land	+0.1	+0.5	+0.3	−0.1	+2.2	+1.6	+0.1	−1.4	−1.6
Baseline income	+0.9	−17.4	−16.4	−1.7	−0.9	+1.3	+2.3	−15.2	−19.9
Remainder	−0.2	+2.3	−0.1	−0.4	−0.6	−2.3	+0.1	+2.0	+1.8
Total endowment effect all sectors aggregated	**+1.7**	**+9.1**	**+1.3**	**+3.3**	**+7.9**	**−0.2**	**−1.5**	**+3.5**	**+3.0**
Education	+0.5	−1.0	−1.2	+0.7	−0.5	−1.3	−0.3	−0.5	n.e.
Experience	n.e.	−0.5	−0.2	n.e.	−0.1	n.e.	n.e.	−0.5	−0.1
Female labour force participation	+0.1	−0.6	−0.6	+0.1	−0.4	−0.4	n.e.	−0.2	−0.2
Working hours	+0.6	+3.9	+1.2	+0.5	+2.5	−0.2	+0.2	+1.6	1.5

Table 2 (continued)

Scenario	Change 2004 – 2012			Change 2004 – 2008			Change 2008 – 2012		
	GINI	P(0) extreme poverty	P(0) moderate poverty	GINI	P(0) extreme poverty	P(0) moderate poverty	GINI	P(0) extreme poverty	P(0) moderate poverty
Sector mobility	−0.1	−0.1	−0.1	−0.1	n.e.	n.e.	n.e.	n.e.	−0.1
Paid labour	−0.7	−0.2	−0.1	+0.5	−0.2	−0.1	−0.9	−0.1	n.e
Non-remunerated labour	n.e.	+0.2	n.e.	n.e.	+0.3	n.e.	n.e.	n.e.	n.e.
Land	+1.0	+6.0	+2.5	+0.8	+4.6	+1.9	+0.4	+1.6	+1.0
Regional mobility	n.e.	n.e.	n.e.	n.e.	−0.1	−0.1	n.e.	+0.1	+0.2
Household size	−0.1	n.e.	n.e.	n.e.	+0.2	+0.1	n.e.	−0.2	−0.1
Remainder	+0.3	+1.4	−0.2	+0.8	+1.6	−0.2	−0.9	+1.6	+0.8

Note: P(0) = poverty headcount; GINI = GINI coefficient as an indicator for income inequality; n.e. = no effect

The upper rows of the table report observed levels of poverty and income inequality in all periods (poverty in per cent and GINI as an index) and the respective changes over time (in (percentage) points). The bottom rows of the table report the changes in poverty and income inequality (in (percentage) points) based on each counterfactual scenario

Source: Authors' elaborations based on regression results and ENAHO data

The bold data indicates the observed changes

Material) and thus do not contribute to distributional change. There are important dynamics that are obscured if only changes over the entire period are considered. While the base income is relatively stable between 2004 and 2008, higher returns to experience and to paid labour reduce extreme and moderate poverty while, however, increasing income inequality. Decreasing returns to land have an impoverishing effect. Between 2008 and 2012, some of these effects reverse. In this period, decreasing returns to experience and education push some households (back) into poverty, but reduce income inequality. At the same time, the recovering land premium lifts some people out of poverty again. The most important effect for poverty reduction between 2008 and 2012, though inequality-increasing, is the large increase in the sectoral base income. It might be counterintuitive that base incomes across rural sectors increase predominantly in the latter period, despite stronger national economic growth rates between 2004 and 2008. This can be explained by various factors: First, lower growth during the period from 2008 to 2012 was mainly attributed to the global economic crisis in 2009; however, the Peruvian economy recovered extremely quickly, reverting to high growth rates. Second, rural markets were not affected by the economic crisis as much as urban markets; the mining industry was hit hardest in rural areas, but this had only limited distributional impacts. Third, Peruvian policies reacted to the crisis by maintaining and increasing investments in infrastructure projects and social spending (Trivelli et al. 2009). These infrastructure projects appear to have been extremely effective in boosting rural incomes. In sum, most price effects counterbalance each other over the entire period of investigation. Exceptions are the increased remuneration of working hours and the strong rise in sectoral base incomes. Due to the major importance of the latter effect across sectors – driven by, for example, higher prices and productivity – we look into this more deeply below.

Decomposing the endowment effect – aggregated across occupations (see bottom rows of Table 2) – shows that the major poverty-increasing and income inequality-increasing effects result from a decline in working hours – and, even more, from reduced agricultural land sizes. Fernandez and Saldarriaga (2014) show that the decline in working hours is associated with receiving social cash payments (see results on non-labour incomes below). They find that recipients reduce their labour supply by six to ten hours per week following the payment date. By contrast, increasing years of schooling and experience – the latter linked to shifts in the age structure of the Peruvian workforce – have poverty-reducing effects. However, these effects are insufficient to compensate for the corresponding price effects and, indeed, even worsen income inequality. However, this does not imply declining incentives to invest in education. Despite the decrease of the skill premium, individuals with higher levels of education continue to earn substantially more than those with lower education levels.

These disaggregated price and endowment effects can be further disaggregated by sector. These results are not reported here, because the differences between sectors turned out to be marginal.[11] Across all sectors, the increase in the base income has the biggest distributional effect between 2004 and 2012. Declining working hours is the dominant impoverishing endowment effect in all sectors.

The descriptive results above and in Supplementary Material E illustrate that the share of non-remunerated workers fell, while especially that of people in non-agricultural wage sectors increased over time. According to our occupational simulation results (see Online Supplementary Material H), we find that about 17 per cent of the simulated non-agricultural wage-employed in 2012 work in a non-remunerated capacity in 2004. Of the

[11] Decomposed price and endowment effects disaggregated for each sector can be obtained from the authors upon request.

simulated non-agricultural wage-employed in, another 6 per cent are inactive or unemployed and another 8 per cent come from maize or potato farming in 2004. Results of the multinomial logit estimations (see Online Supplementary Material G) show that higher education levels and higher age are associated with a higher probability of entering non-agricultural wage employment. Other important shifts occurred within the agricultural sector. In our simulations, about 17 per cent of the agricultural wage-employed in 2012 are non-remunerated workers in 2004, and 4 per cent are inactive or unemployed in that year. Furthermore, many coffee farmers in 2012 are staple-crop farmers in 2004 (about 9 per cent of all coffee farmers in 2012). About 4 per cent of all initial (2004) staple-crop producers shift into 'other' farming, a group also containing many high-value crops, such as fruits and vegetables. The probability of entering the coffee or 'other' farming sectors increases with a higher level of experience on the part of the farmer and depends very much on the specific location of the farm. Comparing the occupational choice simulations of 2004, 2008 and 2012, we find that the above trends are continuous over time.

Despite these occupational shifts to sectors with better pay, the distributional effects of these changes are actually quite small. Given this limited explanatory power of occupational shifts for distributional changes, the detailed results are presented in Online Supplementary Material I. It should be noted, though, that the 'occupational change only' scenarios capture solely static effects, as they assume that incomes in the destination sectors are constant: if initial income differences between the sectors are small, then the associated distributional effects will also be small. This holds true particularly for shifts into the coffee sector, which trigger considerable rates of poverty reduction in the Selva. Here, only the interaction between farmers switching to coffee and the coffee price increase – and hence coffee baseline income – result in a noticeable poverty-reduction effect.

Furthermore, more wage employment in the agricultural sector reduces poverty and income inequality foremost in the Costa, but also in the Selva – both regions that increased fruit and vegetable production for the export market. Again, the static occupational choice effect into this sector is lower than the magnitude of the distributional effect considering both, occupational shifts and wage increases in this sector. This is because agricultural wages, on average, increased faster than wages in most other sectors (see Tables E1 and E2 in the Online Supplementary Material). Our decomposition results also confirm that occupational shifts towards non-agricultural wage employment reduce extreme poverty and moderate poverty by about 1.5 percentage points between 2004 and 2012. About half of this effect is driven by movements out of non-remunerated work.[12]

We find the aggregate price effect to be much more responsible than occupational shifts for changes in poverty and income inequality. Table 3 below reports the disaggregated price effects at the sectoral level, interacted with the aggregate endowment and occupational choice effects (for changes between 2004 and 2012). The bulk of extreme and, to a lesser extent, moderate poverty reduction occurs due to changing returns in maize and potato farming in the Sierra and the Selva. Especially in the Sierra, extreme poverty declines due to the improving incomes of staple-crop producers. The same is observed in the Selva, but here the impoverishing endowment effect (see row a) is still not fully compensated for by the price effects in staple-crop farming. Also, income inequality declines in the Sierra and Selva due to higher returns to staple-crop production. These positive price effects in maize and potato

[12]For details on region- and time-specific results, see Tables I.1, I.2 and I.3 in the Online Supplementary Material.

Table 3 Price effects of different sectors interacted with endowment and occupational choice effect between 2004 and 2012 by rural area (in percentage points)

Scenario	Rural average			Costa			Sierra			Selva		
	GINI	P(0) extreme poverty	P(0) moderate poverty	GINI	P(0) extreme poverty	P(0) moderate poverty	GINI	P(0) extreme poverty	P(0) moderate poverty	GINI	P(0) extreme poverty	P(0) moderate poverty
Observed 2004	40.6	44.7%	86.7%	45.0	22.4%	73.7%	39.1	50.8%	89.2%	36.4	35.2%	84.3%
Observed 2012	42.2	20.9%	55.6%	38.5	5.7%	37.6%	41.5	24.9%	60.5%	42.6	14.9%	47.6%
Observed change 2004 – 2012	**+1.6**	**−23.8**	**−31.1**	**−6.5**	**−16.6**	**−36.1**	**+2.5**	**−25.8**	**−28.7**	**+6.2**	**−20.3**	**−36.7**
a) Endowment + occupational choice effects (all sectors)	+0.8	+10.6	+1.3	−6.2	+1.8	−1.6	+1.7	+11.9	+1.8	+2.8	+9.9	+0.8
b) (a) + staple-crop* price effect	−1.9	−2.9	−9.7	−6.0	−0.4	−5.0	−1.0	−5.1	−11.3	+1.5	+2.8	−6.8
c) (b)+ cash-crop** price effect	−1.7	−5.5	−12.5	−6.1	−0.4	−5.0	−0.9	−5.6	−11.9	+1.9	−7.5	−17.7
d) (c)+ price effect of 'other' farmers***	−1.2	−6.5	−13.8	−5.2	−1.5	−7.9	−0.7	−6.2	−12.5	+1.9	−10.0	−20.6
e) (d) + price effects in agricultural wage employment	−1.1	−9.4	−16.9	−6.8	−8.4	−17.5	−0.7	−8.7	−14.4	+2.2	−12.4	−24.7
f) (e) + price effects in non-agricultural wage employment	+0.6	−12.7	−22.3	−6.5	−9.9	−23.8	+1.7	−12.7	−20.0	+3.6	−13.9	−28.7
g) (f) + price effects in non-agricultural self-employment	+2.2	−14.4	−24.7	−6.1	−10.7	−26.4	+3.9	−14.8	−22.7	+4.8	−14.8	−30.6

Note: P(0) = poverty headcount; GINI = GINI coefficient as an indicator for income inequality; n.e. = no effect; * staple crop refers to maize and potatoes; ** cash crop refers to coffee as it is the single most important cash-crop with distributional effects; *** the category 'other' farmers comprises other staple and cash crops

The upper rows of the table report observed levels of poverty and income inequality in 2004 and 2012 in all rural macroregions (poverty in per cent and GINI as an index) and the respective changes over time (in (percentage) points). The bottom rows of the table report the changes in poverty and income inequality (in (percentage) points) based on each counterfactual scenario

Source: Authors' elaborations based on regression results and ENAHO data

The bold data indicates the observed changes

farming that reduce poverty considerably in Peru's poorest regions result both from increasing producer prices and from increasing yields. After 2008 yields increase even more than prices. Table E3 in the Online Supplementary Material shows that in maize farming the yield effect dominates, while in potato farming the effect from price increases is more pronounced. The data also illustrate that despite an overall positive trend, prices are volatile in both staple crops over the period of investigation.

Positive price effects in coffee production mainly benefit farmers in the Selva, which is the main production region. This effect decreases moderate poverty, but, since coffee farmers are not among the poorest, it has a negative effect on income inequality. In the coffee sector, price increases – driven by world market prices – are most likely the responsible factor for the observed effects, as yields do not improve significantly over time (see Table E3 in Online Supplementary Material E).

The Costa benefits most from increasing returns in agricultural wage employment, substantially reducing extreme and moderate poverty as well as income inequality. Furthermore, higher wages in non-agricultural wage employment lead to the reduction of extreme and moderate poverty across all regions – with the largest effect on extreme poverty in the Sierra and on moderate poverty in the Costa. However, the rich benefit more than the poor, and income inequality worsens accordingly. Changing returns in non-agricultural self-employment have smaller effects on poverty reduction, and increase income inequality in all regions. The sectoral story remains consistent over all sub-periods.

In sum, we can state that a higher premium on experience as well as increasing prices and productivity help to lift people out of poverty, but on average worsen income inequality. Both the poverty-reduction effects and the distributional implications vary by occupation and sector and have an important regional and time dimension to them.

Although the described dynamics in agriculture and the labour market are key drivers of poverty and distributional change in rural areas, we see in Table 1 that non-labour (and non-farm) income sources are also relevant. According to the simulation results reported in Table 4, public transfers contribute to poverty reduction in Peru primarily due to the introduction of Juntos, which has become Peru's flagship poverty-reduction programme. Juntos is the key driver of extreme poverty reduction, particularly in the Sierra region. The effect is strongest between 2004 and 2008, the period during which the programme experienced the strongest expansion in this region (see Online Supplementary Material Table I.4). We find that the effect of the social pension scheme Pensión 65 is rather marginal during the time frame under study, as it was introduced only in 2012. Other public transfers, including disability and survivor pensions, do not contribute to poverty reduction, according to our simulation.

The second important contributor among the non-labour sources is the increase in non-monetary forms of income available to poor households. Increasing property values (imputed rents), more freely accessible medical services and free access to cultural and recreational activities, as well as an increase in food donations, are driving the aggregate effect reported in Table 4. The expansion of non-monetary incomes is a key driver of the observed reduction in moderate poverty, especially in the Costa, an effect most pronounced between 2008 and 2012 (see Online Supplementary Material Table I.5).

The welfare effect attributable to a change in private transfers is somewhat ambiguous. When rescaling remittance income by the average growth rate in (non-zero) transfer values received, we find a small poverty-reducing effect. However, when the lower incidence of remittance receipts due to a potential crowding-out effect from public to private transfers is taken into consideration, the effect reverses to become slightly poverty-increasing. In interaction, this crowding-out effect is simulated to reduce the average effect on rural extreme poverty attributable to the expansion of public transfers from 6.6 to 5.5 percentage points.

Table 4 Simulated effects from changes in non-labour income sources between 2004 and 2012 by rural area (in percentage points)

Scenario	Rural average			Costa			Sierra			Selva		
	GINI	P(0) extreme poverty	P(0) moderate poverty	GINI	P(0) extreme poverty	P(0) moderate poverty	GINI	P(0) extreme poverty	P(0) moderate poverty	GINI	P(0) extreme poverty	P(0) moderate poverty
Observed 2004	40.5	44.7%	86.7%	44.8	22.4%	73.7%	38.9	50.8%	89.2%	36.4	35.2%	84.3%
Observed 2012	42.2	20.9%	55.6%	38.4	5.7%	37.6%	41.5	24.9%	60.5%	42.6	14.9%	47.6%
Observed change	**+1.7**	**−23.8**	**−31.1**	**−6.3**	**−16.6**	**−36.1**	**+2.5**	**−25.8**	**−28.7**	**+6.2**	**−20.3**	**−36.7**
(a) Private transfers	n.e.	−1.5	−1.2	−0.2	−0.7	−1.7	n.e.	−1.9	−1.2	n.e.	−0.6	−0.7
(b) Public transfers (combined effect)	−2.3	−6.6	−2.4	−0.5	−1.5	−0.3	−2.8	−8.4	−3.1	−0.9	−2.9	−1.2
JUNTOS	−2.0	−5.6	−2.1	−0.4	−1.1	−0.3	−2.5	−7.1	−2.7	−0.9	−2.9	−1.1
PENSIÓN 65	−0.2	−1.0	−0.3	−0.1	−0.5	n.e.	−0.3	−1.3	−0.5	n.e.	−0.1	−0.1
Other public transfers	n.e.	n.e.	n.e.	n.e.	0.1	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.
(c) Other monetary income (combined effect)	0.2	−0.2	−0.2	0.4	n.e.	−0.7	0.1	−0.3	−0.2	0.2	−0.2	−0, 3
(d) Other non-monetary income (combined effect)	−0.5	−3.8	−3.4	−1.0	−3.2	−5.0	−0.5	−4.1	−3.3	−0.2	−3.1	−3.0
Interaction effects												
(e) Private transfers with crowding out effect	0.8	0.8	−0.1	0.1	0.1	−1.5	1.0	1.1	n.e.	0.4	0.4	0.1
(f) b) + e)	−1.5	−5.5	−2.6	−0.5	−0.9	−1.6	−1.9	−7.1	−3.2	−0.6	−2.5	−1.3
(g) b) + c) + d) + e)	−1.8	−9.5	−6.5	−1.1	−5.5	−9.1	−2.4	−11.4	−6.4	−0.6	−5.4	−5.5
(h) b) + c) + d) + e) + eligibility effect from change in labour incomes on transfer schemes	−1.6	−8.8	−5.5	−1.0	−5.1	−8.9	−2.1	−10.5	−5.4	−0.5	−5.0	−4.6

Note: P(0) = poverty headcount; GINI = GINI coefficient as an indicator for income inequality; n.e. = no effect

The upper rows of the table report observed levels of poverty and income inequality in 2004 and 2012 in all rural macroregions (poverty in per cent and GINI as an index) and the respective changes over time (in (percentage) points). The bottom rows of the table report the changes in poverty and income inequality (in (percentage) points) based on each counterfactual scenario

Source: Authors' elaborations based on ENAHO data

The bold data indicates the observed changes

4 Discussion and conclusions

We now place the results of the decomposition exercise into the context of the broader literature on the drivers of rural poverty dynamics and distributional change and link the above 'proxy' drivers ('price', 'endowment', 'occupational choice', 'non-labour income effects') to more general observations on rural development in Peru.

While Morley (2017) emphasises the relevance of non-agricultural services income for rural poverty reduction in Peru, our results provide evidence that the patterns of growth in agriculture are also important, in particular for the reduction of extreme poverty. This result is in line with other authors' findings (see e.g. Dixon et al. 2001; Christiaensen et al. 2011). Compared to the study by Morley (2017), our microsimulation approach allows for a more detailed incidence analysis of the labour-income growth pattern in both agricultural and non-agricultural activities. These patterns are characterised by an increased market integration of smallholders and the emergence and expansion of non-traditional export crops, both of which can be attributed to the liberalisation of Peru's agricultural markets (FAO 2010). Indeed, we find that farmers switch from maize farming, and to some extent from potato farming, to coffee farming and 'other' farming activities. Some authors stress the relevance of cash-crop production for poverty reduction in developing countries, but our results show that the static distributional impacts of crop-production shifts towards cash crops (holding incomes in the cash-crop sectors constant over time) are actually rather small. Yet, increasing coffee prices render Peru's key traditional cash crop attractive in the period under investigation. Because of entry barriers into coffee (Lee et al. 2012), these farmers do not tend to be among the poorest, which is confirmed by our analysis. Further, female farmers are particularly hindered from engaging in cash-crop production, especially coffee, and gender-related profit gaps remain high throughout the period of investigation. In part, the limited ability to move from staple- to cash-crop production is due to simple locational reasons. In particular, the southern Sierra has only limited agricultural development potential due to its harsh climate, and coffee can be produced only at certain altitudes (Escobal and Ponce 2008). Yet, many poor farmers, located in areas where cash-crop production is, in principle, possible, struggle to enter into coffee and non-traditional export-crop production. While our analysis does not examine these mechanisms, the recent literature has identified high compliance costs related to international food-quality standards as being responsible for the crowding out of smallholders in non-traditional export crops (Schuster and Maertens 2013).

While coffee farmers including those who switch to coffee may not be among the poorest, many of them are still poor. Coffee-sector growth, driven by both increasing prices and productivity improvements, therefore contributes significantly to poverty reduction, in particular in the Selva, where it explains more than 40 per cent of total poverty reduction between 2004 and 2012. These positive 'price' effects – in the coffee, but also other agricultural sectors – are in part offset by declining farm sizes. Our findings support Fort (2008) and Meade et al. (2010), who find an increased concentration of landholdings and an emergence of larger farms that produce crops predominantly for the export market. Complicated rules of land tenure limit smallholders' access to land, which seems to push some coffee and 'other' farmers in the Selva and the Costa below the poverty line.

Despite the undeniable relevance of the cash-crop sector to rural development, the majority of poorer farmers remain in maize and potato farming. Income growth in these staple crops therefore strongly operates in favour of the poor. Although the decomposition method cannot identify the reasons behind increasing maize and potato base incomes, the accompanying descriptive analysis (see Online Supplementary Material E) of yields and domestic prices shows that both productivity and price effects drive the income increases of farmers who are engaged in the production of these crops. Most likely, improvements in the road network that have reduced transaction costs and allowed for greater returns due to better market access play a role here (Inchauste et al. 2012). For some vulnerable farmers – especially for maize farmers located in the Sierra – these gains are more than offset by decreasing farm sizes over time.

Another structural change affecting rural markets is the rise in agricultural wage employment. Again, the static poverty and inequality effects – i.e. the effects of people moving into this sector (ceteris paribus) – are rather moderate, with the highest effect in the Costa. Yet, while the creation of new jobs is less important, wage increases in this sector strongly contribute to poverty reduction and income-inequality reduction. This is because, generally, the landless, low-skilled and poorest rural population engages in agricultural wage employment (Lanjouw 2001). The new demand for agricultural labour which is accompanied by increasing wages is very likely driven by an increasing engagement in global agricultural trade flows by Peru's horticulture sector. While coffee remains Peru's single-most important agricultural export crop, more than 60 per cent of all Peruvian agricultural exports are now fruits and vegetables. The opportunities arising from this industry may extend to other regions of the country, as recent private and foreign investments in infrastructure projects have connected remote areas to the coast (The Economist 2013). Our results indicate that the Selva may already have benefited from these investments. Here, the mango industry is developing rapidly, becoming another export star of the Peruvian agricultural sector. Our results show that poverty also declines in the Selva, due to new employment opportunities and rising wages in agriculture. Yet, in many regions of the Sierra, the potential for growing these cash crops and progress in agricultural productivity are somewhat limited due to less favourable growing conditions (Gallardo and Saavedra 2009).

Non-agricultural income plays an increasingly important role for rural livelihoods (see e.g. de Janvry and Sadoulet 2001; Reardon et al. 2001; Jonasson 2008; Morley 2017) and offers a potential pathway out of rural poverty. Our analysis confirms these findings in part. Wages and profits increase in non-agricultural employment, and not only in the Costa, where off-farm employment abounds and wages and profits are highest. High urbanisation rates and proximity to markets facilitate the development of non-agricultural businesses and the corresponding profit and wage increases here, especially in food processing and the tourism industry (Jonasson 2008). Poorer regions use their potential to catch up. Foreign investments, flowing for example into mining in the Selva and northern Sierra (PWC 2013; Ticci and Escobal 2013), seem to increase profits and wages in this sector and in related industries and services (Loayza and Rigolini 2016). However, these developments tend to benefit the richer rural households relatively more and lead to higher inequality. This is primarily because the more skilled individuals benefit from higher returns to education outside of agriculture.[13] Nevertheless, non-agricultural wage employment that absorbs those formerly in non-remunerated work and those formerly unemployed contributes to some extent to poverty reduction in all rural areas, but it also increases income inequality in the Sierra and in the Selva.

While increases in labour incomes – including farm incomes – are the main factor explaining improvements in welfare outcomes in Peru between 2004 and 2012, changes in non-labour incomes also play an important role, especially for the poorest. The expansion of public transfers, primarily through the implementation of a large-scale conditional cash-transfer programme (Juntos) since 2005, contributes considerably to the reduction in extreme

[13] See Table F1 in Online Supplementary Material F and compare with previous findings from Escobal (2001), Jonasson (2008), Loayza and Rigolini (2016) and Morley (2017).

poverty, particularly in the Sierra region. The study by Perova and Vakis (2012) confirms these welfare effects. However, as suggested by Fernandez and Saldarriaga (2014), the observed decline in working hours, which has a poverty- and inequality-increasing effect, may be connected to the receipt of Juntos transfers. The Juntos programme not only targets short-term poverty reduction, but also aims to break the intergenerational transmission of poverty through human-capital formation via improved access to education and health services. This might explain that in later years, increases in non-monetary forms of income – including, for example, more freely accessible medical services and public goods – contribute to reductions in poverty. Further, rising property values and an increase in food donations lead to reductions in moderate poverty, especially in the Costa.

Turning to the discussion of methodological aspects, not only are microsimulation models based on household income-generation models are not only effective in assessing the welfare implications of changing returns to rural assets, but they also permit us to model the impacts of discrete changes in individual behaviour – such as occupational choices or sectoral movements. However, empirically modelling these changes is not without its limitations. In the absence of a theoretical foundation and the reduced-form representation of labour-market behaviour, the decomposition exercises do not allow for the identification of causal effects and the related transmission channels of distributional change. Furthermore, the methodology applied is not designed to model any general equilibrium effects. It simply separates out how much of a given change would not have been observed under a well-defined statistical counterfactual, without making any statement about the economic foundations thereof. Yet, the analysis does allow us to focus on the elements that are quantitatively important in describing changes in poverty and inequality.[14]

Another limitation relates to modelling the income-generation process using OLS, as there are endogeneity problems in our estimations. These biases are, however, hard to fully avoid due to the absence of valid instruments. Our analysis also lacks data that reflects capital stocks and technical change in self-employment. This information would be very useful to help disentangle the income effects of changes in prices, productivity and technical change. Furthermore, information on land allocation to different crops per farm is missing. This sometimes makes a clear distinction of farming categories difficult, yet necessary for modelling occupational choices using a multinomial logit model (for details, see Online Supplementary Material D).

Another critical aspect concerns the simplified assumptions to model changes in non-labour incomes. By using the official eligibility criteria to simulate social-transfer receipts, we need to assume full programme coverage. This implies that the simulated effect must be understood as an upper bound, while the actual effect may have been somewhat smaller. Moreover, while we make some attempts to capture eligibility and crowding-out effects, the chosen approach is limited in its ability to capture interconnections between changes in different income sources. Specifically, we do not directly model the feedback effects that may result from a change in non-labour incomes, particularly an increase in public transfers, on labour supply. Two reasons justify this simplification: First, labour-supply responses are assumed to be moderate due to small transfer sizes. Second, the occupational choice equations control for those demographic characteristics that affect eligibility for public-transfer schemes. This indirectly allows for feedback mechanisms that work through the coefficient estimates for these characteristics. Feedback effects from private remittances on labour supply are further assumed to be negligible, as these on average account for 1 to 3 per cent

[14] For a more complete description of the general limitations of microsimulation based on income-generation models, see Bourguignon and Ferreira (2005) and Lay (2010).

of total household income (also compare Trivelli et al. 2009). Vice versa, feedback effects resulting from simulated changes in labour incomes are taken into account when evaluating the eligibility criteria for public transfers, whereas potential effects on other non-labour income sources are ignored.

In conclusion, we find that observed rural poverty reduction in Peru between 2004 and 2012 can be mainly attributed to positive ‘price’ effects in all sectors – most importantly, among staple-crop producers. In addition, increased non-labour income sources are a key explanatory factor. Increasing yields and positive price developments in both of Peru’s main staple crops, maize and potatoes, are not only responsible for more than half of total extreme poverty reduction, but also lead to a decline in income inequality – as many of the poorest farmers can be found operating in these sectors. Income gains in cash-crop farming also contribute to poverty reduction, but richer farmers benefit more than poorer farmers. The (sub-)sectoral patterns of income gains in agriculture thus exhibit clear patterns of distributional impacts. Yield increases in traditional crops help poor farmers, but so do price increases that go beyond the realm of export crops. One of the reasons for this is that domestic demand has been high given the growing domestic economy, which has in turn been driven by international developments – in particular the high demand for commodities and high commodity prices (not only in agriculture). The favourable evolution of the Peruvian economy increased wages and profits and created new jobs both inside and outside of agriculture. However, our analysis shows that these labour-market effects are less pro-poor than one would ideally hope for, as the poverty-reducing effects resulting from occupational shifts are only moderate. The taking-up of new and better-remunerated jobs is largely confined to better-educated (and typically less poor) individuals. Further, shrinking farm sizes and working fewer hours in rural areas hamper poverty reduction and are the main drivers of worsening income inequality in rural Peru.

Since some of the internal and external factors explaining Peru’s poverty reduction are only temporary, future rural development pathways in Peru may look less pro-poor. First, this is because Peru is extremely dependent on the performance of international commodity markets. Second, the key future trends that are likely to continue – the shift into high-value crops, the increase in wage employment and a more prominent role for non-agricultural activities – tend to be inequality-increasing. Yet, these outcomes can also be avoided by enabling the poor to benefit from these trends. The means to do so include improving transport infrastructure and marketing systems to open up opportunities for farmers in the Sierra and the Selva. Relatively lower (agricultural) commodity prices may be compensated by further crop-yield increases that may be achieved by better extension services. That land policies appear to work against the poor implies that these policies may need reconsideration, in particular if land expansion (or consolidation) facilitates entry into higher-value agricultural products. Opportunities in non-agricultural wage employment, especially in areas with limited agricultural development potential, can be harnessed by the poor only if they are equipped with the means to take advantage of them – by way of better public educational institutions or skills training. Whether the cash-transfer programme Juntos can help to provide these important public services to achieve long-term poverty reduction remains to be seen.

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References

Almeida dos Reis, J.G., Paes de Barros, R.: Wage inequality and the distribution of education. J. Dev. Econ. **36**(1), 117–143 (1991)
Blundell, R., Duncan, A., McCrae, J., Meghir, C.: The labour market impact of the working families' tax credit. Fisc. Stud. **21**(1), 75–104 (2000)
Bourguignon, F., Ferreira, F.H.G.: Decomposing changes in the distribution of household incomes: methodological aspects. In: Bourguignon, F., Ferreira, F., Lustig, N. (eds.) The Microeconomics of Income Distribution Dynamics in East Asia and Latin America, pp. 17–46. The World Bank, Oxford University Press, Washington DC (2005)
Bourguignon, F., Spadaro, A.: Microsimulation as a tool for evaluating redistribution policies. J. Econ. Inequal. **4**(1), 77–106 (2006)
Bourguignon, F., Fournier, M., Gurgand, M.: Selection bias corrections based on the multinomial logit model: Monte Carlo comparisons. J. Econ. Surv. **21**(1), 174–205 (2007)
Chong, A., Galdo, V., Torero, M.: Access to telephone services and household income in poor rural areas using a quasi-natural experiment for Peru. Economica **76**(304), 623–648 (2009)
Christiaensen, L., Demery, L., Kuhl, J.: The (evolving) role of agriculture in poverty reduction–an empirical perspective. J. Dev. Econ. **96**(2), 239–254 (2011)
Datt, G., Ravallion, M.: Farm productivity and rural poverty in India. J. Develop. Stud. **34**(4), 62–85 (1998)
de Janvry, A., Sadoulet, E.: Income strategies among rural households in Mexico: The role of off-farm activities. World Dev. **29**(3), 467–480 (2001)
Dercon, S.: Rural poverty: Old challenges in new contexts. World Bank Res. Obs. **24**(1), 1–28 (2009)
Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. Food and Agriculture Organization. In: Dixon, J.A., Gibbon, D.P., Gulliver, A. (eds.) The World Bank, Rome (2001)
Dubin, J.A., McFadden, D.L.: An econometric analysis of residential electric appliance holdings and consumption. Econometrica **52**(2), 345–362 (1984)
Elbers, C., Lanjouw, P.: Intersectoral transfer, growth, and inequality in rural Ecuador. World Dev. **29**(3), 481–496 (2001)
Escobal, J.: The determinants of nonfarm income diversification in rural Peru. World Dev. **29**(3), 497–508 (2001)
Escobal, J., Torero, M.: Measuring the impact of asset complementarities: the case of rural Peru. Cuadernos de economia **42**(125), 137–164 (2005)
Escobal, J., Ponce, C.: Dinàmicas provinciales de pobreza en el Perù 1993-2005. Working Paper Documento de Trabajo no. 11. Programa Dinàmicas Territoriales Rurales. Rimisp, Santiago de Chile (2008)
Fan, S., Zhang, L., Zhang, X.: Reforms, investment, and poverty in rural China. Econ. Dev. Cult. Chang. **52**(2), 395–421 (2004)
FAO: Technical compendium: Description of agricultural trade policies in Peru, Tanzania and Thailand Environment and Natural Resources Management Working Paper no. 36. Bioenergy and Food Security Project, Food and Agriculture Organization, Rome (2010)
Fernandez, F., Saldarriaga, V.: Do benefit recipients change their labor supply after receiving the cash transfer? Evidence from the peruvian juntos program. IZA J. Labor Develop. **3**(1), 2 (2014)
Figari, F., Paulus, A., Sutherland, H.: Microsimulation and policy analysis. In: Handbook of income distribution, vol. 2, pp. 2141–2221. Elsevier (2015)
Fort, R.: Assessing the impact of rural land titling in Peru: The case of the PETT program. Paper presented at the world bank conference on new challenges for land policy and administration. Washington DC (2008)
Gallardo, R.B., Saavedra, M.S. (eds.): Peru: Informe Nacional sobre el Estado de los Recursos Fitogenéticos para la Agricultura y la Alimentaciòn. Instituto Nacional de Inovacion Agraria (INIA). Food and Agriculture Organization, Lima (2009)
Inchauste, G., Olivieri, S., Saavedra, J., Winkler, H.: What is behind the decline in poverty since 2000? Evidence from Bangladesh, Peru and Thailand. World Bank Policy Research Working Paper no. 6199 Washington DC (2012)
INEI: Evoluciòn de la pobreza monetaria 2007 - 2012. Technical Report, Informe Tècnico, Instituto Nacional de Estadistica Informatica Lima (2013a)
INEI: Resultados Definitivos IV Censo Nacional Agropecuario 2012. El Instituto Nacional de Estadistica e Informàtica (INEI). Lima (2013b)
Jonasson, E.: Earnings differentials in the rural labor market: Does non-agricultural employment pay better? Working Paper no. 2008:7, Lund University. Department of Economics, revised 21 Feb 2009 (2008)
Juhn, C., Murphy, K.M., Pierce, B.: Wage inequality and the rise in returns to skill. J. Polit. Econ. **101**(3), 410–442 (1993)

Klasen, S., Priebe, J., Rudolf, R.: Cash crop choice and income dynamics in rural areas: evidence for post-crisis Indonesia. Agric. Econ. **44**(3), 349–364 (2013)
Labeaga, J.M., Oliver, X., Spadaro, A.: Discrete choice models of labour supply, behavioural microsimulation and the Spanish tax reforms. J. Econ. Inequal. **6**(3), 247–273 (2008)
Lanjouw, J.: The rural non-farm sector: Issues and evidence from developing countries. Agric. Econ. **26**(1), 1–23 (2001)
Lay, J.: Sequential macro-micro modelling with behavioural microsimulations. Int. J. Microsimul. **3**(1), 24–34 (2010)
Lee, J., Gereffi, G., Beauvais, J.: Global value chains and agrifood standards: Challenges and possibilities for smallholders in developing countries. Proc. Natl. Acad. Sci. **109**(31), 12326–12331 (2012)
Loayza, N., Rigolini, J.: The local impact of mining on poverty and inequality: Evidence from the commodity boom in Peru. World Dev. **84**, 219–234 (2016)
Losch, B., Frėguin-Gresh, S., White, E.T.: Structural Transformation and Rural Change Revisited, Challenges for Late Developing Countries in a Globalizing World. Agence Franċaise de Dėveloppement. The World Bank, Washington DC (2012)
Maertens, M., Minten, B., Swinnen, J.: Modern food supply chains and development: evidence from horticulture export sectors in Sub-Saharan Africa. Develop. Polic. Rev. **30**(4), 473–497 (2012)
Meade, B., Baldwin, K., Calvin, L.: Peru: An Emerging Exporter of Fruits and Vegetables. A Report from the Economic Research Service FTS-345-01. United States Department of Agriculture, Washington DC (2010)
Morley, S.: Changes in rural poverty in Perú 2004–2012. Latin Amer. Econ. Rev. **26**(1), 1–20 (2017)
Niemeyer, I., Garrido, A.: Latin American agricultural trade: the role of the WTO in sustainable virtual water flows. Paper presented at the European association of agricultural economists (EAAE) 2011 congress – change and uncertainty – challenges for agriculture, food and natural resources, Session: Analysing water usage. Zu̇rich, 30 Aug -2 Sep 2011 (2011)
OECD/FAO: OECD-FAO Agricultural Outlook 2015. OECD Publishing, Paris (2015)
Perova, E., Vakis, R.: 5 years in juntos: New evidence on the program's short and long-term impacts. Economía **35**(69), 53–82 (2012)
PWC: 2013 mining industry doing business in Peru,. Available via PricewaterhouseCoopers S. Civil de R.L. https://www.pwc.de/de/internationale-maerkte/assets/doing-business-in-mining-peru.pdf. Cited 2 Jul 2016 (2013)
Reardon, T., Berdeguė, J., Escobar, G.: Rural nonfarm employment and incomes in Latin America: Overview and policy implications. World Dev. **29**(3), 395–409 (2001)
Schuster, M., Maertens, M.: Do private standards create exclusive supply chains? New evidence from the peruvian asparagus export sector. Food Policy **43**, 291–305 (2013)
The Economist: Peru's roaring economy - hold on tight. Available via The Economist on 2 Feb 2013 from print edition. http://www.economist.com/news/americas/21571162-biggest-threats-latin-americas-economic-star-are-overconfidence-and-complacency-hold. Cited 30 Nov 2015 (2013)
Ticci, E., Escobal, J.: Extractive industries and local development in the Peruvian highlands. Working paper no. 693, University of Siena Department of Economics and Statistics (2013)
Trivelli, C., Yancari, J., de los Ríos, C.: Crisis and Rural Poverty in Latin America Working Paper No. 37. Rural Territorial Dynamics Program. Rimisp, Santiago de Chile (2009)
Velazco, J., Velazco, J.: Caracteristicas del empleo agricola en el peru̇. In: Garavito, C., Muṅoz, I. (eds.) Empleo y Protección Social. 1st edn., pp. 161–211. Departamento de Economia - Pontificia Universidad Catȯlica del Peru̇, Lima (2012)
WDI: World Development Indicators, The World Bank, Washington DC. http://data.worldbank.org/. Cited 13 March 2015 (2015)
Weinberger, K., Lumpkin, T.A.: Diversification into horticulture and poverty reduction: A research agenda. World Dev. **35**(8), 1464–1480 (2007)