

STRUCTURAL CHANGE: A REGIONAL ANALYSIS FOR PERU, 2003-2011

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Abstract This paper estimates three measures of ‘structural change’ associated to the contribution of labor reallocations between productive sectors and formal-informal activities to labor productivity growth in 24 regions of Peru during its growing period of 2003-2011. Thereafter, it presents an exploratory analyzes of a set of factors that may promote or hinder the process of ‘structural change’ in this economy. Along this period, productive structure and the share of the informal labor force for Peruvian economy and its regions have not changed in a significant way. Accordingly, the contribution to labor productivity growth of Peruvian economy (particularly in rich regions which concentrate about 43% of the Peruvian population) of sectoral and formal-informal activities measures of ‘structural change’ were relative small. Rising relative prices of the mining sector and the availability of information and telecommunications technology instruments may have promoted the small sectoral structural change experienced in the period. On the other hand, the four percentages point’s reduction of the share of the labor force working in informal activities from 2003 to 2012 seems to be caused by the decline of relative prices of the transport and communications sectors, regional economic growth and to less extent by the decrease of the share of agriculture output.

JEL Classification O17, R11, J24

Key Words: Structural changes, labor reallocation

1. Introduction

In the last ten years Peruvian economy has been one of the Latin American and Caribbean countries with an impressed rate of GDP economic growth (with annual average of 6.3%) and poverty population decline (from 58.7% in 2004 to 25.8% in 2012). However, it is no clear whether this growth has been accompanied by ‘structural change’ or economic development. On this matter, Rodrik & McMillan (2011) point out that: *“one of the earliest and most central insights of the literature on economic development is that development entails structural change. The countries that manage to pull out of poverty and get richer are those that are able to diversify away from agriculture and other traditional products. As labor and other resources move from agriculture into modern economic activities, overall productivity rises and incomes expand”*.

Based upon a set of surveys of households, this paper provides three estimations for ‘structural change’ and present an exploratory analyzes of a set of factors (postulated in the literature) that may promote or hinder the process of ‘structural change’ in Peruvian economy in period 2003-2011. As in Rodrik & Millan (2011), this is measured by the

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contribution of the regional reallocation of the labor force¹ between sectors and formal-informal activities² to labor productivity growth of each region of Peru. The period considered is divided in three sub-periods: one of expansion (2003-2008, with an annual average per capita real GDP rate of growth of 5.7%), another of lower growth (2009-2010 with a rate of per capita real GDP growth of 3.6%) and the last one of recovery (2011, with a per capita real GDP growth of 5.7%).

The remaining of the paper is divided in 5 sections. Section 2 describes a brief literature review on the subject. Section 3 describes some economic, geographic and social features of the regions of Peru. Section 4 estimates three measures of structural change and describe the ad-hoc model used to analyze the factors that affect these three measures. Section 5 presents the results of an exploratory analysis of factors that may have promoted or hinder the process of structural change. Section 6 summarizes the main conclusions.

2. Literature Review

Recent work on structural change across (developed and developing) countries has been developed by Alvarez-Cuadrado and Poschke (2011); Timmer and de Vries (2008), Rodrik and McMillan (2011). The first study deals with the ‘labor push’ and ‘labor pull’ causes of the decline of the agricultural employment share in 12 developed countries for period 1800-2000. They postulate that the key drivers of the decline of the agricultural employment share were: improvements in agricultural technology combined with Engel’s law release resources from agriculture (“labor push”), and improvements in industrial technology attract labor out of agriculture (“labor pull”). Based upon pool regressions techniques, their empirical results suggest that the “pull” channel dominated until 1920 and the “push” channel dominated after 1960. The “pull” channel mattered more in countries in early stages of the structural transformation.

The last two studies use the Groningen Growth and Development Centre (GGDC)-10 sectors data base³ and the shift-share analysis following Chenery, Robinson, and Syrquin (1986) of the labor productivity decomposition to measure ‘structural change’. Timer & de Vries, (TdV, 2008) analyze 19 Asian and Latin American developing countries for period 1950-2005 and Rodrik & McMillan (RM, 2011) analyze 38 countries (10 from Asia, 9 from Africa, 9 from Latin America, and 9 developed economies and 1 from Middle-East) in period 1990-2005. These studies find different results of the ‘shift, between or labor reallocation sectors effect’, denominated by RM (2011) the ‘structural change component’. On the one hand, TdV finds that growth

¹ Any individual between 14 and 98 years of age belongs to the employed labor force when one of the following conditions is satisfied. First, it had a temporal or fixed employment (which is not a household job) wherein it worked at least one hour during the week previous to that of the survey. Second, it did not have a job the previous week to the survey week although it had a fixed employment or business working at least an hour and that in the near future this individual will work again.

² An individual in the labor force, independent worker, a family worker without pay, or firm owner undertakes ‘informal activities’ when he or she is not legally registered or when he or she does not carry out countable books for tax purposes. The ‘informal activities’ do not include government or military activities.

³ <http://www.rug.nl/feb/Onderzoek/Onderzoekscentra/GGDC/data/10sector>

accelerations are explained by productivity increases within sectors, not by reallocation of employment to more productive sectors⁴. On the other hand, RM finds that in the post-liberalization period China, India, and some other Asian countries high-productivity employment opportunities have expanded and structural change has contributed to overall growth. However, in many other cases – in Latin America and Sub-Saharan Africa – globalization appears not to have fostered the desirable kind of structural change. Labor has moved in the wrong direction, from more productive to less productive activities, most notably, toward informal activities.

RM also analyze some determinants of structural change and find that the share of a country's exports that is accounted for by raw materials (as an indicator of comparative advantage) had a negative coefficient and a highly significant effect on structural change. Thus, they conclude that countries that specialize in primary products are at a distinct disadvantage.

Another contribution on the theoretical size (Krüger, 2008) postulates that supply- and demand-side factors closely interact in shaping the process of structural change. On the supply side, technological progress leads either to improved production technologies or to new goods. Improved production technologies allow for producing the same goods with lower unit costs and are therefore associated with productivity improvements. New goods frequently satisfy the same needs better than the existing ones and are consequently associated with higher product quality. On the demand side, factors like relative prices, preference for higher quality (at a given price), the desire for new goods and increasing saturation in the case of the existing ones influence quantity and composition of demand for the goods of different industries. The interaction of these factors gives structural change a specific direction and influences the speed at which this process is taking place

A second group of the literature has been concentrated on the analysis of structural change or the reallocation of labor in regions or sectors of particular countries. Thus, Andrienko and Guriev (2004) analyze the determinants of internal migration in Russia. Using panel data on region-to-region migration gross flows in 1992–99, they estimate the effect of economic, political and social factors. Two main results are obtained. First, people move from poorer and job scarce regions with worse public good provision to those, which are richer and prospering better in terms of both employment prospects and public goods. Second, for the poorest regions, an increase in income raises rather than decreases outmigration. On the other hand, Aquino and Muendler (2007) analyze jobs reallocations across employers and industries after Brazil's trade liberalization in the 1990s. They show that foreign import penetration and tariff reductions trigger worker displacements but that neither comparative-advantage industries nor exporters absorb displaced workers for years. Further, trade liberalization is associated with significantly more transitions to informal work status and self-employment.

Finally, a third group of literature emphasize the relationship of human capital (HK), economic growth, and structural change (e.g., Capasso, Carillo, and De Siano, 2012; Schivardi and Torrini, 2010; Buera and Kaboski, 2009; Ciccone and Papaioannou,

⁴ Only one (i.e., Bolivia) of the 19 countries did not follow this pattern of growth.

2006, Azzoni and Silveira Neto, 2005, Poirson, 2000; and many others). On the one hand, new theories of structural change with non-homothetic preferences and biased productivity change when incorporate the supply and demand side of human capital⁵ may explain better the changes in production structure. On the other hand, economic growth (generated by HK or other sources) may increase the demand of labor in sectors and/or activities wherein this growth is higher promoting labor reallocation among sectors or activities.⁶

Summing up, the literature revised postulates a series of factors that may promote or hinder structural change. First, pull and push factors related to technological change affecting the share of the agriculture sector (S_{Ag}), which has the lowest level of labor productivity in Peruvian economy. Thus, shifts of this share may be used as a proxy of such factors. Rising shares hinder structural change and declining share will promote this change. Other factors that may represent technological changes are the supply of information and communication technologies tools such as the number of mobile (T_{MOBIL}) and fixed telephones lines (T_{Fixed}) per one hundred persons. Second, comparative advantage in natural resource intensive sectors represented by the share of primary export value out of the total export value (SX_{PRIM}) will promote (hinder) structural change whenever these sectors do (not) develop linkages with other sectors and/or when their unskilled labor requirements is relative high (low). Third, the sectoral relative prices which captures supply, demand and technological factors. The most representative prices (relative to the deflator of the gross value added) are those of the agriculture (IPr_{Ag}), manufacturing (IPr_M), mining (IPr_{MIN}) and transport and communications sectors (IPr_{TC}).

Fourth, the regional increases of supply of public good and services, which may attract labor from other regions. This supply may be represented by the share of public investment out of the total gross value added ($SINV_{PUB}$) and the share of investment on public infrastructure out of total government expenditures (SG_{INFRA}). Fifth, regional economic growth ($dlnY$) may support structural change to the extent that sectoral growth and income effects may create pull and push to incentive for workers to mobilize towards sectors and activities of high labor productivity. Lastly, human capital represented by the share of literate labor force ($SLit$) out of the population older than fifteen years and the real investment expenditures in education (dollars of 1994) per capita ($GEDU_{pc}$) may also promote structural change through their supply and demand effects on sectors and activities intensives in the use of this factor. The ad-hoc model presented in Section 4 and estimated in Section 5 show the relevance of this set of factors in explaining sectoral and formal-informal activity regional structural changes in Peruvian economy during the period 2003-2011.

3. Economic and Geographic Features of Peruvian Regions

Figures in Tables 1, 2 and 3 show the regional heterogeneity in terms of poverty, per capita real gross value, size of labor force employed in informal activities and labor

⁵ Thus, availability of HK labor may promote reallocation of labor towards HK intensive industries and/or higher demand of goods and services intensive in the use of HK may promote such a labor reallocation

⁶ Empirical analysis of reverse causality going from labor reallocation to growth is not analyzed here.

productivity. The 24 regions⁷ of the economy are divided in three groups of regions: poor⁸, middle-income⁹ and rich regions.¹⁰

Table 1: Poverty, Population and Real Gross Value by Regions of Peru

Region	Poverty 2004 (%)	Poverty 2012 (%)	Population 2012 (000's)	GAV per capita av. Growth	GAV per capita 2011 (US\$ 1994)
Huancavelica	92.76	49.47	484	2.89	1,491
Apurimac	70.37	55.51	452	6.25	952
Huánuco	84.94	44.92	841	4.23	1,045
Puno	79.31	35.90	1377	5.08	1,426
Ayacucho	72.43	52.62	666	7.00	1,398
Pasco	67.13	41.88	298	3.04	2,851
Cajamarca	77.66	54.16	1514	3.71	1,515
Amazonas	71.49	44.48	418	5.89	1,383
Loreto	74.62	41.78	1007	4.75	1,772
Cuzco	63.95	21.92	1292	9.01	2,157
Poor	75.47	44.26	8348	5.24	1,583
Piura	73.38	34.87	1800	6.18	2,062
San Martin	67.88	29.65	806	6.65	1,489
Junín	56.16	23.73	1321	4.91	2,187
Ucayali	60.66	13.24	478	4.99	1,918
Ancash	62.24	27.43	1129	4.73	2,717
La Libertad	58.89	30.63	1792	7.09	2,474
Lambayeque	58.29	25.24	1229	5.43	2,035
Middle Income R.	62.50	26.40	8555	5.75	2,188
Moquegua	50.83	9.56	175	4.25	6,325
Arequipa	39.95	11.90	1245	6.78	4,198
Lima-Callao	45.46	14.44	10364	6.85	4,845
Tacna	43.27	11.69	329	4.75	3,666
Madre De Dios	29.14	2.36	128	7.37	3,030
Tumbes	35.99	11.70	228	6.27	1,906
Ica	43.13	8.08	764	8.95	3,800
Rich	41.11	9.96	13233	6.82	4,646
Peru	58.7	25.8	30136	6.82	3,095

⁷ The regions of Lima and Callao have been merged in only one region due to data limitations.

⁸ Huancavelica, Apurímac, Huánuco, Puno, Ayacucho, Pasco, Cajamarca, Amazonas, Loreto, and Cuzco.

⁹ Piura, San Martin, Junín, Ucayali, Ancash, La Libertad and Lambayeque.

¹⁰ Moquegua, Arequipa, Lima-Callao, Tacna, Madre de Dios, Tumbes and Ica.

Table 2: Share of the Informal Jobs and Regional of the EEAP by Regions of Peru

Regions	Share of OEAP (%)				Share of Informal Jobs of OEAP (%)			
	2002-08	2009-10	2011-12	2001-12	2002-08	2009-10	2011-12	2001-12
Huancavelica	1.66	1.57	1.59	1.64	90.73	88.44	88.22	89.92
Apurimac	1.63	1.54	1.55	1.61	88.09	87.90	88.20	88.14
Huanuco	2.97	2.84	2.79	2.92	91.07	88.60	85.51	89.83
Puno	5.27	5.02	4.96	5.21	88.57	87.03	87.02	88.05
Ayacucho	2.24	2.14	2.12	2.21	88.16	85.28	85.66	87.80
Pasco	0.92	1.00	0.98	0.94	77.93	76.24	76.99	77.71
Cajamarca	5.89	5.42	5.10	5.68	90.88	87.20	84.09	89.00
Amazonas	1.52	1.50	1.46	1.51	89.66	87.72	88.10	88.82
Loreto	3.11	3.03	3.08	3.08	79.65	78.39	77.81	79.03
Cuzco	4.87	4.67	4.70	4.83	85.93	81.76	79.96	84.33
Poor Regions	30.08	28.71	28.34	29.64	87.79	85.11	83.91	86.68
Piura	5.68	5.72	5.55	5.67	83.27	79.53	78.85	81.83
San Martin	2.74	2.71	2.74	2.73	85.90	81.14	82.27	84.28
Junín	4.54	4.35	4.39	4.49	84.53	81.27	79.15	83.28
Ucayali	1.47	1.64	1.66	1.53	78.55	77.85	78.34	78.55
Ancash	4.01	3.81	3.75	3.93	81.60	76.53	76.79	80.18
La Libertad	5.58	5.87	5.79	5.66	78.97	76.47	75.01	78.04
Lambayeque	3.91	4.08	3.98	3.95	81.62	81.72	80.42	81.08
Middle Inc. Regions	28.00	28.18	27.85	27.96	82.15	79.12	78.35	81.04
Moquegua	0.64	0.62	0.62	0.63	66.95	61.83	63.87	66.12
Arequipa	4.18	4.06	4.09	4.15	72.20	65.99	66.58	70.53
Lima-Callao	32.28	33.60	34.20	32.82	62.25	61.03	58.14	61.81
Tacna	1.13	1.08	1.10	1.12	71.45	66.68	67.42	70.23
Madre De Dios	0.40	0.46	0.46	0.42	79.36	76.55	74.56	78.32
Tumbes	0.80	0.79	0.79	0.80	79.74	72.67	75.42	77.79
Ica	2.44	2.49	2.54	2.47	67.78	65.05	65.67	66.95
Rich Regions	41.91	43.11	43.81	42.41	64.39	62.26	60.17	63.72
Peru	100	100.00	100.00	100.00	76.40	73.57	71.96	75.36

Source: INEI-ENAH0 (2002-2011). Author's own work

Table 3: Labor Productivity of Formal and Informal Jobs by Regions of Peru

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Indicator	Period	Huanca velica	Apuri mac	Huánu co	Puno	Aya cucho	Pasco	Caja marca	Ama zonas	Lore to	Cuzco	Poor
Average Total Labor Productivity (1994 US\$)	2003-11	2742	1483	1792	2168	2264	6048	2614	2167	3282	2818	2738
	2003-08	2666	1377	1729	2035	2024	6267	2530	2042	3123	2486	2628
	2009-10	2861	1646	1864	2378	2733	5592	2750	2377	3490	3289	2898
	2011	2961	1793	2031	2543	2766	5650	2842	2504	3815	3869	3077
Growth Rate Total Labor Productivity	2003-11	2.04	4.55	2.95	3.17	4.65	-0.30	1.77	3.32	1.98	8.55	3.27
	2003-08	1.77	3.21	2.74	3.07	4.29	2.65	0.73	3.70	0.78	8.13	3.11
	2009-10	3.04	8.39	2.28	2.81	8.66	-10.45	4.45	2.42	3.30	9.26	3.42
	2011	1.65	4.92	5.57	4.46	-1.20	2.30	2.65	2.86	6.52	9.64	3.94
Growth Rate Informal Labor Productivity	2003-11	13.27	7.42	10.25	14.09	9.10	9.42	3.80	11.69	11.93	12.34	10.33
	2003-08	10.87	4.48	12.44	16.34	9.68	12.78	2.31	14.93	11.57	15.34	11.07
	2009-10	22.90	26.40	5.50	11.01	17.74	9.01	12.62	10.27	23.64	12.57	15.16
	2011	8.41	-12.88	6.56	6.74	-11.61	-9.93	-4.90	-4.87	-9.37	-6.11	-3.80
Growth Rate in Formal Labor Productivity	2003-11	-1.16	6.02	-2.53	-0.36	5.98	-2.65	-2.32	1.68	2.70	6.11	1.35
	2003-08	-0.80	3.76	-2.07	-2.68	9.26	-1.59	1.71	2.60	2.49	4.66	1.73
	2009-10	-9.18	3.50	-4.13	4.38	-9.39	-11.09	-11.20	-9.39	-2.04	5.42	-4.31
	2011	12.68	24.61	-2.11	4.09	17.03	7.86	-8.78	18.27	13.47	16.19	10.33
Ratio Informa/Formal Labor Productivity (%)	2003-11	1.08	3.66	4.46	2.44	2.94	2.05	2.24	6.06	5.39	3.09	3.34
	2003-08	0.71	3.04	3.22	2.00	2.28	1.73	1.67	4.79	3.66	2.46	2.56
	2009-10	1.81	5.17	6.52	3.21	4.42	2.74	3.19	9.05	9.04	4.67	4.98
	2011	1.86	4.40	7.81	3.53	3.97	2.59	3.69	7.71	8.50	3.65	4.77

Source: INEI-ENAH0 (2002-2011). Author's own work**Table 3:** Labor Productivity of Formal and Informal Jobs by Regions of Peru

Indicator	Period	Piura	San Martin	Junin	Ucayali	Ancash	La Libertad	Lamba yeque	Middle Inc. Regions
Average Total Labor Productivity (1994 US\$)	2003-11	3618	2336	3716	3519	4870	4247	3452	3680
	2003-08	3396	2161	3541	3500	4673	4008	3267	3506
	2009-10	3910	2650	3978	3551	5235	4590	3700	3945
	2011	4368	2755	4247	3572	5324	4992	4064	4189
Growth Rate Total Labor Productivity	2003-11	4.10	3.66	3.25	0.07	1.25	4.28	1.87	2.64
	2003-08	4.19	4.03	3.75	0.01	1.25	5.28	0.94	2.78
	2009-10	1.11	2.61	1.32	0.48	1.36	0.47	2.39	1.39
	2011	9.55	3.51	4.07	-0.39	1.02	5.91	6.36	4.29
Growth Rate Informal Labor Productivity	2003-11	9.14	11.18	19.43	9.90	7.72	10.77	13.13	11.61
	2003-08	8.34	17.60	27.00	13.20	5.27	16.34	16.76	14.93
	2009-10	11.85	-1.55	-1.00	1.24	25.35	-4.11	4.89	5.24
	2011	8.48	-1.93	14.89	7.42	-12.91	7.16	7.81	4.42
Growth Rate in Formal Labor Productivity	2003-11	4.67	2.99	-3.61	-1.16	-1.82	1.77	2.07	0.70
	2003-08	5.25	-1.15	-3.11	-2.89	-0.99	3.51	2.45	0.44
	2009-10	1.46	-1.17	-3.10	5.17	-8.65	-4.56	1.73	-1.30
	2011	7.61	36.11	-7.64	-3.48	6.89	3.98	0.53	6.29
Ratio Informa/Formal Labor Productivity (%)	2003-11	2.95	9.89	4.62	9.89	2.48	4.56	4.01	5.49
	2003-08	2.25	8.04	3.48	8.18	1.73	4.11	3.41	4.46
	2009-10	4.42	14.60	6.47	13.17	4.04	5.56	5.08	7.62
	2011	4.19	11.55	7.71	13.61	3.89	5.29	5.42	7.38

Source: INEI-ENAH0 (2002-2011). Author's own work

Table 3: Labor Productivity of Formal and Informal Jobs by Regions of Peru

Indicator	Period	Moquegua	Arequipa	Lima	Tacna	Madre De Dios	Tumbes	Ica	Rich R.	Peru
Average Total Labor Productivity (1994 US\$)	2003-11	11822	6958	8022	6355	4694	2948	5946	6678	5079
	2003-08	11806	6470	7549	6134	4539	2760	5356	6373	4761
	2009-10	11954	7832	8700	6695	4761	3220	7001	7166	5557
	2011	11653	8140	9508	7005	5490	3526	7372	7528	6026
Growth Rate Total Labor Productivity	2003-11	1.24	4.32	3.62	2.00	2.45	3.14	5.70	3.21	3.70
	2003-08	2.91	5.60	3.61	1.52	1.15	2.26	7.01	3.44	3.80
	2009-10	-1.88	1.79	2.44	3.30	1.49	4.53	3.44	2.16	2.59
	2011	-2.54	1.70	5.97	2.30	12.12	5.69	2.33	3.94	5.33
Growth Rate Informal Labor Productivity	2003-11	4.52	11.99	14.52	18.63	21.21	17.58	12.29	14.39	11.74
	2003-08	6.46	15.93	23.18	26.17	29.56	23.83	16.58	20.24	16.63
	2009-10	-4.09	4.91	-2.90	8.31	3.61	5.88	8.96	3.53	3.38
	2011	10.09	2.50	-2.59	-5.93	6.28	3.43	-6.77	1.00	-0.89
Growth Rate in Formal Labor Productivity	2003-11	1.27	1.94	3.07	2.64	0.98	-0.63	5.25	2.07	1.96
	2003-08	1.86	2.21	3.06	1.91	-1.18	-1.88	7.25	1.89	2.10
	2009-10	-5.22	-0.51	5.69	-6.73	1.26	-3.30	-1.19	-1.43	1.41
	2011	10.71	5.26	-2.13	25.73	13.39	12.21	6.15	10.19	2.20
Ratio Informal/Formal Labor Productivity (%)	2003-11	2.22	5.44	6.23	5.00	8.56	12.80	4.96	6.46	4.34
	2003-08	1.83	4.22	5.42	3.61	6.48	9.89	4.00	5.07	3.58
	2009-10	2.97	7.76	8.04	8.12	13.09	19.18	7.26	9.49	5.92
	2011	3.09	8.13	7.52	7.08	11.94	17.48	6.09	8.76	5.73

Source: INEI-ENAH0 (2002-2011). Author's own work

Despite of the relative high economic growth and decline of the poverty rate¹¹ experienced by all groups in the period analyzed, still there exist notable differences in terms of those features. First, close to half of the poor population live in poor regions being its per capita real gross value about half of the respective of Peruvian economy and a third of per capita real gross value of the rich group of regions. Second, informal jobs still dominates the labor force employed in all the regions, its size (relative to the total employed economic active population, EEAP) was 72% between 2011 and 2012 with a decline of 4 percentages points with respect to period 2002-2008.

Informal labor force in poor regions in period 2011-2012 was 84% of the labor force and its decline was of 3.9 percentages points between the two periods. Third, labor productivity has been growing at rate greater than 2.6% in all groups of regions and the differences in this productivity between groups are similar to those of per capita real gross value. However, in all the groups of regions labor productivity in informal jobs is less than 10% of that of formal jobs, being 4.8% the lowest ratio in poor regions.

Finally, sectoral productive practically has remained constant throughout the period. Most of the regions are specialized on primary natural resources intensive sectors (such as mining, agriculture-which includes hunting and forestry, and fishing) and services of low labor productivity. These are the main *base sectors*¹² of the regions.

¹¹ Let 'z' and 'g' be the poverty line and the per capita expenditure on goods of services of a households 'i' respectively and 'n' the number of households then poverty rate is equal to: $\sum_i [(z-g_i)/z]^2 / n$. Note that z varies by region and in 2012 z for Peru was about 3.6 US dollars a day.

¹² Let s_{irt} be the output share (out of the total real gross value) of sector 'i' of region 'r' at period 't' and s_{it} is the respective share for the Peruvian economy. The ratio of these shares is $R_{irt} = s_{irt}/s_{it}$.

4. Estimation of Structural Change and The Ad-hoc Model Specification

Following Chenery *et al* (1986), Timmer and de Vries (2008) and Rodrik and McMillan (2011), three measures of ‘structural change’ are used in this paper. The first one decomposes labor productivity changes by two activities formal and informal. Let P_{rt} be the labor productivity¹³ of region ‘r’ at period ‘t’, P_{rinft} and P_{rft} are respectively the labor productivity of the labor force ‘employed’ in informal and formal activities of region ‘r’ at period ‘t’, and ω_{rinft} and ω_{rft} their respective labor shares out of the total labor force of the region ‘r’ at period t¹⁴. Then:

$$P_{rt} = \omega_{rinft} \cdot P_{rinft} + \omega_{rft} \cdot P_{rft}; \quad r=1, ..24; t=2002, \dots 2011; \quad (1)$$

$$\Delta P_{rt} = \omega_{rinft0} \cdot \Delta P_{rinft} + \omega_{rft0} \cdot \Delta P_{rft} + P_{rinft0} \cdot \Delta \omega_{rinft} + P_{rft0} \cdot \Delta \omega_{rft}; \quad (2)$$

$$\omega_{rinft0} = (\omega_{rinft} + \omega_{rinft(t-1)})/2; \quad \omega_{rft0} = (\omega_{rft} + \omega_{rft(t-1)})/2;$$

$$P_{rinft0} = (P_{rinft} + P_{rinft(t-1)})/2; \quad P_{rft0} = (P_{rft} + P_{rft(t-1)})/2;$$

Since $\Delta \omega_{rinft} + \Delta \omega_{rft} = 0$, then:

$$\Delta P_{rt} = \omega_{rinft0} \cdot \Delta P_{rinft} + \omega_{rft0} \cdot \Delta P_{rft} + \Delta \omega_{rinft} \cdot (P_{rinft0} - P_{rft0}); \quad \text{or} \quad (2)'$$

$$\Delta P_{rt}/P_{rt(t-1)} = [\omega_{rinft0} \cdot \Delta P_{rinft} + \omega_{rft0} \cdot \Delta P_{rft} + \Delta \omega_{rinft} \cdot (P_{rinft0} - P_{rft0})]/P_{rt(t-1)} \quad (3)$$

Wherein Δ is the differential operator. The first two components of the right hand side of equations (2)' or (3) denominated ‘within effects’ measures the contribution of the change of the labor productivity of the informal and formal within each activity. The third component of these equations is the regional ‘between or reallocation effects’ (RE_a) which measures the contribution on the change of the regional labor productivity of the reallocation of labor between informal and formal jobs. This is the first measure of structural change. Given that labor productivity of the informal jobs are lower than that of the formal then, for positive reallocation effects labor force is moving from informal towards formal jobs and regional labor productivity will increase. If this effect is negative, the contrary will occur and structural change will not take in place. Moreover, the labor size working on informal activities will increase. This RE_a is the sum of the regional reallocation effects of the labor force of formal (RE_{af}) and informal (RE_{aif}) jobs. These two last effects measures the changes of the share of the labor force in each activity with respect to the labor force of each region.

The second measure of structural change decomposes the regional labor productivity by nine productive sectors¹⁵. Then equations (1) and (3) become:

$$P_{rt} = \sum_s \omega_{rst} \cdot P_{rst}; \quad r=1, 24; s=1, 9, t=2002-2011; \quad (4)$$

$$\Delta P_{rt}/P_{rt(t-1)} = [\omega_{r10} \cdot \Delta P_{r1t} + \sum_s \omega_{rs0} \cdot \Delta P_{rst} + \sum_s \Delta \omega_{rst} \cdot (P_{rs0} - P_{r10})]/P_{rt(t-1)}; \quad (5)$$

$r=1, 24, s=2, 9, t=2003-2011$

This ratio is computed by year and then an average for period 2001-2011 is computed. Base sectors are those with R_{irt} values higher than one.

¹³ Measure by the real gross value added per worker in US dollars of 1994.

¹⁴ Note that: $\omega_{rinft} + \omega_{rft} = 1$

¹⁵ Agriculture, hunting and forestry; Mining and Electricity; Manufacture; Construction; Trade; Transport and Communications; Restaurants and Hotels; Government Services; and Other Services.

$$\omega_{rs0} = (\omega_{rst} + \omega_{rs(t-1)})/2; \quad P_{rs0} = (P_{rst} + P_{rs(t-1)})/2;$$

Similar to the previous equations, the first two terms of equation (5) represent the within effects in each sector 's' and the last one represent the sectoral reallocation effect, RE_{Srt} . This term is positive when the weighted shares of the non-agriculture more productive sectors (i.e., for s from 2 to 9) increases¹⁶ and negative if such shares decrease. The third measure of structural change arises when productive sectors are decomposed by activities. The formulas are the following:

$$P_{rt} = \sum_s \omega_{rfst} \cdot P_{rfst} + \sum_j \omega_{rinfst} \cdot P_{rinfst}; \quad \omega_{rfst} = L_{rfst}/L_{rt}; \quad \omega_{rinfst} = L_{rinfst}/L_{rt}; \quad (6)$$

$$WE_{Sart} = \sum_s \Delta P_{rfst} \cdot \omega_{rfst0} + \sum_s \Delta P_{rinfst} \cdot \omega_{rinfst0}; \quad (7)$$

$$RE_{Sart} = \sum_s \Delta \omega_{rfst} \cdot P_{rfst0} + \sum_s \Delta \omega_{rinfst} \cdot P_{rinfst0} =$$

$$\sum_s \Delta \omega_{rfst} \cdot (P_{rfst0} - P_{rinfst0}) + \sum_s (\Delta \omega_{rinfst} + \Delta \omega_{rfst}) \cdot P_{rinfst0}$$

$$RE_{Sart} = \sum_s \Delta \omega_{rfst} \cdot (P_{rfst0} - P_{rinfst0}) + \sum_s \Delta \omega_{rst} \cdot P_{rinfst0}; \quad (8) RE_{Sart} =$$

$$\sum_s \Delta \omega_{rfst} \cdot (P_{rfst0} - P_{rinfst0}) + \sum_{s'} \Delta \omega_{rs't} \cdot (P_{rinfst'0} - P_{rinfst0}); \quad s'=2, 9; \quad (8)'$$

$$P_{rfst0} = 0.5 \cdot (P_{rfst} + P_{rfst(t-1)}); \quad P_{rinfst0} = 0.5 \cdot (P_{rinfst} + P_{rinfst(t-1)});$$

$$\omega_{rfst0} = 0.5 \cdot (\omega_{rfst} + \omega_{rfst(t-1)}); \quad \omega_{rinfst0} = 0.5 \cdot (\omega_{rinfst} + \omega_{rinfst(t-1)});$$

$$\sum_s \Delta \omega_{rst} = 0 = \sum_s (\Delta \omega_{rfst} + \Delta \omega_{rinfst}); \quad (9)$$

$$\Delta P_{rt} = WE_{rSat} + RE_{rSat}; \quad r=1, 24; \quad s=1, 9, \quad t=2002-2011; \quad (10)$$

The sectoral-activity structural change, RE_{Sart} , is positive if, ceteris paribus, in average the labor share of the formal jobs within sectors increases or if in average the share of labor occupied on non-agricultural informal activities increases¹⁷. This sectoral-activity reallocation effect will be also positive if any of their components is positive and in its absolute value greater than the other component.

Equations (3), (5) and (8)' show the main differences among the three measures of structural change. The activity reallocation effects (RE_{art}) only captures the labor flows between informal and formal jobs and do not take into account the labor reallocation within sectors of the same activity despite of the fact that there might be labor productivity differences for a job activity of different productive sectors. The sectoral reallocation effects (RE_{Srt}), on the other hand, captures these labor flows between productive sectors but do not take account the labor reallocation between activities with different labor productivities belonging to the same sector. The sectoral-activity reallocation effects measure capture both labor flows between activities and sectors. Thus, when one informal worker belonging to one sector moves to another sector with higher labor productivity and works under the same informal conditions, then labor productivity of the region will increase despite the fact that informal labor force has not changed. This labor reallocation is not captured in the activity reallocation measure of structural change. On the other hand, when one worker of a sector moves from an informal to a formal activity within the same sector, labor productivity of the region will also increase. This reallocation effect, however, is not captured by the sectoral

¹⁶ s=1 is the agriculture, hunting and forestry sector. The average ratio between the labor productivity in any non-agriculture sector and the respective productivity of the agriculture sector in period 2002-2011 varies between 2.3 (for restaurants and hotels) and 22.5 (for mining).

¹⁷ The average ratio between the labor productivity of any non-agriculture sector and the respective of the agriculture sector in informal activities in period 2002-2011 varies between 1.18 (for restaurants and hotels) and 1.9 (for transport and communications).

reallocation measure of structural change. In both of these examples, the sector-activity reallocation effect will capture these movements of the labor force.

Tables 4, 5 and 6 show the estimations of these measures of structural change. Data sources of these measures come from the Households Surveys (INEI-ENAH, 2002-2011). To expand the indicators of the sample of household to population figures the expansion factors of 2007 were used. The numbers in column 'Fr' indicate the share of the number of the structural change measures with the same sign that the respective average of the group out of the total number of observations (equal to the number of years for each period multiplied by the number of regions of each group). The figures in these tables indicate that:

i) For the group of poor regions, in average for period 2003-2011 the sectoral reallocation effect was positive contributing 76% of the rate of labor productivity growth of this group. On the other hand, the activity reallocation effect was also positive although of lower magnitude of the former measure. This effect contributed to 52% the rate of labor productivity of this group. When sectoral and activities labor reallocation are taken together, the sectoral-activity structural change measure was negative. Moreover, around half of the number of observations for all three measures, the sign of the reallocations effects was negative¹⁸ suggesting that structural change did not occurred in this period or if it did, its size was rather small;

ii) For middle-income regions, structural change was also small for period 2003-2011. At the sectoral level, the sector reallocation effect contributed to 32% to the rate of growth of labor productivity of this group and 19% when sectors and activities are considered together. Similar to the former case, near half of the years and regions the sign of the three measures of structural change was negative¹⁹ suggesting also that structural change was small;

iii) For rich regions, even though the sectoral and activity within effect component explain more than 65% of the respective labor productivity growth of the period 2003-2011, the positive sectoral-activity reallocation effect explain more than 67% of the labor productivity growth for Peru and rich regions. This means that in those regions and for Peru, their labor productivity growth was mainly explained by the positive reallocation of informal workers between sectors. Once again, near half of the years and regions the signs of the three measures of structural change were negative²⁰;

iv) Sectoral-activity reallocation effects for middle income and rich regions of Peru have followed the same procyclical pattern of their respective labor productivities. Furthermore, such effects were negative for poor and middle-income regions in the period of low economic growth (2009-2010) suggesting that regardless of the sectors, informal jobs with low levels of labor productivity served as buffers for unemployed workers in recession periods. Nonetheless, labor productivity for poor regions has sustainably grown up throughout the period. Contrarily, the sectoral and activity reallocation effects had

¹⁸ In average for all the sub-periods, 46% of the observations (years and regions) of the sectoral reallocation effects were negative. The respective numbers for the activity and sectoral-activity reallocations effects were 53% and 49%.

¹⁹ In average for all the sub-periods, the negative sign for the sectoral, activity and sectoral-activity reallocations effects were respectively 48%, 39% and 44% of the observations.

²⁰ The respective averages were for this group: 49%, 53% and 47% of the observations.

different patterns. The sectoral reallocations effects grew sustainable during the whole period for poor and middle-income regions. The respective effects for rich regions were, however, procyclical. The activity reallocation effects had a countercyclical pattern for all three groups of regions, grew in recession periods and decreased in expanding periods for all the regions. Finally, for all the sub-periods, the signs of the structural change measures were negative in around 50% of the total number of years and regions. In the case of Peru, wherein the change of labor productivity is the weighted sum of the labor productivity of jobs in formal and informal activities, the activity and sectoral-activity reallocation effects were positive and procyclical. This pattern is consistent with the decreasing share of the informal jobs in the period (Table 2).

Summing up, the three measures of structural change in Peruvian economy suggest that this has not been significative throughout 2002-2011 and has been different between the three groups of regions of Peru. Thus, the group of poor region had the lowest levels of structural change considering jobs flows between sectors and activities and the rich group of regions had the highest levels.

Table 4: Sectoral Job Within and Reallocations Effects by Groups of Regions and Sectors of Peru (%)

Sector		Poor Regions								Middle Poverty Regions							
		2003-2008		2009-2010		2011		2003-2011		2003-2008		2009-2010		2011		2003-2011	
		ΔP/P	Fr	ΔP/P	Fr	ΔP/P	Fr	ΔP/P	Fr	ΔP/P	Fr	ΔP/P	Fr	ΔP/P	Fr	ΔP/P	Fr
A	W	0.502	57	0.840	80	0.446	60	0.571	62	0.745	71	0.689	86	0.233	86	0.676	76
	RE _S	-0.411	67	-0.423	75	0.032	60	-0.365	66	-0.499	64	-0.529	79	0.285	57	-0.418	65
Min.	W	-1.555	57	-0.556	55	2.100	40	-0.927	57	-0.051	62	0.685	43	-1.595	71	-0.059	62
	RE _S	1.937	55	0.359	65	-1.964	40	1.153	58	0.237	64	-1.125	50	0.969	71	0.016	62
Man.	W	0.188	52	0.211	45	0.367	70	0.213	52	0.155	60	-0.752	57	2.274	100	0.189	60
	RE _S	0.098	57	-0.088	45	-0.217	50	0.021	56	0.397	50	0.302	57	-1.491	71	0.166	49
C	W	0.375	58	-0.229	35	0.828	60	0.291	60	0.102	48	0.066	57	-0.142	57	0.067	49
	RE _S	0.129	55	1.348	70	-0.072	50	0.377	58	0.407	62	0.666	57	0.029	57	0.422	60
T	W	0.080	52	0.452	70	0.240	60	0.181	57	0.351	60	0.231	71	1.206	86	0.419	65
	RE _S	0.241	57	-0.012	50	0.416	60	0.204	56	-0.105	48	0.084	50	0.006	43	-0.051	49
TC	W	0.034	50	-0.007	55	-0.278	60	-0.010	52	-0.055	45	0.189	64	0.264	71	0.034	59
	RE _S	0.292	58	0.188	60	0.620	60	0.305	59	0.417	64	-0.016	64	0.287	57	0.306	57
RH	W	-0.038	47	-0.025	60	0.045	60	-0.026	49	-0.114	60	-0.222	57	0.560	71	-0.063	56
	RE _S	0.190	60	0.183	60	0.168	40	0.186	58	0.214	67	0.293	50	-0.236	57	0.181	60
Gov	W	0.001	47	-0.106	45	1.821	80	0.179	52	0.145	52	-0.084	64	0.962	86	0.185	52
	B	0.625	63	0.778	55	-1.227	70	0.453	58	0.088	57	0.401	64	-0.462	71	0.096	56
Other	RE _S	0.242	55	0.336	65	0.725	60	0.317	58	0.305	62	0.368	50	0.600	86	0.352	62
	B	0.179	52	0.168	65	-0.112	40	0.144	56	0.043	45	0.146	57	0.542	71	0.121	51
Pro duc tivity	W	-0.171	48	0.917	57	6.293	59	0.789	54	1.583	54	1.171	55	4.361	73	1.800	56
	RE _S	3.278	54	2.500	56	-2.356	48	2.479	55	1.198	55	0.221	49	-0.069	51	0.840	53
	Total	3.107	74	3.417	74	3.937	82	3.268	75	2.781	72	1.392	65	4.292	84	2.640	72

Notes: A=Agriculture, hunting and forestry. Min=Mining and Electricity, Man=Manufacture, C=Construction, T=Trade, TC=Transport and Communications, RH=Restaurants and Hotels, Gov=Government Services, Other=Other Services, Productivity=Labor productivity in the region

Table 4: Sectoral Job Within and Reallocations Effects by Groups of Regions and Sectors of Peru (%)

Sector		Rich Regions								Peru							
		2003-2008		2009-2010		2011		2003-2011		2003-2008		2009-2010		2011		2003-2011	
		$\Delta P/P$	Fr	$\Delta P/P$	Fr	$\Delta P/P$	Fr	$\Delta P/P$	Fr	$\Delta P/P$	Fr	$\Delta P/P$	Fr	$\Delta P/P$	Fr	$\Delta P/P$	Fr
A	W	0.430	67	0.387	64	0.221	71	0.397	67	0.433	83	0.379	100	0.350	100	0.412	89
	RE _S	-0.410	64	-0.470	71	0.407	86	-0.332	60	-0.321	83	-0.303	100	0.022	100	-0.279	78
Min.	W	0.639	50	0.863	57	-3.996	71	0.174	49	-0.384	67	0.103	50	-0.537	100	-0.292	67
	RE _S	-0.172	50	-0.949	50	4.520	86	0.177	54	0.590	83	-0.154	50	0.594	100	0.425	78
Man.	W	-0.147	45	-0.874	64	2.378	100	-0.028	44	0.413	67	0.469	50	1.571	100	0.554	67
	RE _S	0.697	57	0.623	43	-2.230	100	0.355	48	0.351	83	-0.361	100	-0.820	100	0.063	56
C	W	0.588	64	0.605	43	-1.452	71	0.365	56	0.237	67	-0.095	50	0.027	100	0.140	67
	RE _S	0.197	40	0.366	71	1.047	57	0.329	49	0.199	67	0.737	100	0.093	100	0.307	78
T	W	0.454	71	0.713	79	0.441	71	0.510	73	0.796	83	0.394	50	1.427	100	0.777	78
	RE _S	-0.087	50	-0.369	71	0.396	57	-0.096	54	-0.013	50	0.025	50	-0.229	100	-0.028	56
TC	W	0.225	55	0.114	50	-0.395	57	0.132	52	0.129	67	0.239	100	0.584	100	0.204	78
	RE _S	0.255	55	0.093	43	1.041	71	0.306	54	0.452	83	-0.105	50	0.301	100	0.312	78
RH	W	0.033	50	-0.040	50	0.636	100	0.084	56	0.062	67	-0.095	100	0.425	100	0.068	56
	RE _S	0.077	52	0.133	57	-0.350	86	0.042	49	0.082	67	0.224	100	-0.082	100	0.095	67
Gov	W	-0.030	55	0.016	50	1.035	86	0.098	51	0.031	67	-0.006	100	0.437	100	0.068	56
	RE _S	0.232	55	0.391	71	-0.709	71	0.163	56	0.135	50	0.307	100	-0.188	100	0.138	56
Other	W	0.583	64	0.089	50	1.925	86	0.622	63	0.497	67	0.668	100	0.804	100	0.569	78
	RE _S	-0.126	55	0.467	50	-0.978	71	-0.089	56	0.108	50	0.163	50	0.549	100	0.169	56
Pro duc tivity	W	2.774	58	1.874	53	0.793	68	2.354	58	2.215	54	2.055	55	5.090	66	2.499	56
	RE _S	0.663	51	0.285	51	3.146	52	0.855	51	1.584	53	0.533	52	0.240	50	1.201	53
Total		3.437	71	2.159	67	3.939	83	3.209	71	3.799	72	2.588	69	5.329	83	3.700	73

Notes: A=Agriculture, hunting and forestry. Min=Mining and Electricity, Man=Manufacture, C=Construction, T=Trade, TC=Transport and Communications, RH=Restaurants and Hotels, Gov=Government Services, Other=Other Services, Productivity=Labor productivity in the region

On the other hand, the middle-income group of regions had the lowest of structural change considering jobs flows between sectors and the poor group of regions had the highest levels. Finally, the rich group of regions had the lowest level of structural change considering jobs flows between activities and the poor group of regions had the highest levels. The next section analyzes the factors that have affected these measures of structural change using the following ad-hoc model:

$$RE_{mrt} = \beta_{0mrt} + \sum_j \beta_{jmrt} \cdot X_{jmrt(t-1)} + \varepsilon_{mrt}; r=1, 24; m=a; S; Sa; t=2003, 2011; j=1, K \quad (11)$$

Wherein RE_{mrt} represent the 'm' measure of structural change by region 'r' and period 't'; $X_{jmrt(t-1)}$ represent the set of K factors of region 'r', at period 't-1' that may affect the structural change 'm' measure through the parameter β_{jmrt} . This set of factors is drawn upon the literature reviewed in Section 2.

Table 5: Activity Formal and Informal Within and Job Reallocations Effects by Groups of Regions (%)

		Within Effect				Reallocation effect				Total					
		Formal	Fr	Informal	Fr	Formal	Fr	Informal	Fr	Within	Fr	Between	Fr	Total	Fr
Poor Regions	2003-11	0.36	51	1.19	60	1.77	54	-0.05	54	1.55	52	1.71	54	3.27	80
	2003-08	0.62	52	0.99	53	1.53	57	-0.03	57	1.61	53	1.50	57	3.11	78
	2009-10	-3.93	65	2.87	95	4.68	65	-0.20	65	-1.07	70	4.49	65	3.42	80
	2011	7.39	80	-0.91	70	-2.66	80	0.12	80	6.48	90	-2.54	80	3.94	90
Middle Poverty Regions	2003-11	-0.14	45	1.17	56	1.67	62	-0.07	72	1.03	56	1.61	62	2.64	76
	2003-08	-0.35	45	1.45	52	1.76	62	-0.08	62	1.10	57	1.68	62	2.78	79
	2009-10	-1.53	50	0.46	57	2.62	64	-0.16	64	-1.07	57	2.46	64	1.39	64
	2011	3.89	71	0.94	71	-0.76	43	0.23	43	4.83	71	-0.53	43	4.29	86
Rich Regions	2003-11	1.32	56	1.14	56	0.83	56	-0.09	56	2.47	60	0.74	56	3.21	76
	2003-08	1.24	55	1.42	50	0.86	62	-0.08	62	2.66	62	0.78	62	3.44	76
	2009-10	-1.68	47	0.73	71	3.43	50	-0.33	50	-0.95	57	3.11	50	2.16	71
	2011	7.86	86	0.28	57	-4.53	71	0.33	29	8.14	86	-4.20	71	3.94	86
Peru ¹	2003-11	1.65	67	0.82	44	1.29	78	-0.06	100	2.48	78	1.22	78	3.70	78
	2003-08	1.75	67	1.10	33	0.99	67	-0.04	100	2.85	83	0.95	67	3.80	83
	2009-10	1.21	50	0.48	100	0.96	100	-0.06	100	1.68	50	0.90	100	2.59	50
	2011	1.93	100	-0.12	100	3.74	100	-0.22	100	1.80	100	3.53	100	5.33	100

Source: INEI-ENAO (2002-2011). Author's own work. Fr Share of number of observations (region and years) with the same of sign of the average REs. ¹ For Peru, the number of observations is the number of years of the period.

Table 6: Sectoral-Activity (Formal, Informal) Within and Job Reallocation Effects by Group of Regions of Peru (%)

		Within Effect				Reallocation effect				Total					
		Formal	Fr	Informal	Fr	Formal	Fr	Informal	Fr	Within	Fr	Between	Fr	Total	Fr
Poor Regions	2003-11	2.64	48	1.38	55	-0.76	45	0.00	53	4.02	50	-0.75	44	3.27	75
	2003-08	3.74	47	1.17	54	-1.79	46	-0.01	46	-1.80	44	4.91	50	3.11	74
	2009-10	-4.47	57	3.30	65	4.73	59	-0.14	51	4.59	61	-1.17	53	3.42	74
	2011	10.31	62	-1.26	55	-5.52	50	0.40	54	-5.12	54	9.05	57	3.94	82
Middle Poverty Regions	2003-11	-0.67	49	1.18	55	2.18	53	-0.05	50	2.13	55	0.51	51	2.64	72
	2003-08	-1.27	51	1.51	54	2.65	55	-0.10	49	2.55	55	0.24	50	2.78	72
	2009-10	-1.97	58	0.41	56	3.07	53	-0.12	54	2.95	57	-1.56	52	1.39	65
	2011	5.56	62	0.77	57	-2.38	57	0.34	50	-2.04	54	6.33	67	4.29	84
Rich Regions	2003-11	2.46	51	1.34	55	-0.54	46	-0.05	52	-0.60	54	3.81	52	3.21	71
	2003-08	3.70	51	1.66	57	-1.83	47	-0.08	50	-1.92	47	5.35	52	3.44	71
	2009-10	0.21	44	1.03	54	1.23	59	-0.30	55	0.92	59	1.24	47	2.16	67
	2011	-0.45	38	0.10	45	3.65	54	0.64	46	4.29	51	-0.36	35	3.94	83
Peru ¹	2003-11	1.58	67	0.92	33	1.27	78	-0.07	78	1.19	78	2.51	78	3.70	78
	2003-08	1.65	67	1.23	33	0.97	67	-0.05	67	0.92	67	2.88	83	3.80	83
	2009-10	1.16	50	0.54	50	0.94	100	-0.06	100	0.88	100	1.70	50	2.59	50
	2011	2.02	100	-0.13	100	3.68	100	-0.24	100	3.44	100	1.89	100	5.33	100

Source: INEI-ENAO (2002-2011). Author's own work. Fr Share of number of observations (region and years) with the same of sign of the average REs. ¹ For Peru, the number of observations is the number of years of the period.

5. An Exploratory Analysis of the Determinants of Structural Change: Estimation and Results

Figures in Table 6 report the averages and standard deviation of the variables used to estimate equation (11) by group of regions in period 2003-2011. Data sources of each variable are the following:

- i) INEI-ENAH0 (2002-2011) for the reallocation effects measures as described in the former section;
- ii) INEI (2013) for the output shares, relative prices, literate rates and population older than 15 years;
- iii) MTC (2013) for fixed and mobile telephones lines;
- iv) SIICEX (2013) for the share of primary exports;
- v) MEF (2013) for public, infrastructure and education government expenditures, and
- vi) BCRP (2013) for government expenditures price index and the exchange rate of 1994.

Some features of the figures of Table 6 are worth mentioning. First, consistent with figures in Table 1, productive structure of the regions of Peru is oriented towards the production and exports of primary products, particularly mineral and agricultural products. However, the share of mining and agriculture sectors out of total real gross value and primary export value out of total exports are lower as the regional per capita real gross value added increases. Second, in the period 2002-2011, relative prices of agriculture, transport and telecommunications and manufacturing products has decreased and the respective of the mining sector has increased. These changes of prices have been associated with an increase of the share of the mining sector (gS_{MIN}) and a decrease of the share of the agriculture sector (gS_{Ag}). Third, as the per capita real gross value added of the group of regions rises, the rates of growth of the real gross valued added as well as the rate of the literate population older than fifteen years also rise.

Figures in Table 7 show the coefficients of three estimations methods of equation (11): the pooled generalized least squares (GLS) without regional effects and pooled generalized least squares with regional fixed (FE) and random effects (RE). All estimated with robust standard errors²¹.

Despite of the weak statistical results associated to data restrictions, figures of Table 7 indicate some plausible evidences. First, the reduction of the relative prices in the agriculture sector may have limited the reduction of the share of informal due to its statistical significative incidence on the activity reallocation effect. On the contrary, the effects of the reduction of the relative prices of transport and telecommunications output and the potential increase in human capital through an increase in the per capita public expenditure in education may have overcompensated the negative effect of prices promoting structural change in favor of formal jobs²².

²¹ Regressions for R_a and RE_s in all the three methods assume cross-section (regional) heteroskedasticity allowing for a different residual variance for each region and use a Panel Corrected Standard Error (PCSE) methodology (Beck and Katz, 1995) with cross-section correlation (period clustering) for computing the standard errors of the coefficients. In the case of RE_{Sa} the methods pooled LS and RE use cross-sections heteroskedastic and serially correlated (cross-section clustered) errors for computing the standard errors of the coefficients. The FE method follows the same error structure of R_a and RE_s .

²² Note that the RE_a was positive for all the groups of regions in period 2003-2010.

Table 6: Mean and Standard Deviation of Variables of Equation (11) by Group of Regions of Peru, 2002-2011 (%)

	Poor		Middle		Rich		Peru	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Rea	1.715	10.113	1.607	9.530	0.742	9.592	1.399	9.759
RE _s	2.479	16.320	0.840	10.240	0.855	6.955	1.527	12.453
RE _{Sa}	-0.752	42.828	2.127	20.981	-0.597	28.234	0.133	33.433
dlnY	4.980	3.905	5.494	3.506	6.170	4.275	5.477	3.923
dlnY _B	4.434	43.059	4.602	8.364	4.844	7.304	4.602	28.348
gS _{MIN}	12.497	77.932	0.127	11.940	0.785	13.614	5.473	51.438
SMIN	13.372	15.752	8.669	10.197	13.776	13.598	12.118	13.825
gS _{Ag}	-1.518	7.036	-1.408	7.507	-1.302	11.069	-1.423	8.495
S _{Ag}	20.012	8.554	15.386	7.282	9.043	4.494	15.463	8.496
SXPRIM	62.526	39.706	42.843	33.048	23.063	19.847	45.275	36.781
SINVPUB	9.582	7.598	5.012	3.673	6.132	8.207	7.243	7.167
dlnGEDU _{PC}	8.522	6.623	6.895	5.046	6.260	12.042	7.388	8.269
SALF	83.217	5.788	89.915	3.093	94.324	1.748	88.410	6.302
dlnIPrA	-1.097	9.037	-0.093	8.994	-1.990	12.324	-1.065	10.078
dlnIPrTC	-1.864	7.219	-0.795	5.132	-2.592	6.847	-1.765	6.573
dlnIPrMAN	-2.018	7.550	-1.360	4.826	-1.687	5.777	-1.730	6.328
dlnIPrMIN	7.995	15.819	6.742	13.906	7.728	14.523	7.552	14.855
SG_INFRA	3.178	4.006	1.643	1.732	2.181	5.440	2.439	4.061
dlnTMOBIL	42.191	31.616	33.828	27.461	29.991	25.247	36.193	29.047
dlnTFIJO	6.427	8.260	6.966	6.117	4.347	6.635	5.978	7.275

Sources: INEI-ENHO (2002-2011), INEI (2013, 2013), MEF (2013), BCRP (2013), MTC (2013), SICEX (2013). Author's work. The period for the reallocation effects is 2003-2011.

Table 7: Regression Coefficients of Equation (11) of Regional, Sectoral and Activity Structural Change in Peru, 2003-2011

	GLS			Fixed Effects			Random Effects		
	RE _s	RE _a	RE _{Sa}	RE _s	RE _a	RE _{Sa}	RE _s	RE _a	RE _{Sa}
dlnY _(t-1)	0.003	0.106	0.790***	-0.046	0.121	0.748***	-0.202	0.097	0.417
S _{Ag(t-1)}	-0.025	-0.008	-0.187	0.103	-0.079	-1.171	-0.031	-0.020	-0.288**
SX _{PRIM(t-1)}	-0.010	-0.002	0.038	-0.024	0.028	0.147**	-0.001	-0.009	0.043
SIN _{V_{PUB(t-1)}}	0.078	-0.006	0.336	0.081	0.060	0.170	0.385	0.005	0.918
SG_INFRA _(t-1)	-0.131	-0.231	-0.535	-0.093	-0.308	-0.083	-0.568	-0.220	-1.838
SLit _(t-1)	-0.144	-0.109	0.023	0.458	0.305	0.305	-0.006	-0.092	0.330
dlnIPr _{A(t-1)}	0.032	0.268***	0.195	0.002	0.238***	0.152	0.004	0.235***	0.203
dlnIPr _{TC(t-1)}	-0.104	-0.321***	-0.347	-0.082	-0.295**	-0.331	-0.219*	-0.189	-0.537
dlnIPr _{M(t-1)}	-0.013	-0.030	0.095	-0.037	0.023	0.122	-0.062	-0.066	0.219
dlnIPr _{MIN(t-1)}	0.030*	0.046	-0.003	0.038*	0.065*	0.003	0.064	0.048	0.107
dlnGEDUp _{C(t-1)}	0.029	0.180**	0.065	-0.002	0.177**	0.064	-0.066	0.121	0.038
dlnT _{FIJA(t-1)}	-0.069	-0.125	0.143	0.010	-0.049	0.170	0.276	-0.093	0.228
dlnT _{MOBIL(t-1)}	0.035*	0.007	0.047	0.039*	0.008	0.040	0.038	0.028	0.117
Constant	13.37	10.06	-8.73	-41.57	-27.89	-23.62	-1.42	8.25	38.24
Obser.	216	216	216	216	216	216	216	216	216
R ²	0.081	0.161	0.077	0.125	0.203	0.109	0.069	0.078	0.046
Adj-R ²	0.022	0.107	0.018	-0.052	0.042	-0.070	0.009	0.018	-0.015
F	1.71*	3.34***	4.59***	2.59***	3.67***	1.16	2.75***	1.90**	5.2***
χ ²	24.0**	46.7***	64.3***	36.3**	51.4***	16.2	38.5***	26.64**	72.8***

Second, regional economic growth and to less extent reduction in the agriculture output share may have contributed to the sectoral-activity reallocation effect.

Third, sectoral reallocation effects, the lowest in magnitude of the three measures of structural change would seem to respond positive and in statistical sense to increase in the

relative prices of the mining sector and the growth of the number of mobile lines per 100 persons experienced throughout the period. This small magnitude of the sectoral reallocation effects is consistent with the constant productive structure of Peru and its regions oriented toward the production of primary natural resources intensive products and services of low level of labor productivity.

6. Conclusions

This paper has estimated three measures of ‘structural change’ associated to the contribution of labor reallocation between sectors and formal and informal activities on the rate of change of the labor productivity of 24 regions of Peru during the period 2003-2011. The empirical results indicate that sectoral productive structure for the Peruvian economy and its regions practically has remained constant throughout the period. Consequently, the sectoral measure of structural change had the lowest level of the three measures explaining between 27% and 32% of the rate of change of labor productivity of the Peru and its middle income and rich regions. Subject to data limitations, the exploratory analysis of the factors that may promote or hinder structural change suggests that the increase of the relative prices of the mining sector and the growth of mobile telephone lines may have contributed to the small sectoral structural change experienced in the period.

On the other hand, the four percentage points reduction of the share of the labor force working in informal activities informal is consistent with the formal-informal activity measure of ‘structural change’ which contribute between 33% and 61% of the rate of growth of labor productivity of Peru and its three group of regions. The exploratory analysis indicates that the decrease of the relative prices of the transport and telecommunication output and the increase of the per capita government expenditures in education may have promoted the increase of the share of the labor force employed in formal jobs

The last measure of structural change in addition to the contribution of the reallocation of labor between sectors and between formal-informal activities to labor productivity growth incorporates the contribution of labor reallocation between activities of the same sector and between sectors of the same activity. This measure contributed between 16% and 86% of the labor productivity growth of Peru and its 3 group of regions. Regional economic growth and to less extent the decrease of the share of the agriculture output might have explained this measure during the period 2003-2011.

The three measure of structural change indicates that despite of the impressive record of economic growth and poverty reduction experienced by Peruvian economy, this growth has not contributed in a significant way to the process of economic development in its regions, and large gaps of labor productivities between regions, formal-informal jobs activities, and sectors persist. Consequently, development process would not only need economic growth and decline of poverty but also it would require, on the one hand, a drastic change of the productive structure through product-sector diversification away from natural-resources intensive industries and services of low labor productivity. On the other hand, it would require a reduction of the labor productivity gaps between sectors and jobs activities either by labor reallocation from low to high productivity sectors or jobs or by promoting substantial productivity increases in sectors and jobs activities of low productivity.

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