

# LABOR ELASTICITY OF GROWTH BY SECTOR AND DEPARTMENT IN COLOMBIA: THE IMPORTANCE OF THE AGRICULTURAL EMPLOYMENT ELASTICITY

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## ABSTRACT

The employment elasticity measures the employment generated per unit of economic growth. The general literature suggests that low elasticities in the agricultural sector, along with high elasticities in the other sectors are appropriate for pro-poor economic growth. This paper estimates the employment elasticities in Colombia at the national and departmental level, in general as well as by sector, and analyzes how they relate to certain socioeconomic variables. Main results show positive nation-wide elasticities, relatively lower in agriculture, suggesting a movement from lower to higher-productive jobs. Highly competitive regions show positive and large elasticities in manufacturing and services, while low competitive regions have large negative elasticities in the agricultural sector.

**Key words:** Agricultural sector, Colombian labor market, competitiveness, economic growth, employment elasticity, inter-sectoral shifts

## RESUMEN

La elasticidad de empleo mide la cantidad de empleo generado por unidad de crecimiento económico. En general, la literatura sugiere que bajas elasticidades en el sector agrícola, conjuntamente con altas elasticidades en otros sectores, favorecen el crecimiento pro-pobres. Este artículo estima las elasticidades de empleo en Colombia a nivel nacional y departamental, en general y por sector, al tiempo que analiza su relación con algunas variables socioeconómicas. Los resultados muestran elasticidades positivas a nivel general, relativamente más bajas en agricultura lo que sugiere movimiento desde trabajos con baja productividad hacia trabajos más productivos. Regiones altamente competitivas muestran elasticidades altas y positivas en manufactura y servicios, mientras que regiones con bajos niveles de competitividad tienen altas elasticidades negativas en agricultura.

**Palabras clave:** crecimiento económico, competitividad, elasticidad de empleo, mercado laboral colombiano, movimientos inter-sectoriales, sector agrícola

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## RÉSUMÉ

L'élasticité de l'emploi mesure la quantité d'emplois générés par unité de croissance économique. En général, la littérature suggère que les faibles élasticités du secteur agricole, conjuguées à des élasticités élevées dans d'autres secteurs, stimulent une croissance favorable chez les populations en situation de pauvreté. En ce sens, ce travail vise à évaluer les élasticités de l'emploi en Colombie aux niveaux national et départemental, en général et par secteur, ainsi qu'à analyser leur relation par rapport à variables socio-économiques sélectionnées. Les résultats montrent des élasticités positives à un niveau général, relativement plus faibles dans l'agriculture que dans d'autres secteurs économiques. Ce résultat-ci suggère un mouvement des emplois à faible productivité, vers des emplois plus productifs. Les régions très concurrentielles affichent des élasticités élevées et positives dans la fabrication et les services, tandis que les régions à faible niveau de compétitivité ont des élasticités négatives élevées dans l'agriculture. **Mots-clé** : compétitivité, croissance économique, élasticité de l'emploi, marché du travail, mouvements intersectoriels, secteur agricole, Colombie

## RESUMO

A elasticidade do emprego mede a quantidade de emprego gerada por unidade de crescimento econômico. Em geral, a literatura sugere que baixas elasticidades no setor agrícola, juntamente com altas elasticidades em outros setores, favorecem o crescimento pró-pobre. Este artigo estima as elasticidades de emprego na Colômbia nos níveis nacional e departamental, em geral e por setor, e analisa sua relação com variáveis socioeconômicas. Os resultados mostram elasticidades positivas em um nível geral, relativamente baixo na agricultura, o que sugere a movimentação de empregos com baixa produtividade para empregos mais produtivos. Regiões altamente competitivas mostram elasticidades altas e positivas na manufatura e nos serviços, enquanto regiões com baixos níveis de competitividade têm elasticidades negativas elevadas na agricultura.

**Palavras-chave:** competitividade, crescimento econômico, elasticidade do emprego, mercado de trabalho colombiano, movimentos intersetoriais, setor agrícola

## 1. INTRODUCTION

Pro-poor economic growth is crucial for poverty reduction through decent and productive employment, including the reduction of informality. In the last decades, several countries have experienced jobless growth; this is, positive economic rates of growth accompanied by an insufficient increase in employment. The output-employment elasticity, labor intensity of growth or employment elasticity (EE) denotes the rate at which employment grows when output increases by one percent.

Like other labor market indicators, the EE does not have a unique interpretation, which could be misleading for policymakers. Since this elasticity is represented as the ratio between the change in employment and the change in output, a positive (negative) value is not always a good (bad) signal. High, positive or increasing values can indicate that more jobs are created per unit of output growth, but also could mean that labor productivity is falling and therefore working

poor are increasing. Low, but positive or decreasing values could indicate that fewer jobs are created per unit of economic growth, and therefore unemployment is rising or could be the result of increasing productivity and falling unemployment. Negative elasticities arise when either employment or economic growth is negative, which is always a negative sign. However, this elasticity could end up being positive if both employment and output fall simultaneously<sup>3</sup>.

It is not just the magnitude of the effect that matters. It is also necessary to address the question about in what sectors are these elasticities observed and how they relate to the quality of jobs, because promoting employment-intensive growth may not necessarily imply poverty reduction<sup>4</sup>. Raising the EE or improving the quality of the available jobs (which is expected to raise the

<sup>3</sup> Kapsos (2005) summarizes the interpretation for all possible combinations of employment and output growth.

income these jobs generate) is a dilemma policymakers face for pro-poor growth purposes. Another dilemma is whether these policies should promote growth in the sectors where the majority of workers are poor, to enhance employment opportunities for them, or to promote growth in other sectors where poor could move in (ILO, 2003). The idea behind this, that concerns to this research, is that promoting labor-intensive growth in some key sectors might be better for poverty reduction than raising the total impact of growth (sectoral impact of growth), by dragging poor workers from low to higher-earning sectors of the economy, *i.e.* inter-sectoral shifts.

Therefore, it is not just the EE by itself that matters, but also its sectoral pattern and the productivity behavior in those sectors. According to Gutierrez, Orecchia, Paci, & Serneels (2007), high EE in the secondary sector reduces poverty, while high EE in the primary sector increases it so that pro-poor policies should promote more jobs in the first and more productivity in the second. Since productivity-intensive growth in agriculture has a significant effect on poverty, Manning & Purnagunawan (2013) call for policies targeting the EE in some specific sectors and subsectors. Particularly, they consider that a negative employment elasticity in agriculture is a positive sign, indicative of an inter-sectoral shift away from low productivity jobs.

As said before, EE is highly associated with productivity factors which, in turns, determine the capacity of an economy to compete in international markets. Like many other Latin American countries, Colombia has struggled to improve its productivity and become more competitive. According to the Global Competitiveness Report 2016-2017

(WEF, 2016), Colombia is the fifth more competitive country in Latin America, occupying the position 61<sup>5</sup> out of 138, after Chile (35), Panamá (50), Costa Rica (52) and Mexico (57). This is a good indicator, especially if we consider all the variables taken into account to compute the Global Competitiveness Index (GCI), which includes institutional, political and economic factors<sup>6</sup>. This result classifies Colombia as an efficiency-driven economy (stage two of the GCI)<sup>7</sup>. Particularly, the country exhibits its main strength in the efficiency sub-index (position 48) and innovation (63), but perform worse in the basic requirements sub-index (85). However, Colombia is a heterogeneous country so that that index as a whole does not reflect the existing deep inequalities across regions. This is why since 2008 the Private Competitiveness Council (CPC, by its name in Spanish) estimates a Departmental Competitiveness Index (DCI), similar to the GDI, for Bogotá and 25 of the 32 departments in the country<sup>8</sup>.

The purpose of this paper is twofold. First, we estimate the general and sectoral EE (agriculture, manufacturing and services

<sup>5</sup> Colombia ranked 69<sup>th</sup> in 2014-15 and 66<sup>th</sup> in 2015-16.

<sup>6</sup> The index relies on 119 indicators combined in 12 pillars, organized in 3 sub-indexes: Basic requirements (institutions, infrastructure, macroeconomic environment, health and primary education), efficiency (higher education and training, goods market and labor market efficiency, financial market development, technological readiness market size) and innovations and sophistication (business sophistication and innovation).

<sup>7</sup> The GCI classifies countries in five different stages: Factor-driven, efficiency-driven, innovation-driven, transition from stage 1 to 2 and transition from stage 2 to 3.

<sup>8</sup> Colombia is divided 32 departments and Bogotá, distributed across 5 regions. The Atlantic region includes Atlántico, Bolívar, Cesar, Córdoba, La Guajira, Magdalena, and Sucre. Bogotá D.C., as well as the departments of Antioquia, Boyacá, Caldas, Cauca, Cundinamarca, Huila, Nariño, Norte Santander, Quindío, Risaralda, Santander, Tolima, and Valle del Cauca are located in the Andean region. The remaining 9 departments are located in the last three regions: Pacific, Orinoco and Amazon. Of them, information is only available for Caquetá, Chocó, and Meta.

<sup>4</sup> Poverty rate decreases when workers are able to either move from bad to good jobs (inter-sectoral shift) or jump into them from unemployment, as the result of a higher demand for products in this last group. If workers move from bad to good jobs, there will be a productivity-intensive growth without affecting the unemployment. However, the higher the productivity the higher the wage, which can also help to reduce poverty. These effects may not be observed in the short run since capital is fixed (Gutierrez, Orecchia, Paci & Serneels, 2007).

sectors) for the country as a whole as well as for 24 departments, including Bogotá D.C., for which information is available. Second, we use Principal Component Analysis to relate these EE to macroeconomic variables and competitive indicators at the departmental level and use cluster analysis to classify departments according to their elasticities and competitiveness. The results show an EE above one for the country, and a promising behavior at the different sectors: Greater than one in services and manufacturing sectors, and high but less than one in agriculture, behavior that could suggest workers are moving from low-productive to high-productive jobs. Unfortunately, it says nothing about the quality of the jobs, especially if we consider the high level of informality that averaged 56.3% in 2016.

Competitiveness appears to be negatively associated with informality and unemployment but positively related to high elasticities in agriculture, sector that represents the majority of the non-oil Colombian exports. High elasticities in manufacturing and services are accompanied by higher levels of economic growth. However, according to these results, economic growth does not necessarily mean to be competitive, and vice-versa. The majority of the departments show negative elasticities in agriculture, while all elasticities in services are positive. The cluster analysis generates four groups, with the most competitive departments showing positive elasticities, larger in services. Even though there is no clear indication of how competitiveness and elasticities relate to each other, the clusters based on competitiveness, on elasticities, or both show similar results.

**2. THEORETICAL FRAMEWORK**

The EE represents the ratio between the relative change in employment (*E*) and the relative change in output (*Y*):

$$EE = \frac{\left[ \frac{E_t - E_{t-1}}{E_{t-1}} \right]}{\left[ \frac{Y_t - Y_{t-1}}{Y_{t-1}} \right]} \quad (1)$$

which can be obtained by either direct application of the above expression or

through econometrics models. The simplest model is given by

$$\dot{e}_t = \beta_1 + \beta_2 \dot{y}_t + \varepsilon_t \quad (2)$$

or

$$\text{Ln}_E_t = \beta_1 + \beta_2 \text{Ln}_Y_t + \varepsilon_t \quad (3)$$

where  $\dot{e}_t$  and  $\dot{y}_t$  represent rates of growth,  $\text{Ln}_E_t$  and  $\text{Ln}_Y_t$  stay for the logarithm of employment and output, and  $\beta_2$  is the estimated EE. Seyfried (2014) modifies equation (2) to consider the persistence of employment growth for several European countries during the period 1999-2012, using impulse-response analysis to determine the appropriate lag-structure based on the Akaike information criterion:

$$\dot{e}_t = \beta_1 + \beta_2 \dot{y}_{t-1} + \beta_3 \dot{e}_{t-j} + \varepsilon_t \quad (4)$$

Gutierrez *et al.* (2007), on the other hand, measures the effect of changes in per capita value added on employment by sector, instead of economic growth, considering a sample of 37 developing countries for the period 1980-2004 based on the following expression:

$$EE_i = (\Delta y/y) \bar{y}_i (1-\bar{a}) \bar{e}_i \quad (5)$$

where  $y = Y/A$  represents the value added per working person, with **Y** indicating the total value added, **A** as the total population working age, and  $\bar{y}_i$  as the share of growth in **y** in sector *i* attributable to economic growth;  $\bar{a}$  corresponds to the marginal contribution of the inverse of the dependency ratio (*A/N*) to the change in per capita income, with *N* indicating total population;  $\bar{e}_i$  represents the share of total growth attributable to growth in the employment rate, with  $e = E/A$ .

Besso (2010) analyzes the impact of some macroeconomic variables on EE in Cameroon for the period 1994-2003. To do that, he estimates equation (2) considering the production of primary, secondary and tertiary sectors, and its share (*b*) in the total output, as follows:

$$\dot{e}_t = \beta_0 + \beta_1 h_1 \dot{y}_{1t} + \beta_2 h_2 \dot{y}_{2t} + \beta_3 h_3 \dot{y}_{3t} + \varepsilon_t \quad (6)$$

Then, he uses the estimated elasticities to fit a model in which labor force, growth rate of rural and urban population, final consumption expenditure of household, household income, rate of growth of financial capital and productivity of labor are used as explanatory variables. He also estimates the EE separately for public and private (formal and informal) sectors, gender and age group. His results indicate that the effect of all these variables is weak.

It is well known that in developed economies the primary sector employs a relatively small proportion of workers with a declining and even negative labor intensity but increasing productivity<sup>9</sup>. In fact, countries that have proven to substantially reduce poverty showed a significant increase in workers' productivity that allows them an inter-sectoral shift in their transition out of agriculture. Ernst & Berg (2009) indicate that alleviating poverty in the agriculture sector requires incentives such as fair prices, access to services and markets, and land rights to encourage investments in technology. The higher the productivity in this sector, the higher the opportunity for workers to move to more productive and better-paid jobs in manufacturing and services, with a substantial reduction in poverty as proven by the experience in Indonesia, China, Vietnam and Uganda in the last decades of the XX century. In fact, the poverty reduction in East Asia was mostly due to high EE in secondary and tertiary sectors (Khan, 2007). This does not imply abandoning agricultural activities to saturate the labor market in the other sectors, but making the primary sector productive enough to support the development of the others to become competitive.

Papers such as Nuñez & Espinosa (2005) and Sarmiento, González, Alonso, Angulo, & Espinoza (2005) analyze the economic evolution of Colombia across years and

conclude that the observed growth was not in favor of the poor due to the lack of policies aimed at the creation of quality employment and to the improvement in the productivity level of each sector. For several years, the CPC has been working on the design of proposals that guide public policies around a structural change in the country that allows improving its level of competitiveness and reduce poverty. These proposals revolve around the sophistication of the Colombian productive system, and the solution of some structural problems that prevent such sophistication.

The Colombian National Development Plan 2014-2018 (República de Colombia, 2015) proposes a modern industrial policy based on achieving a sustainable economic growth by improving the productivity in such a sector and the generation of export products with high value added. According to this Plan, the government grants a very important role to the industrial sector as a source of employment and economic growth, for which it is necessary the introduction of more sophisticated and diversified production processes, the investments in research and development by both, the public and private sector, and the generation of opportunities for workers to move to better paid jobs.

So far some improvement in the productivity of all sectors has been achieved, especially in the services one. However, a report of the CPC (2014) shows that Colombia is very far from this goal, with an inefficient allocation of resources and high heterogeneity in labor productivity across regions. Production factors should be allowed to migrate among sectors in order to improve the worker's opportunities to have access to higher quality jobs and, therefore, raise their living conditions. According to the report, by the year 2012, the agricultural was the sector with the lowest level of productivity but employed nearly 19% of all workers, almost the same proportion as the much more productive and dynamic industrial sector. The remaining 60% of the workers were occupied in activities at the services sector, especially in the area of commerce, restaurants, and hotels, of relatively low productivity. Which sectors should then be prioritized? Although

<sup>9</sup> According to Ludena (2010), agricultural development and high productivity are preconditions for an economy to be able to release resources (inputs and workers) to other sectors. This has been the key to the successful industrialization in the US, Japan, and some European countries.

the document recognizes the difficulty of considering whether one sector is «better» than another, it is true that some activities trigger greater externalities or serve as a bridge towards productive diversification (Hausmann & Klinger, 2008). However, not all studies point to the same direction. Porter (1998), for example, states that it is not the sector that matters, but its productivity. In spite of it, the study of the CPC emphasizes the need for defining priority macro-sector, according to the potentials and limitations of each region or department, as well as the identification and development of productive clusters, such as tourism (services) and the manufacture of products based on the comparative advantage and resources of each region (dairy products, chocolates, cosmetics, energy, etc.), something similar to that public policies proposed in similar countries, such as Malaysia.

Even more, the OECD (2017) supports the need to facilitate the reallocation of labor and capital to the most competitive sectors in Colombia, in order to take advantage of its potential for inclusive growth, not forcing workers to remain in low-paying jobs. The report recognizes that public investment is essential to reduce the gaps in infrastructure that will increase the competitiveness of all sectors and reduce regional inequalities. In this sense, the study points out that Colombia should take advantage of the identification and development of value chains or clusters, some of which has been identified by the CPC. To do this, it is necessary a better understanding of the pattern of behavior of the employment generated per unit of economic growth, especially across regions.

As said previously, a competitive pattern of growth should show differences in the values and directions of the EE across sectors, declining and even becoming negative in agriculture, while increasing in manufacturing and services as these two last sectors absorb labor force fast enough as to exceed its growth. On the contrary, high labor intensity in the primary sector indicates that agriculture is acting as a refuge for displaced workers (Ernst & Berg, 2009) that absorbs labor force during a recession and expels it to another sector in

periods of expansion (Manning & Purnagunawan, 2013). According to these studies, poverty reduction does not imply increasing employment intensity of growth in this sector but its productivity, to facilitate the workers' transition to secondary and tertiary more productive jobs in sectors with higher elasticities of employment. Therefore, policies and programs should be targeted to increase employment in the secondary and tertiary sectors as well as increase productivity in the primary sector. This seems to contradict the conclusion reached in 2008 by the Committee of Experts on the Application of Conventions and Recommendations that highlights the importance of rural employment in poverty reduction and pointed out as a policy option identify and adopt measures to increase labor intensity as well as employment promotion in rural areas (De Luca, Fernando, Crunel & Smith, 2012). However, this kind of promotion must be oriented to the nonagricultural sector. Of course, the weight of the primary sector in generating jobs may affect the results<sup>10</sup>.

### 3. LITERATURE REVIEW

Several studies have attempted to estimate the EE for different countries. The results vary among regions and periods. Piacentini & Pini (2000) find negative elasticities for Italy, Germany, United Kingdom and Sweden during the 90s, while Seyfried (2014) show positive values for Portugal, Ireland, Italy, Greece, and Spain in more recent years. According to Padalino & Vivarelli (1997), the EE averages 0.5 in the US and Canada, while Choi (2007) observes declining values of the EE in Korea, going from 0.49 in the period 1971-1980 to 0.38 in 2000-2005. The relationship between employment and economic growth may differ across sectors and regions within a country. Perugini (2009) illustrates these inequalities in Italy, using

<sup>10</sup> Besso (2010) found that in Cameroon the primary sector employs more than 60% of the labor force with low-quality jobs, reason why many tend to abandon it to move to small-scale activities at the informal sector. This explains the similarities in the EE in both sectors, along with negative values in manufacturing. |

regional data for period 1970-2004. However, not only regional and sectoral differences are important. It is necessary to identify the labor-intensive activities within each sector that should be targeted. Sassi & Goaid (2016) use panel data information for 15 industries to estimate the long-run elasticities and identify the most labor-intensive industries (services and export manufacturing industries).

Manning & Purnagunawan (2013) analyze the situation of Indonesia considering agricultural, non-agricultural and total GDP. Their findings show negative values (-1.7) in the former sector and a positive elasticity for nonagricultural activity (3.4), with a total average of 1.4. Mazumdar (2003) analyzes the manufacturing sector to estimate the effect of economic growth on employment in Latin America and the Caribbean, East Asia, and the OECD countries, finding negative manufacturing EE in the first region. Kapsos (2005) is probably the largest study in the field for the period 1991-2003, with 160 countries including Colombia. The study is conducted at the general level but also by gender and sector (agriculture, industry, and services) in order to detect structural changes, considering both value added and GDP. He estimates the EE to be about 0.23, 0.18, 0.45 and -0.42 for North America, East Asia, Latin America and the Caribbean region, respectively. The highest values are observed in Africa and the Middle East. His analysis is also conducted by country in three different periods (1971-1980, 1981-1992 and 1993-2003). The declining trend in the responsiveness of employment to changes in GDP observed by Kapsos is confirmed by Navarro (2009), based on data from 15 Latin-American countries, including Colombia, over the period 1980-2008.

Hvozdíková & Morvay (2015) estimate the EE in Slovakia and compares it with other economies in the region during the period 1997-2010. According to them, the observed low<sup>11</sup> values are common in developing economies, trying to overcome the technological and productivity gap. This contradicts some statistics shown by the

International Labour Organization (ILO) according to which Europe and East Asia exhibit elasticities as low as 0.2 and 0.3 while Latin America has values above 0.5. Pagés, Pierre, & Scarpetta (2009) evaluate the factors affecting the countries' ability to create more jobs in spite of experiencing economic growth, considering the case of Latin America and the Caribbean for the period 1990-2006. In general, they conclude that the low productivity levels must be blamed for the modest economic growth observed by most of them: by 2006, the average productivity in the region was 21 percent of that of the United States. Only a few countries, such as Brazil, Mexico, Panamá, Peru, and others experienced simultaneously an increase in employment and in productivity; Colombia, on the other hand, along with Argentina, Chile, Jamaica, and Uruguay suffered jobless growth. The ability of the labor market to react to changes in the output in the region was also studied by González (1999) based on the Okun's Law applied to thirteen Latin American countries for the period 1960-1995. He finds out that the labor market in the region reacts adjusting real wages more than they do in the United States, while employment reacts less to changes in GDP<sup>12</sup>.

For the case of Colombia, the EE estimated by Kapsos (2005) for the three periods considered are 0.63, 0.42 and 0.94. The EE is about 1.14 in the agricultural sector, -0.29 for manufacturing activities and 0.93 in the services sector. Moreover, the elasticity shows a decreasing pattern for women (moving from 0.82 to 0.35) and increasing for men (from 0.52 to 1.33). Also for Latin America, the ILO (2010) finds evidence of a shift away from employment in the agricultural towards the services sector. Another study involving Colombia as part of a larger cross-country dataset estimates the EE for the country to be about 0.98 for years 1991-2011 (Ben Slimane, 2015). Angel (2004) analyzes the effect of an increase in minimum wage on EE, while Argüello, Jiménez, Torres, & Gasca (2016) measure the impact of a sustained oil

<sup>11</sup> The general literature considers the EE to be high if it is above 0.5 and low if it is below 0.2.

<sup>12</sup> For an accurate review of the literature at this regard, see Mkhize (2015).

export boom in the labor dynamic, including the EE in that sector. To our knowledge, there does not exist a study that attempts to estimate EE in Colombia at the departmental and sectoral level, and associates them to relevant economic variables.

#### 4. METHODOLOGY

To estimate the general and sectoral EE for Colombia, the study uses information from the National Administrative Department of Statistics (DANE in Spanish) and the Bank of the Republic (BR), as well as the World Bank indexes (WDI) and the DCI from the Consejo Privado de Competitividad (CPC). Nationwide EE are estimated for the period 1990-2016 through ordinary least squares applied to equation (3), including lagged values of employment to account for its persistence effect. Sectoral elasticities are also estimated based on equation (6) just to corroborate the results obtained from (3). As for the departmental EE, these are obtained based also on equation (3) limited to the regions for which information is available (24 out of 32 Departments including Bogotá D.C.) At the general level, for these last elasticities, we use data for period 2001-2016, while sectoral values are based on the longest possible period of time available, varying from 2001-2016 to 2007-2016.

Like Besso (2010), Ben Slimane (2015) and others, we assess the factors associated with the EE at the department level. However, unlike them, we do not run regression models but use Principal Component Analysis (PCA) considering macroeconomic variables and DCI information for the year 2016. PCA is an exploratory multivariate analysis technique used to uncover the internal structure of the relationship in a large set of variables, grouping them into new variables called components, based on the correlation among them and their dispersion. Particularly, PCA explains the variance-covariance structure of the data through linear combinations of quantitative variables, in order to reduce the data dimensionality and to facilitate its interpretation. The analysis provides a graphical representation of such positive (variables in the same side) or negative (variables in opposite sides) associations, with

the axes formed by the components on which individuals can be plotted.

Due to limited information, we apply a two-step PCA: first, all social, economic and competitiveness variables are used to construct an economic framework; this framework is then used to analyze the estimated elasticities. Only components whose eigenvalues are greater than or equal to 1 are retained. By doing so we can take advantage of all variables available, in spite of their limited number of observations. Following Ben Slimane (2015), the variables included in the first stage of the analysis are real value added (in constant -2010- dollars); real imports and exports (in constant -2010- dollars), to consider the role of international trade; inflation rate (%) that introduces noise and uncertainty into the economy, and social and labor market indicators such as working age population (%), unemployment rate (%), underemployment (%), and labor force rate (%), to which we also add the informality rate (%) and the proportion of poor households according to the index of unsatisfied basic needs (%). To account for the effect of the guerrilla warfare, we used the proportion of displaced from each department. Finally, the DCI is included, as well as its basic requirements, efficiency, and innovations and sophistication sub-indexes. The variables included in the second stage of the PCA are the components previously obtained as well as the estimated general and sectoral elasticities for the year 2016. Biplot is graphically used to represent these results.

Finally, we group departments according to their elasticities and levels of competitiveness, being the complete linkage hierarchical cluster analysis the one that yielded the most comprehensive results. This is an iterative method in which, starting from as many clusters as available observations, we sequentially combine them based on the shortest distance between elements in two different groups that are as far away as possible from each other. The results are represented by a dendrogram (Figure N<sup>o</sup> 1).

#### 5. RESULTS AND DISCUSSION

As stated before, high and positive EE could indicate that more jobs are created per

unit of output. For the case of Colombia, the estimated value of the employment intensity of growth is 1.03, larger than the value estimated by Kapsos (2005) and Ben Slimane (2015), and above the 0.5 estimated by ILO for the region (see Table N° 1).

A pro-poor pattern of growth is expected to show larger EEs in the manufacturing and services sector, and low or even negative numbers at the agricultural level. The results show that sectoral elasticities match this

behavior, with the largest value in manufacturing (2.39) and the lowest but still high in agriculture (0.85)<sup>13</sup>, which differ from the estimates obtained by Kapsos (2005) for a different period.

Dragging people out from low-productivity jobs to more productive sectors helped some Asian countries to substantially reduce poverty and become more competitive. In Colombia, the employment in agricultural sector shows a sharp reduction, accompanied

Table 1  
Employment elasticities estimates and competitiveness sub-indexes

Department	General	Agriculture	Manufacture	Services	DCI sub-indexes		
					Basic requirements	Efficiency	Innovation sophistication
Nacional	1.03	0.85	2.39	1.14	4.35	4.38	3.65
Antioquia	0.59	0.22	0.36	0.65	6.97	6.10	7.06
Atlántico	0.72	-0.30	0.40	0.84	5.91	4.76	5.54
Bogotá D.C.	0.76	-	0.72	0.78	6.99	8.21	9.61
Bolívar	0.66	1.51	0.29	0.52	5.03	4.01	4.41
Boyacá <sup>a</sup>	0.20	-0.22	-0.52	0.49	5.90	5.26	3.10
Caldas	0.15	0.24	0.21	0.21	5.93	6.53	5.26
Caquetá <sup>a</sup>	0.33	-1.29	-0.24	0.63	3.75	2.37	0.67
Cauca <sup>c</sup>	-0.02	-0.74	1.22	0.41	4.61	4.11	3.76
Cesar <sup>b</sup>	0.33	0.32	1.89	0.75	4.87	3.28	1.90
Chocó <sup>b</sup>	-0.15	-0.69	1.59	0.48	2.97	1.51	0.85
Córdoba	0.79	-0.91	0.41	0.56	4.49	3.14	2.10
Cundinamarca	0.86	0.95	0.49	0.93	5.94	4.93	5.67
La Guajira <sup>b</sup>	1.23	-0.53	0.21	1.53	3.05	3.17	1.74
Huila <sup>a</sup>	0.89	0.23	-0.55	0.64	5.74	3.49	2.46
Magdalena <sup>b</sup>	0.28	0.40	1.12	0.73	4.48	3.24	3.32
Meta	0.23	-0.10	0.19	0.41	5.83	3.87	2.59
N. Santander	0.38	-0.13	0.07	0.18	5.49	3.28	3.48
Nariño	0.39	-0.21	-0.52	0.22	5.04	3.27	2.67
Quindío <sup>c</sup>	0.57	-0.36	0.43	0.75	5.67	4.30	2.87
Risaralda	0.31	-0.19	-0.03	0.15	5.89	5.28	4.71
Santander	0.41	0.55	0.01	0.47	6.63	5.77	4.96
Sucre <sup>c</sup>	0.48	2.01	0.76	0.78	4.53	3.56	2.47
Tolima	0.53	0.13	-0.15	0.25	5.23	3.83	3.00
Valle del Cauca	0.50	0.50	0.27	0.55	5.93	4.95	5.95

Notes: Sectoral elasticities based on a) period 2005-2016, b) period 2006-2016, c) period 2007-2016

Source: Authors, with data from DANE, BR, and CPC

<sup>13</sup> Results based on real value added rather than real GDP, as suggested by Gutierrez et al. (2007) and Kapsos (2005), based on the information available.

by an increasing participation of the tertiary sector in the labor market, as well as a sustained growth of the value added in that same sector (see Figures N<sup>a</sup> 1a and N<sup>a</sup> 1b). This decreasing employment in agriculture comes with a raising productivity in such a sector, moving from 4,174 constant (1980) dollars to USD 4,250 in 2000 and USD 6,536 in 2016.

The results at regional level highlight the heterogeneity within the country, but somehow support conclusions for the country as a whole. The majority of the departments shows negative EE in the agricultural sector, suggesting individuals are escaping for poor jobs in this sector or from the violence in rural areas. In many cases, these negative elasticities in the primary sector come along with positive and large elasticities in manufacturing and/or services. Notice also that the number of departments with negative elasticities declines as we move from the agricultural to the tertiary sector, with no negative elasticities in the last one. The richest and usually more competitive departments (Bogotá D.C., Antioquia, Valle del Cauca, Santander, Cundinamarca, and Meta) do not

necessarily show the largest EE, in the same way that the poorest ones do not exhibit a clear pattern of behavior at this regard. However, high elasticities usually accompany high levels of innovations and sophistication. Chocó, which can be considered the poorest department in Colombia, shows the largest negative global elasticity.

The first stage of the unrotated PCA on macroeconomic variables generates four factors or components that can be described as follows. The first is a component of competitiveness explains 57.99% of the total variability of the variables and is named *COMPETE*, since added value, DCI and its sub-indexes are strongly opposed to poverty and informality, meaning that high levels of competitiveness are associated to high levels of added value and low levels of these two problems. The second component explains 12.39% of the total variability and opposes added value and international trade variables to labor market indicators such as unemployment rate and labor force, reason why it can be considered a component of economic growth and is given the name of *GROWTH*. The third is a Phillips curve

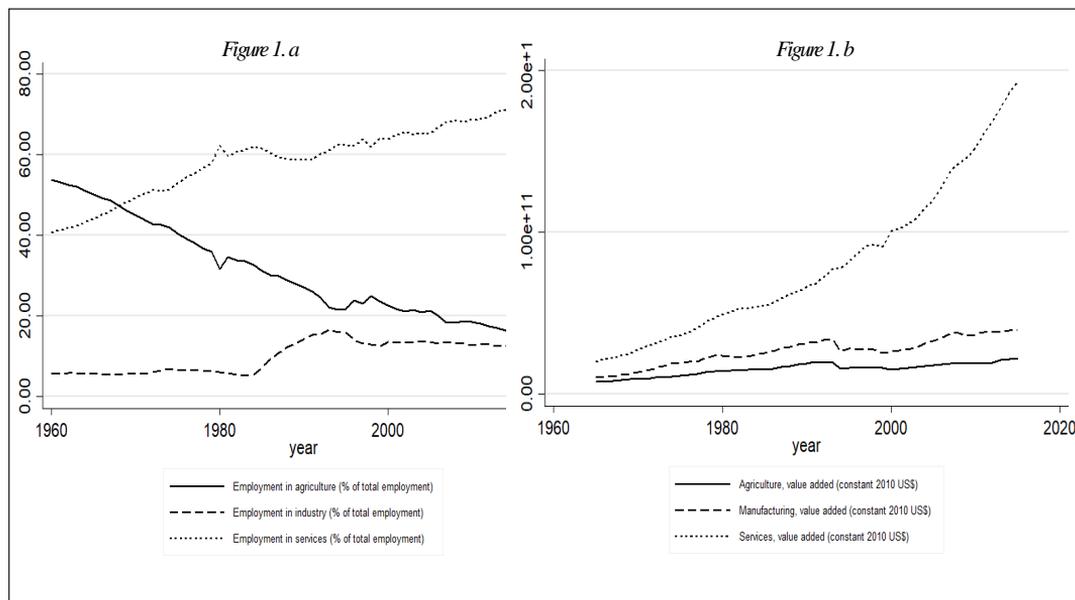


Figure 1. Employment and real value added by sector

Source: Authors, with data from WDI

component that explains 9.59% and opposes inflation to unemployment, therefore receiving that same name. Finally, the last component has an explanatory capacity of 7.07% and opposes informality, inadequate employment, and the displaced to exports, so that it reflects the capacity of the economy to absorb the labor force, and is given is named *INFORMAL* (see Table N° 2).

The second stage of the PCA indicates a separation between elasticities in the agricultural sector (*EAG*) from those in the manufacturing (*EMN*) and services (*ESR*) sectors. The first of the three components obtained explains 34.28% of the total variability. According to this component, high elasticities in the secondary and the tertiary sectors imply economic growth but not necessarily competitiveness. The second component (23.84%) associates high elasticities in the agricultural sector with competitive capacity, but also with inflation, commonly observed among agricultural product. Once again, high elasticities at the agricultural sector and competitive capacity are opposed to high employment elasticity in manufacturing (see Table N° 3).

Table 3  
First-step PCA results: Economic framework

Variables	Comp1	Comp2	Comp3
<i>Compete</i>	<b>-0.2247</b>	<b>0.4354</b>	<b>-0.4701</b>
<i>Growth</i>	<b>0.5168</b>	-0.1026	-0.0833
<i>Phillips</i>	0.1233	<b>0.5002</b>	-0.0737
<i>Informal</i>	0.1172	0.2184	<b>0.8481</b>
<i>EE</i>	0.3740	0.3957	0.0685
<i>EAG</i>	0.0375	<b>0.4956</b>	-0.0740
<i>EMN</i>	<b>0.4616</b>	<b>-0.2991</b>	-0.1929
<i>ESR</i>	<b>0.5590</b>	0.1019	-0.0035

Source: Authors, with data from DANE, BR, and UER

The last component retained explains 14.6% of the total variability and clearly opposes the country's capacity to provide formal and adequate jobs to competitiveness, indicating that informality and better working conditions are required for Colombia to become more competitive. The biplot tool allows us to graphically represent the departments along with these components. As expected, Bogotá, Antioquia, Valle del Cauca, Santander, and Cundinamarca appear at the right side of the plot as the most competitive departments, opposed to Chocó and Caquetá, the poorest in the country. High

Table 2  
First-step PCA results: Economic framework

Variables	Comp1 (Compete)	Comp2 (Growth)	Comp3 (Phillips)	Com4 (Informal)
Value added	<b>0.3071</b>	<b>0.2934</b>	-0.1922	0.0637
Imports	0.2769	<b>0.3532</b>	-0.1426	0.1264
Exports	0.2275	<b>0.3376</b>	-0.1185	<b>-0.3548</b>
Inflation	-0.0038	0.0113	<b>0.6734</b>	-0.1721
Poverty	<b>-0.2801</b>	0.1807	-0.0004	-0.1223
Working age	<b>0.3076</b>	0.2917	-0.1431	0.0569
Labor force	0.2711	<b>-0.4342</b>	0.0992	0.0595
Unemployment	0.0005	<b>-0.3444</b>	<b>-0.5372</b>	0.1880
Informality	<b>-0.2935</b>	0.0629	-0.1570	<b>0.3402</b>
Underemployment	0.1024	0.2077	0.3397	<b>0.7982</b>
Desplaced	-0.1602	0.0685	-0.0052	<b>-0.2517</b>
EE	<b>0.3436</b>	0.0925	-0.0556	-0.0251
Efficiency sub-index	<b>0.3309</b>	-0.0876	0.1127	-0.0947
Basic requirement sub-index	<b>0.3074</b>	-0.2710	0.0243	0.0677
<b>Innovation/ sophistication sub-index</b>	<b>0.3347</b>	0.0342	0.0017	-0.0157

Source: Authors, with data from DANE, BR, and UER

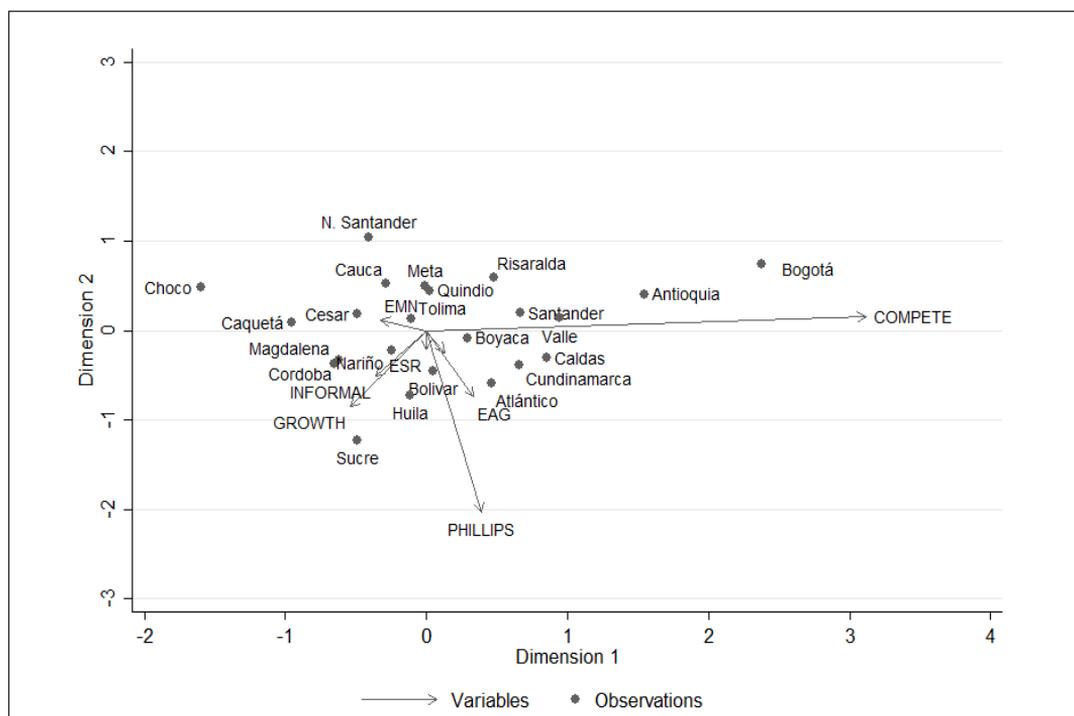


Figure 2. Biplot results

Source: Authors, based on their own estimates and UER

manufacturing employment elasticities are observed at departments with low agricultural elasticities (Cesar, Tolima, Cauca, Meta, among others), indicating a possible intersectoral shift of workers. In the same way, departments at the bottom of the plot show faster rates of growth in spite of their high informality levels, and higher elasticities in the tertiary sector (see Figure N° 2).

The dendrogram suggests four groups at a distance of less than 5 (see Figure N° 3)<sup>14</sup>. The first cluster includes Bogotá and Antioquia, regions that show high and positive elasticities, especially in the services sector<sup>15</sup>, as well as the highest levels of competitiveness, especially in terms of innovation and sophistication.

The second cluster includes the departments that follow in the DCI ranking,

which are those with acceptable values in the basic requirements and innovation and sophistication sub-indexes, separated into two groups: regions with low elasticities in manufacturing but high elasticities in services (Atlántico, Cundinamarca, Valle del Cauca), and regions such as Caldas, Risaralda, Santander, and Boyacá with low elasticities in both sectors. The third cluster includes all the remaining departments but, Caquetá, La Guajira, and Chocó. The competitive levels in this group are relatively low and appear particularly weak in innovation and sophistication. Their elasticities do not show a clear pattern of behavior, ranging from all high and positive (Sucre) to all low or negative (Meta, Tolima, and Norte Santander). Finally, the last cluster includes the least competitive departments for which we observe extreme values of EE (the largest negative value in Chocó and the largest positive value in La Guajira), large negative values in the agricultural sector and very high values in manufacturing or services.

<sup>14</sup> The clusters shown here are based on the sectoral elasticities and the competitiveness index and sub-indexes.

<sup>15</sup> Bogotá D.C. does not have agricultural activity.

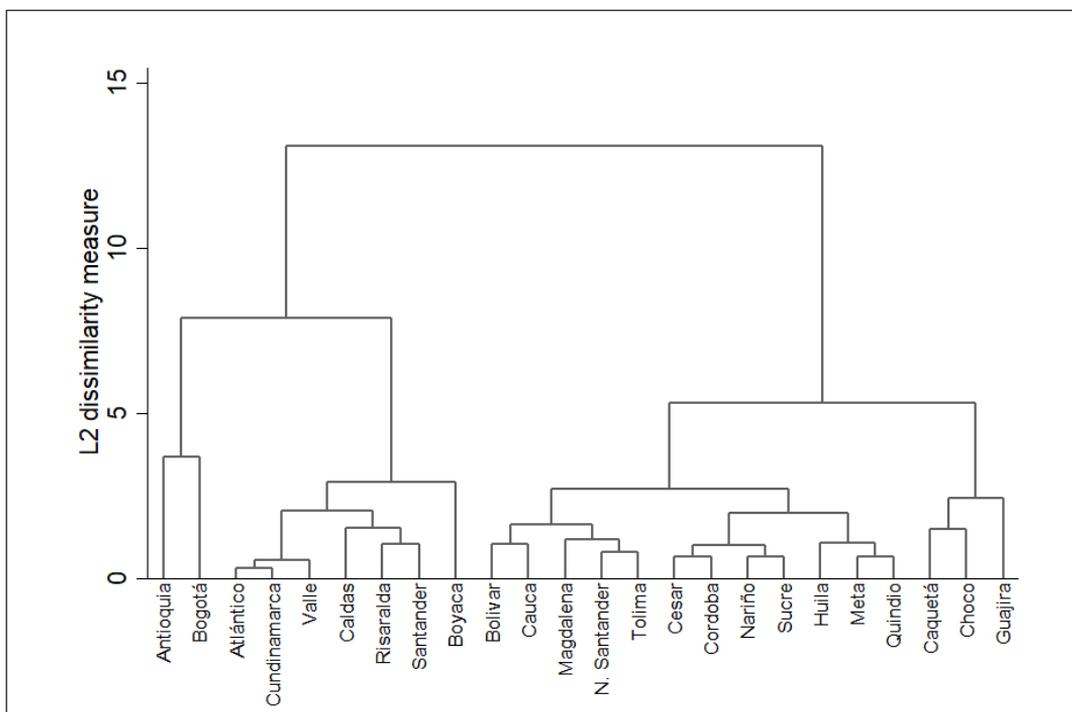


Figure 3. Dendrogram

Source: Authors, based on their own estimates and UER

### 6. CONCLUSIONS

Employment elasticity is used to measure by how much employment increases per unit of economic growth. In spite of its weaknesses, it is necessary to analyze the behavior of such an index across sectors in an attempt to detect jobless growth and introduce policies to correct it. The experience observed in several countries indicate that promoting the creation of employment in some key sectors, may contribute to substantially reduce poverty.

Using information for the period 1990-2016, the study estimates the EE for Colombia. The country shows a 1.03 elasticity as a whole, meaning that employment grows almost proportionally with the output. As for sectoral behavior, higher values are observed in manufacturing (2.39) and services (1.14) compared to agriculture (0.89), indicative of a potential inter-sectoral shift from poor to better jobs, especially in the light of the increasing added value in the former sectors, and declining in the last one. In fact, while the share of the agricultural sector in total employment has moved from 50% in 1980

to less than 17% in 2016, the real (2010) added value per worker in this sector went from US\$ 4,174 to US\$ 6,536 in that same period. Several studies suggest that declining or even negative elasticities in agriculture, along with high and positive elasticities in services and industry facilitate the transition of workers to more productive and better-paid jobs, a condition required for both economic growth and competitiveness, especially in the light of the negative association observed between this and informality.

The analysis is conducted also for 23 out of the 32 departments in Colombia in addition to Bogotá, but limited to the period 2001-2016 or 2007-2016, based on data availability. Their elasticities range varied from 1.23 (La Guajira) to -0.02 (Cauca) and -0.15 (Chocó). The majority (52.2%) show negative elasticities in agriculture, while for only 17.4% of them the largest positive elasticity is observed in this same sector. The number of departments with negative elasticities shrinks as we move from primary to tertiary sector, with only 25% of the departments with

negative elasticities in manufacturing (the sector with the highest values), and no negative elasticities in the services.

Principal Component Analysis is used to uncover the association of the estimated elasticities with some socioeconomic variables. To overcome the lack of information, the analysis is performed in two steps. The first part of the analysis uses a set of macroeconomic, demographic, and competitive variables to build an economic framework in which to analyze the estimated elasticities. Four components explaining 87.04% of the total variability are obtained. The second part of the analysis combines these four factors along with the sectoral elasticities, yielding three factors that account for 72.72% of the total variability. According to them, competitiveness is associated with low levels of poverty and informality. In this scenario, relatively low but positive elasticities are observed in the manufacturing and services sectors. Another component suggests that the increasing valued added and active international trade come with low levels of unemployment, but at the cost of higher prices. In this case, higher elasticities in the secondary and tertiary sectors are especially associated with economic growth, while inflation is usually associated with high elasticities in agriculture.

The study also uses cluster analysis to classify departments based on their competitiveness and elasticities, which helps to better understand the relationship between these two factors. The results indicate that very highly competitive regions, especially in terms of innovation and sophistication, have positive and relatively higher elasticities in manufacturing and services. Only Bogotá and Antioquia are part of this cluster. Highly competitive departments in terms of basic conditions and innovations and sophistication, consistently show low elasticities in agriculture and manufacturing; this cluster includes Atlántico, Cundinamarca, Santander, Valle del Cauca Caldas and Risaralda. The least competitive regions, La Guajira and Chocó, have large negative elasticities in the agricultural sector along with extremely high elasticities in any of the others. As for the departments with average levels of competitiveness, no clear pattern of behavior of the elasticities is observed.

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