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EHES Working Paper | No. 145 | January 2019

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Abstract

In this article we discuss whether there was a single Latin American pattern of agricultural growth between 1950 and 2008. We analyse the sources of growth of agricultural production and productivity in ten Latin American countries. Our results show that the differences between these countries are too strong to establish a single pattern for this region. However, certain common trends may be observed, such as the growing importance of labour productivity to explain agricultural production growth and the increasing importance of TFP to explain agricultural labour productivity growth.

JEL Codes: N56, Q10, Q11
Keywords: Latin American Economic History, Latin American Agriculture, Agricultural Productivity, Agricultural Growth, Total Factor Productivity.

Aknowledgement

This study has received financial support from the Ministry of Science and Innovation of Spain, project ECO2015-65582-P, the Spanish Ministry of Education's FPU Programme, and from the Government of Aragon, through the Research Group S55_17R. We are grateful for the comments received from the participants in the 11th Conference of the Spanish Economic History Association, the 4th Latin American Economic History Conference (CLADHE IV), the 10th Uruguayan Economic History Association, the 14th and 15th Sociedad de Estudios de Historia Agraria (SEHA) Conferences, the Economic History Seminar of the University Carlos III, the XVIIth World Economic History Congress, the 3rd Workshop "New Economic Historians of Latin America", the Brown Bag Seminar of the Faculty of Economics and Business Studies of the Universidad de Zaragoza, the Faculty of Economics of the Universidad de Santiago de Chile, and for those made by Pablo Astorga. Leandro Prados de la Escosura played a key role in the genesis of this article, as he was the author of the main idea on how to structure it. Consequently, we would like to express our most sincere gratitude to him. The usual disclaimers apply.

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1. Introduction

Although the structural change which has taken place over the last two centuries in a considerable part of the world has substantially reduced the importance of agriculture in economic activities as a whole, it continues to be a strategic sector (Timmer, 2009). This is not only because it satisfies one of the basic demands of human beings, namely to be fed, but also because in the economies of developing countries its weight is still sizeable (Alston and Pardey, 2014). In addition, agriculture can make a significant contribution to economic growth in developing countries (World Bank, 2007).

Since the beginning of the industrial revolution until today the agricultural sector has experienced extremely deep transformations. One of these has been the growth of agricultural production and productivity, which have received considerable attention because of their importance in feeding a growing world population. The causes of the sharp increase in agricultural production and productivity and the considerable regional differences in these increases have been the themes which, from a long-term economic perspective, have attracted most attention (Federico, 2005; Grigg, 1992; Hayami and Ruttan 1985; Lains and Pinilla, 2009; Pinilla and Willebald, 2018).

Following World War Two, agricultural production grew more quickly than the world's population, thereby generating simultaneously situations of excess supply in some world regions and of food insufficiency or even hunger in others. This growth in production is largely explained by technical change which, while very deep-rooted, has been highly unequal from a geographical point of view. Moreover, all countries modified their agricultural policy together with their trade and regional integration policies, which created different systems of incentives to agricultural activity (Anderson, 2009). The diversity in the adoption of these transformations, both technical and institutional, gave rise to significant differences in the agricultural development of various countries. Furthermore, in recent years a considerable number of studies have attempted to establish a taxonomy of these experiences of agricultural growth (Alston and Pardey, 2014; Timmer, 2009).

Given this background, the aim of the present paper is to analyse the case of Latin America in the context of the agricultural change that has taken place in the world. We discuss if there is a single Latin American pattern of agricultural growth or whether, in fact, the enormous differences within this region could suggest the existence of various paths. To this end, we have analysed the sources of growth of agricultural production and productivity in ten Latin American countries in the second half of the twentieth century[1]. We analyse production as a relationship between the evolution of labour endowment and labour productivity. We explain labour productivity through the land-labour ratio and land productivity as well as Total Factor Productivity (TFP, henceforth) and factor endowment per worker.

So far, very few studies have conducted a long-term analysis in the second half of the twentieth century for this region, although there are some that, with different methodologies or for shorter periods, are also based on a comparative perspective similar to ours (Ludena, 2012; Martín-Retortillo et al., 2019; Nin-Prat et al., 2015; Solbrig, 2006).

Our analysis of the situation of Latin America against a world backdrop shows that, despite the region being characterised by the typical conditions of the agricultural sector in developing countries, it displays a trend in the pattern of developed regions.

However, when we disaggregate the whole of Latin America into its different national trajectories our results reveal that the differences between these countries are too strong to establish a single pattern for this region. Despite this, there are certain common trends in the second half of the twentieth century, such as the growing importance of labour productivity to explain agricultural production growth, while labour endowment lost relevance. Another trend discovered is the increasing importance of TFP to explain agricultural labour productivity growth, while factor endowment per worker loses significance throughout the period.

[1] The countries that we have analysed represented 85-90 percent of total agricultural production in Latin America in the period.

Following this introduction, the second section develops the conceptual framework used for the empirical analysis, namely the methodology and data sources. The third section explains the path of Latin American agricultural growth in the worldwide context. The fourth section analyses the evolution of agricultural production growth and its drivers in Latin American countries in the second half of the twentieth century. In section five, we study agricultural productivity, starting with labour productivity and following TFP in Latin American countries. Finally, our conclusions are presented in section six.

2. Analytical model and data

In order to identify the growth sources of agricultural production and agricultural labour productivity, this section develops our analytical model based on an accounting growth conceptual framework.

Let us assume, in the first place, the following identity of the agricultural production (Y) expressed as the multiplication of labour productivity (Y/L) and labour endowment (L).

$$Y = \frac{\mathrm{Y}}{\mathrm{L}} \cdot L \qquad (1)$$

After applying logarithms to the equation and deriving with respect to time (1), we obtain:

$$y = y/l + l \qquad (2)$$

where y, y/l and l are the logarithmic growth of output, labour productivity and labour, respectively[2].

Having decomposed the growth of production into improvements in labour productivity and variations in the labour force, we analyse what lies behind the changes in labour productivity. In order to do this, the analysis is carried out following the identity used by Hayami and Ruttan (1985: 139):

$$\frac{Y}{L} = \frac{Y}{A} \cdot \frac{A}{L} \qquad (3)$$

[2] We have considered the average logarithmic growth rates.

where Y, A and L are the agricultural output, land input and labour input, respectively. Expressing equation (3) in logarithmic form, the following equations are derived:

$$ln\ \frac{Y}{L}) = \ln(\frac{Y}{A}) + \ln(\frac{A}{L}) \quad (4)$$

$$\frac{y}{l} = \frac{y}{a} + \frac{a}{l} \quad (5)$$

In equation (5) the term on the left-hand side represents the logarithmic average growth rate of agricultural labour productivity (y/*l*), which is decomposed into the average logarithmic growth rate of land productivity (*y/a*) and the average logarithmic growth rate of the land/labour ratio (*a/l*). This analysis has been used frequently in other studies on historical agricultural labour productivity, such as O'Brien and Prados (1992).

In order to study, in greater depth, the evolution of labour productivity, we shall decompose it into two factors: TFP and the factor endowment per worker. This analysis allows us to identify whether the growth of labour productivity depends on improvements in productive efficiency or on the accumulation of greater quantities of inputs used per worker.

We can therefore explain labour productivity growth using these determinants. To this end, we have followed the decomposition derived from the Cobb-Douglas production function[3]. A function is assumed that displays constant returns to scale and has three inputs (labour, L; Land, A; and capital, K). Therefore, equation (6) represents the technological relationships between the amounts of inputs and output:

$$Y = DA^{\alpha}K^{\beta}L^{1-(\alpha+\beta)} \quad (6)$$

Where D is an efficiency parameter (TFP) and α, β and [1-(α +β)] are the output elasticities of land, capital and labour, respectively. After dividing each side of equation (6) by input labour (L) and reorganizing in terms of factor endowment, the following equation is obtained:

[3] An approximation of the use of the agricultural production function for the Latin American context can be found in Elías (1985). This function has also been used in Astorga and Bergés (2011) for the economies of six Latin American countries.

$$\frac{Y}{L} = D(\frac{A}{L})^{\alpha}(\frac{K}{L})^{\beta} \quad (7)$$

After applying logarithms to equation (7), this is transformed to:

$$\ln\left(\frac{Y}{L}\right) = lnD + \alpha \ln\left(\frac{A}{L}\right) + \beta \ln\left(\frac{K}{L}\right) \quad (8)$$

Equation (8) could be expressed in terms of productivity efficiency and factor accumulation. Let's assume that *tfp* is the logarithm of TFP (LnD) and *f* is the factor endowment per worker, namely land and capital per worker in logarithmic terms and adjusted by their respective output elasticities. This means that:

$$f = \alpha \ln\left(\frac{A}{L}\right) + \beta \ln\left(\frac{K}{L}\right) \quad (9)$$

Therefore, equation (8) is expressed as

$$\ln(\frac{Y}{L}) = tfp + f \quad (10)$$

Finally, *f* is calculated as a residual: *f = ln(Y/L) – tfp*.

But before calculating *f*, we must estimate the TFP. The measurement proposed for TFP follows the methodology of growth accounting. This productivity is based on the primary definition of the Solow residual; that is to say, it is calculated as the difference between the growth of output and of a combination of production factors. In this analysis, this combination is formed by the land factor, comprised of an aggregation of rainfed and irrigated land (arable hectares of land and permanent crops), labour and capital, which comprises chemical fertilisers, self-propelled machinery and livestock units.

This combination is a weighted average in which the weightings are the remunerations that each factor receives in percentage terms over total production (see Appendix). The formula employed to obtain the growth of TFP is that proposed by Fuglie (2010 and 2012):

$$\ln\left(\frac{TFP_{i,t}}{TFP_{i,t-1}}\right) = \ln\left(\frac{Y_{i,t}}{Y_{i,t-1}}\right) - \sum_i (s_{i,j,t}) \cdot \ln\left(\frac{x_{i,j,t}}{x_{i,j,t-1}}\right) \quad (11)$$

where:

Y and *x* are vectors of output and inputs respectively*; s*: weightings; *i*, countries; *j*, inputs. i=1,…, 10; j=1,…,5[4].

The data that we have used for carrying out our empirical exercises have been drawn from FAOSTAT, FAO (1948-2004) and IFA (2014). In order to meet our objectives using the developed analytical model, it has been necessary to build a quantitative annual database for all the countries examined in this work. It is largely formed by the Food and Agricultural Organisation (FAO henceforth) statistics, although a series of estimates also had to be made. The main variables in our study, namely, agricultural production, labour, land, machinery and livestock units are available from 1961 in FAOSTAT (2012). To achieve a complete database from1950, we had to obtain the data from FAO (1948-2004). In this way, we have obtained an annual series from 1950, which we have linked with those of FAOSTAT, which began in 1961[5]. In the case of the chemical fertilisers, we have obtained the data from 1961 to 2008 from IFA (2014). Then, we obtained a complete series of chemical fertilisers joining this IFA series with the data from FAO (1948-2004) for the 1950s.

3. Latin American agriculture in the world context

This section conducts a comparative analysis on an international scale of the evolution of agricultural production and labour productivity growth, so as to situate Latin American agriculture in the world panorama. We also clarify the principal trends of their evolution.

First, we will examine world trends in agricultural production. Table 1 shows that its growth was far greater in the developing regions than in the developed countries. Thus, in the former its increase in absolute terms, on the whole, exceeded 200% between 1965 and 2005, while in the developed countries the increase was no greater than 100%, and generally lower. In this context, the growth of Latin America fits perfectly within the model of developing countries.

[4] For further details, see the Appendix.
[5] For further details, see the Appendix.

[Insert Table 1]

Following the observation of the different production growth rates, it is important to understand how these increases were achieved. To do this, we use equation (2).

Table 1 shows the decrease in agricultural labour endowment in the developed regions, with the exception of the slight increase in Australia and New Zealand. The continuous structural change in these economies played a fundamental role in this decrease. On the other hand, labour endowment in the developing regions grew, although the diversity in these increases of the workforce was also remarkable. Labour endowment in Latin America, the Middle East and North Africa increased by much less than in Sub-Saharan Africa, China or Southern Asia. Normally, within developing economies, those with more advanced processes of industrialisation only increased their agricultural workforce very slightly (Grigg, 1992; Timmer, 2009).

However, all the regions of the world augmented their agricultural labour productivity, but the differences between these regions were significant (Table 1). The highest increases occurred in the developed regions; in the developing regions growth was more modest, although also remarkable. Once more, of the developing countries the increase in productivity was higher in Latin America, the Middle East and North Africa than in other regions.

Using the decomposition developed in equation (5), variations in productivity might have been due to highly diverse technological innovations employed in agriculture and also to varied patterns in the use of inputs (Federico, 2005). However, in all the regions of the world, sharp increases in productivity occurred, whether from labour productivity or land productivity or, often, from both simultaneously. Figure 1 show the diversity of experiences, taking into account the starting levels and the increase in productivity of land and labour[6].

[Insert Figure 1]

[6] See also the Table A.1 in the appendix.

Thus, there are two very different models of agricultural productivity increases; on the one hand, in the developed countries, there was a large increase in labour productivity, due both to increases in the productivity of the land and in the land-labour ratio. In this group of regions a moderate increase in production and strong gains in productivity took place due to biological improvements, a notable increase in mechanisation and decreases in the absolute numbers of the agricultural labour force. These decreases are explained by the strong demand for workers from the rest of the economy.

On the other hand, in developing countries, production grew much faster, although the role of labour productivity was considerably lower and was based on increases in the productivity of land, normally greater than those of the developed countries, while the land-labour ratio worsened in most world regions. Among the developing regions, it was only in Latin America that the land-labour ratio improved. The growth of labour productivity was therefore based, in almost all the developing regions, on a sharp increase in land productivity, as mechanisation played a minor role due to the strong demographic pressure experienced by these countries, which meant increases in the absolute number of agricultural workers in all of them (although their percentage with regard to the total active population decreased). However, all the innovations related to the green revolution, as well as hybridisation and the genetic selection of seeds, and the use of fertilizers, pesticides and other chemical inputs explain the key role played by the sharp increase in land productivity on labour productivity (Evenson and Golin, 2002; Pingali, 2012, Harwood, 2018).

Where can Latin America be placed between these two models? It is a peculiar case, since the region shares characteristics with both and appears to be located in an intermediate situation. It appears to start from a position typical of developing countries and converges towards that of the developed countries. Its growth of production is similar to that of the developing countries, but its growth of labour productivity has been based as much on an increase in land productivity as on the land-labour ratio. In fact, it is the only region of the developing world in which, in recent years, the numbers of the

agricultural workforce have already begun to decrease. Furthermore, Latin America was the only developing region in which the land-labour ratio played a positive role in the increase of labour productivity. The evolution of the agricultural labour force in Latin America therefore contrasts with the trajectory followed by the developed countries, with strong falls, but also with the developing countries of Asia and Africa, with very strong increases.

However, an aggregate analysis is unable to clarify the differences between Latin American countries. Latin America is very diverse from a geographical, climatic, social, economic or institutional point of view. As Solbrig (2006: 535) stated, within Latin America "diversity was and continues to be a characteristic of the agriculture of this vast region, a result of the variety of climates, topography, history, and societies". We believe, consequently, that a profound understanding of the growth of agricultural production and productivity requires a consideration of the experiences of the different countries, to attempt to determine to what extent a single Latin American pattern exists, or whether the aggregate result mentioned conceals highly diverse trajectories.

4. The drivers of agricultural production growth in Latin America

In this section, we analyse the growth of agricultural production and its drivers in Latin American countries in the second half of the twentieth century using equation (2). To facilitate the analysis, we have further divided the whole period into three subperiods. The first spans between 1950 and 1973 and was the implementation phase of the policies of import substituting industrialization (ISI). During this time there was a considerable expansion of the scope of state action with respect to economic and social conditions which was geared, mainly, towards the domestic market. According to Bértola and Ocampo (2012), this period includes the "classical" phase of industrialization in Latin America –from the end of the Second World War to the mid-1960s– and different strategies were implemented until the first oil shock, when the industrialization process reached its peak in the region. The international economic crisis began in 1973, following the sharp rise in the price of oil.

Therefore, the second subperiod corresponds to the years 1973 to 1993, coinciding with the crisis and the lost decade of economic growth for Latin America until the beginning of the 1990s, when the majority of the region started deep structural reforms (Thorp, 1998)[7]. The last subperiod began in 1993 when the economic development model of the Latin American countries changed substantially as a result of the widespread change in policies in Latin America to overcome the deep economic crisis. This last period coincides with the reintegration of Latin America into international trade and the implementation of structural reforms known as the Washington Consensus. In the following years, the rapid growth of the Asian economies, mainly China, generated an intense demand for raw materials and food, which Latin American countries took advantage of to substantially increase their exports of these products.

Firstly, we can observe that all Latin American countries experienced significant increases in agricultural production during the second half of the twentieth century (Table 2 and Figure A.1). In Latin America as a whole production increased at an average annual rate of almost 3%. Particularly important were Brazil, Mexico and Venezuela, with growth far exceeding Latin America taken together. Brazil is surely the most outstanding case, since its agriculture has undergone an incredible transformation. Its backward and low productivity agriculture has become a major front-runner both in terms of production and productivity (Mueller and Mueller, 2018).

[Insert Table 2]

As stated in the previous section, we will now describe the sources of agricultural production, based on the increases in labour productivity and labour endowment (equation 1). Table 2 and Figure A.1 show the logarithmic growth rates of agricultural production, labour productivity and labour endowment over the whole period (1950-2008).

[7] With the exception of Chile, Uruguay and Argentina, which began these reforms (programme of stabilisation, trade liberalisation, financial reform, privatisation, etc.) in the 1970s, the other countries implemented these types of reforms mostly from the beginning of the 1990s.

In the period as a whole, 1950-2008, labour productivity was determinant in the growth of agricultural production (with a contribution of approximately 80 per cent), although the increase in the workforce had a minor but important role, especially in Peru, Colombia and Panama (63, 40 and 38 per cent, respectively). The exceptions to this Latin American pattern in the whole period were Argentina and Uruguay. These countries reduced their labour force throughout the second half of the twentieth century, owing to structural change in these more advanced economies, and therefore their growth in output can be completely explained by labour productivity growth. Argentina and Uruguay specialized in livestock and cereals production (typical outputs of temperate climates) and showed great dynamism during the First Globalization era (Martín-Retortillo et al., 2018; Pinilla and Rayes, 2019). This dynamism enabled high levels in land and labour productivities to be reached. However, both agricultures experienced intense processes of stagnation when faced with the limitations of a closed agrarian frontier and serious difficulties to incorporate technical progress (which was especially notorious since the 1930s). In fact, at the beginning of our period of analysis, both agricultures were immersed in structural problems (see Campi, 2012 and Barksy and Gelman, 2001 for Argentina; Astori, 1984, and Moraes, 2008, for Uruguay) that caused them severe difficulties to definitively embark on a new expansion trajectory. This situation would not be overcome until the 1980s with the constitution of a real structural transformation based on the incorporation of a new technology package.

Studying the events in each of the subperiods we can observe that in the first subperiod (1950-1973) labour endowment and agricultural labour productivity were almost equally important in explaining the agricultural output growth of Latin America (48 and 52 per cent, respectively). Between 1950 and 1973 the growth of the labour force played the most important role throughout the second half of the twentieth century. This increase in the labour workforce coincided with a massive incorporation of agricultural machinery and chemical products, which produced a strong growth of agricultural production and labour productivity (Federico, 2005). During these years, the Latin American population also experienced very rapid

growth, increasing from 161 million inhabitants to 300 million (Yañez et al., 2014).

Labour endowment reduced its role in explaining output growth (to 22 percent) in the subperiod characterised by the oil crisis and the lost decade of economic growth (1973-1993), while agricultural labour productivity gained importance (78 per cent). However, these two decades were highly diverse in the countries of Latin America, probably due to the differing effects of the oil crises and its consequences. This remarkable diversity is shown by the fact that in several countries the labour force in agriculture fell compared with the first subperiod, as was the case of Brazil, Colombia or Mexico, but in others it rose, for example in Peru, Uruguay or Venezuela. On the other hand, labour productivity growth also displayed different trends, depending on the country chosen.

The panorama after the beginning of the 1990s was different compared with the four decades analysed previously. There was an overall Latin American pattern after 1993, in which labour productivity growth explained production growth in all countries and its growth was (with few exceptions) the highest of the second half of the twentieth century. In addition, labour endowment fell in the majority of countries, with the exception of Peru and Colombia. This change of trend coincides with structural reforms, trade openness and with the strongest growth in agricultural production. The incorporation of Latin American countries into international markets after the lost decade (the 1980s), in which primary and agricultural products played a remarkable role, was fundamental to understand the development process in this region (Martín-Retortillo et al., 2018). The new strategy involved mobilising resources in competitive agricultural export sectors. The result was an increase in agricultural exports and a certain change in their composition towards products with a greater degree of industrial transformation or to meet consumer requirements (Serrano and Pinilla, 2014 and 2016). This process was, especially from the beginning of the twentieth first century onwards, a response to the dynamic demand for commodities resulting from

the growth of emerging economies (with China at the head of the expansion) (Hanson, 2012).

5. Explaining agricultural labour productivity in Latin America

5.1 Land productivity *vs.* land-labour ratio: towards two agricultural models

We will now continue with the analysis of the evolution of agricultural labour productivity in Latin American countries, employing the same methodology used in the distinct regions of the world.

Table 3 shows the levels of agricultural labour productivity (production per worker), land productivity (production per hectare) and land-labour ratios (hectares per worker). The variations in the levels of labour productivity between the Latin American countries were huge throughout the second half of the twentieth century[8]. By 1950, Argentina and Uruguay had already very high levels of labour productivity compared to the other countries, while Chile, Venezuela and Panama were located at intermediate levels, somewhat above the average for the region, while all the others were clearly below the average. The evolution of labour productivity in the second half of the twentieth century consolidated the advantage of the countries with high productivity (Argentina, Uruguay and Venezuela).

On the other hand, the case of Brazil is extraordinary; its labour productivity increased most, at an annual rate of 3.7%, meaning that it ceased to be one of the countries with the lowest productivity and became located above the regional average. Agricultural labour productivity in Brazil not only grew very fast after 1950, but its pace accelerated progressively. From 1993 it did so at an average annual rate of 5.6%, a speed so high that no other country in Latin America came near to matching it in any of the subperiods analysed. In this improvement of productivity, which also coincided with a strong increase in production, an important agricultural research effort played a key role from the early 1970s in searching for appropriate technologies for the different biomes and climates of the country. EMBRAPA (the Brazilian Enterprise for

[8] Nevertheless, this dispersion fell, as the coefficient of variation was 0.94 in 1950 and 0.79 in 2008.

Agricultural Research), created in 1973 by the Ministry of Agriculture, was the steering body of this effort. In addition, since the beginning of the twentieth first century, stable and open institutions which have provided macroeconomic and political stability have been very important for this improvement in productivity (Mueller and Mueller, 2016).

[Insert Table 3]

In the case of land productivity, differences between countries, although significant, were fewer than in the case of labour productivity. Colombia was the leader in 1950 and maintained this position at the end of the period when the differences among countries fell. The leaders in terms of growth were Chile (775%), Mexico (470%) and Venezuela (459%) and the worst performer was Argentina (with an increase of only 28%).

Table 3 also shows that the countries with greater land-labour ratios had higher levels of agricultural labour productivity and low land productivity[9]. The differences between Latin American countries were remarkable, especially between Argentina and Uruguay and the rest of the region. These two countries, as we have seen, merely had a very high level of labour productivity in the middle of the century.

However, it is interesting to observe the drivers of labour agricultural growth, following equation 5 used in the previous section. With this objective in mind, we can see the logarithmic growth rates of these three variables in Table 4.

In the case of agricultural labour productivity, Latin American growth was notable throughout the second half of the twentieth century and the early years of the twentieth first century, with an annual rate of increase of 2.33%. Land productivity also increased in this period, although it did so at a rate lower than that of labour productivity (1.67%). The land-labour ratio increased by only 0.66% throughout the entire period. Thus, we can explain labour productivity growth as a result of increases in land productivity, as in

[9] The same process happened in Europe since 1950 (Martín-Retortillo and Pinilla, 2015).

the rest of developing regions, but the land-labour ratio accounts for almost 30% of the explanation of this growth.

It can therefore be said that the differences in the intensity of technical innovations adopted during this period, such as agricultural machinery, chemical products or the hybridisation and genetic selection of seeds generated significant differences in the determinants of the growth of productivity in agricultural labour.

[Insert Table 4]

The trends of these two types of productivity and the land-labour ratio can be illustrated in a graph (Figure 2), to clarify the different patterns among Latin American countries in the second half of the twentieth century. This graph depicts the relationship between labour productivity (left-hand axis) and land productivity (horizontal axis) for the ten countries and Latin America as a whole. If we compare the levels and variation of the two types of productivity, it can be observed that the countries which had the highest levels of labour productivity towards 1950 did not have especially high levels of land productivity. This was the norm throughout the period and, in fact, in some cases the correlation was negative (as in 1950 and 2008). In turn, and as can be expected, the positive relationship between the two types of productivity was weak for the countries considered individually (with linear coefficients of between 0.90 and 1).

[Insert Figure 2]

A comparison with the (darkest) line of Latin America permits two patterns to be visualized. The countries in which the land-labour coefficient is greater are located above the adjustment line; in other words, those economies in which the use of labour is relatively more intense than that of land (where more land per unit of labour is used). There are two countries which clearly display this characteristic –Argentina and Uruguay–, one which displays a trend towards the same direction –Brazil– and another which abandons this group –Chile. The remaining countries reveal a pattern based on the more intensive use of labour. The figure shows that the differences are more important in the levels of labour productivity than in land productivity.

We want now, as in the previous section, to explain the determinants of labour productivity in the different subperiods.

In the first two decades of the second half of the twentieth century, the growth in the land-labour ratio (0.83%) was fundamental for understanding the growth of labour productivity (1.48%), especially in Argentina, Brazil, Colombia, Panama and Honduras. One explanation of these trends is the sharp increase in the land cultivated in Latin America (2.2% annually in this subperiod), which reduced the potential increase of land productivity in some countries due to technical change, while the land-labour ratio also rose (Martín-Retortillo et al. 2019). During this subperiod, three countries, Mexico, Venezuela, and Chile, followed a different path than that of Latin America as a whole, with very high increases in land productivity in the first two. In the case of Mexico, this strong increase in the productivity of the land is explained by two reasons: the pioneering role that this country had in the green revolution and the very strong increase in irrigation in its northern region, especially in the 1950s. (Yúñez, 2014). In the 1940s and 1950s the Rockefeller Foundation supported a wheat breeding programme under the direction of Norman Borlaug which in a few years obtained new high yield seeds (HYS) that substantially increased yields. Between 1946 and 1975, the irrigated area increased by more than two and a half million hectares (Cerutti, 2015: 94). In fact, irrigation and the green revolution formed part of the same technological package.

The situation of Latin American agriculture changed in the second subperiod, characterised by the oil crisis and the lost decade (1973-1993). Land productivity became the fundamental source of growth in agricultural labour productivity (almost 95% of labour productivity growth is explained by land productivity). That is to say, not only did the use of land increase in Latin America but it was also increasingly productive, given the intensification of its use (Solbrig, 2006). The land-labour ratio in all the Latin American countries, except Brazil, decreased or increased slightly. The Brazilian case is striking because it did not follow the general path, as over 40% of labour productivity growth was due to increases in the land-labour ratio. In these years while the

labour employed in agriculture fell slightly in this country, the cultivated area increased substantially. This expansion occurred mainly in the Cerrado savannah, considered until then as unproductive. EMBRAPA was particularly successful with the development of HYS adapted to the physical and climatic environment (Evenson and Rosegrant, 2002).

After 1993 the land-labour ratio partially recovered the importance lost in the previous subperiod (28% of labour productivity growth was due to growth in this ratio). Thus, land productivity is key to understanding labour productivity, as in the rest of the developing regions worldwide[10]. In Latin America, with the important Mexican exception, the employment of HYS was delayed somewhat with regard to Asia. However, after the mid-1980s they subsequently made an important contribution to the increase in land productivity (Evenson and Gollin, 2002).

Two patterns divided Latin American agriculture in this subperiod: on the one hand, countries such as Chile, Colombia, Honduras and Peru decreased their land-labour ratio and land productivity is the only variable that increased labour productivity. In the case of Chile, this decrease (2.7%) was due to an increasing intensity of the labour factor. The change of specialization of Chilean agriculture towards labour-intensive crops for export such as fruits and vegetables can explain this (Foster and Valdés, 2006).

On the other hand, land-labour ratios in countries like Argentina, Brazil or Uruguay increased, and came to represent a large part of labour productivity (39% for Argentina and Brazil and 60% for Uruguay). The increase in Brazil (over 2% annually) is explained by the fact that the country could be considered as having an open frontier. At the end of the 1980s, Brazil promoted a political strategy of extending the free market, with the elimination of taxes on exports and price control mechanisms, which confronted agriculture with new challenges.

5.2 Total Factor Productivity *vs* factor endowment per worker

[10] However, the Latin American region is the developing area where the land-labour ratio has the greatest importance explaining agricultural labour growth.

Table 5 shows the growth rates of the variables obtained following equation (10), namely TFP and factor endowment per worker. For our calculation we applied to Argentina, Chile and Uruguay the weightings of Argentina; to Mexico, Colombia, Honduras and Peru that of Mexico; and to the rest that of Brazil[11]. To calculate the Latin-American averages we have used the weightings of Brazil, because this country possesses the most diverse agriculture of our sample. Agriculture in Brazil includes tropical products, temperate crops, industrial crops, and livestock and represents an "average" of Latin America[12].

It may be observed that the main source of agricultural labour productivity in the whole period (1950-2008) in Latin American countries was the improvement of efficiency (TFP growth). The remarkable incorporation of innovations into the agricultural sector permitted this increase and was based on an intensive growth of agricultural outputs, such as self-propelled machinery, chemical products and the hybridisation and selection of seeds (Federico, 2005).

Despite the importance of efficiency gains in the whole region, there are some exceptions in which the sources of factor accumulation per worker were fundamental to understanding agricultural labour productivity growth. The principal exceptions are Argentina and Uruguay, where the main source of agricultural labour productivity was the increase in the factor endowment per worker with a very small contribution of TFP growth. The sharp increases in the use of land, especially in Argentina, the maintenance or the reduction of the workforce and the incorporation of capital inputs can explain these exceptions.

However, it is more interesting to observe these sources of growth throughout the previously used subperiods. This analysis allows us to understand the differences in trends of the sources of Latin American agriculture.

[11] See the Appendix.

[12] However, we have calculated the TFP of the whole of Latin America with the other two weightings, namely from Argentina and Mexico, to check the robustness of our results. See the Appendix.

The first period was dominated by the importance of the accumulation of inputs in the agricultural sector. This accumulation was predominant, due to the increasing incorporation into the production process of agricultural machinery, chemical products and land. This incorporation was higher than the growth of labour, producing the increase in the ratio of factor endowment per worker. Despite this general trend, Mexico and Venezuela did not follow the Latin American pattern in this subperiod. In these countries, between 1950 and 1973, TFP provided the main explanation for agricultural labour productivity. In the case of Mexico, the development of the Green Revolution in this period was able to strongly affect the growth of TFP.

In Venezuela, after the hegemony of coffee and cocoa exports, agriculture fell into decline before the oil boom that began in the 1930s. Venezuela is an example of a country with a rentier state that depends on the income generated by the export of oil. A consequence of this fact is the appreciation of the exchange rate that encourages imports and discourages the promotion of non-oil exports and local production (Thorp, 1998). Between the Second World War and the 1960s, the ISI became the dominant strategy. This consisted in replacing the import of agricultural products processed by their raw materials. As a result of this approach, wheat, sugar, animal feed, fats, oils, cattle and milk production were developed. In order to achieve agricultural modernization, two fundamental measures were carried out. The first one was an agrarian reform that extended the agricultural frontier through the use of public and private lands. The second measure was an agricultural policy, in which the State financed and sustained agricultural expansion through cheap credits and inputs and a price policy that guaranteed low prices for domestic consumers. In addition to this, the State was responsible for technological development (research, extension and technical assistance).

During the period 1958-1968, agriculture showed its greatest dynamism in Venezuela, and this was reflected in the remarkable TFP performance. However, the years between 1969 and 1973 constituted a deceleration phase, which was later reversed by the extraordinary revenues of the oil boom and public investment regained its expansion rate in the

agricultural sector. The following periods were marked by alternating periods of economic crisis, adjustment, recovery, sector expansion, with the vicious cycle repeating itself. At the end of the 1970s, the development model was exhausted and the macroeconomic instability of the 1980s and 1990s, the adjustment programmes, and the volatility of State revenues defined the destination and the limited options for sustained agricultural expansion. This reality has changed little in spite of the political changes that began in 1999 that led to the modification of the Constitution which explicitly mentions as a national priority the development of agriculture, food production, rural development and food security of the population (Hernández, 2008 and 2009).

Therefore, the strategy of the various governments, with the exception of periods of falling oil income and economic crisis, has been to encourage agricultural production through massive transfers (subsidized loans, price controls, technical transfer, etc.). The result has been the development of a modern agriculture, intensive in the use of fertilizers and agricultural machinery. However, this model of agricultural expansion is highly vulnerable insofar as it depends on State support and protectionist policies (Gutiérrez, 1997).

In the intermediate subperiod, 1973-1993, in Latin America, TFP growth was higher and the endowment per worker factor declined in importance in explaining agricultural labour productivity. TFP gained weight in all countries except Mexico and Peru. In the case of Peru this can be explained by the difficult economic and political situation experienced in those years which was characterized by a serious external debt crisis, the spread of political violence and hyperinflation.

Generally, the incorporation of inputs was lower, but the growth of output stagnated in the entire region. The adjustment programmes had an impact upon agriculture. On the one hand, there was a fall in the provisions for agricultural development, the supply of subsidised inputs, state purchases with guaranteed prices, technical assistance or the subsidising of rural credit. Consequently, both private and public agricultural investment was reduced. Moreover, countries in which agricultural products accounted for a substantial

part of their exports were seriously affected by the sharp deterioration of international agricultural prices in this period. In addition, the drop in real prices was more important in those products in which the agrarian export sector of Latin America was specialized: basic products and plantation products (with the exception of tobacco) (Serrano and Pinilla, 2011: 221).

Therefore, efficiency and accumulation sources equally explained agricultural labour productivity growth in the years of the oil crisis and the lost decade.

Nevertheless, in these two decades there were several countries (Chile, Colombia and Peru) in which TFP growth fully explained labour productivity growth. This is striking because these three countries also increased their land productivity and decreased their land-labour ratio. This could be explained by the fact that the path followed by these countries to raise their labour productivity was based on the intensification of the use of land.

The trends followed by the sources of labour productivity in the last fifteen years of our sample intensified the direction taken in the intermediate subperiod. The principal source of agricultural labour productivity growth between 1993 and 2008 was significantly raising TFP in most of the Latin American countries, with the exception of Argentina[13]. TFP explained between 65% and 71% of the agricultural labour productivity growth in the whole region. The higher growth of TFP coincides with the reforms leading to trade integration. Consequently, these reforms produced an exit of resources to non-agricultural activities, but also the development of an internationally competitive agriculture.

One of the examples of this process is Brazil[14]. Until the end of the 1980s, agricultural production had been stimulated fundamentally by the greater use of inputs and, especially, by the occupation of new regions in the centre and west of the country (Garcia et. al, 2010; Wesz Junior, 2017). In fact, in the mid-1980s, public policy shifted towards reform movements in land

[13] Despite factor endowment per worker being more important, TFP produced almost 30% of agricultural labour productivity growth in Argentina.
[14] The contribution of TFP to agricultural labour productivity growth in Brazil was 32% in the period 1950-73, 52% in the intermediate subperiod and 64% between 1993 and 2008.

ownership, with the aim of alleviating the problems of rural poverty, including subsidised loans, research and extension services. However, this type of extensive growth gave rise to another more intensive growth with a predominance of productivity gains which involved improvements in the qualification of the labour force, increases in the operational capacity of machinery and greater expenditure on research and development applied to the land (Mueller and Mueller, 2018). Nevertheless, and despite substantial improvements in agricultural productivity (even when compared with countries on the technological frontier, such as the United States), serious problems of structural heterogeneity persisted (Fornazier and Ribeiro, 2013).

In this period, Peru was the country with the greatest increase in the TFP, which has been explained by the increasing openness to international markets –favoured by the growing international demand for healthy, high-quality food–, domestic higher quality food demand, and the expansion of private investment in agriculture (Velazco and Pinilla, 2018: 431-432).

6. Conclusions

The transformations of the agricultural sector in the second half of the twentieth century were deep-rooted and essential for understanding the evolution of this sector and the development process of many countries. The differences in these transformations can be observed through the evolution of agricultural production and labour productivity.

In our analysis of agricultural growth in the second half of the twentieth century we have observed two different models: developed and developing regions. Developed countries, with a moderate increase in production, displayed a strong increase in agricultural labour productivity, owing to increases in the land-labour ratios. In turn, developing regions increased their labour productivity to a lesser extent than developed countries but their production expanded more quickly. In addition, developing regions augmented their labour productivity, due to increases in land productivity.

In this study, we have shown, firstly, that the growth model of Latin American agricultural production possesses some typical characteristics which hinder its insertion into the more general pattern of not only developed countries but also developing countries. The rapid growth of production fits well within that of developing countries, while its increase in labour productivity places it at an intermediate level between the lowest of developing countries and the highest of developed countries. Furthermore, it has been the only region of the developing world in which the improvement of labour productivity has been based not only on improvements in land productivity but also on the land-labour ratio.

Subsequently, we have analysed the main determinants of agricultural production and labour productivity in Latin American countries in the second half of the twentieth century. Furthermore, we have discussed the existence of a Latin American pattern in order to understand the determinants of these variables. We can observe that the differences in Latin American agriculture are strong enough to explain the behaviour of these variables and to indicate the existence of a Latin American pattern. However, we can identify several general trends in this region. The first is related to the explanation of agricultural production growth. The determinants of this variable have tended to depict a growing importance of labour productivity and a diminishing importance of labour endowment from the first subperiod (1950-1973) to the last (1993-2008).

The second general trend is related to the determinants of agricultural labour productivity growth, when these determinants are divided into land productivity and the land-labour ratio. The diversity of these determinants is the most observable trend. Throughout the period, land productivity has been crucial in explaining labour productivity, as in other developing world regions, but this role has changed over the period or between countries. This analysis shows the different patterns among Latin American countries, as we have seen in Table 4 and Figure A.3. On the one hand, several countries increased their labour productivity, thanks to increases in land-labour ratios, for example Argentina and Uruguay. On the other hand, there are others in which land

productivity growth explained labour productivity growth, such as Colombia or Chile.

Finally, we have tried to understand the sources of agricultural labour productivity growth, decomposing this between TFP (efficiency) and factor endowment per worker (accumulation). We have found a greater importance of TFP throughout the second half of the twentieth century, while the endowment per worker factor declined in importance. The latter was the most important source of labour productivity growth between 1950 and 1973 while it was TFP in the last subperiod.

The changes in the innovations and new techniques adopted, the institutional framework and also the geographical conditions in each country are very important in order to understand these trends in the Latin American agricultural sector. These trends are essential to identify the sources of the differences between them. Furthermore, these differences between Latin American agricultural sectors are fundamental to clarify the differences in income in these countries.

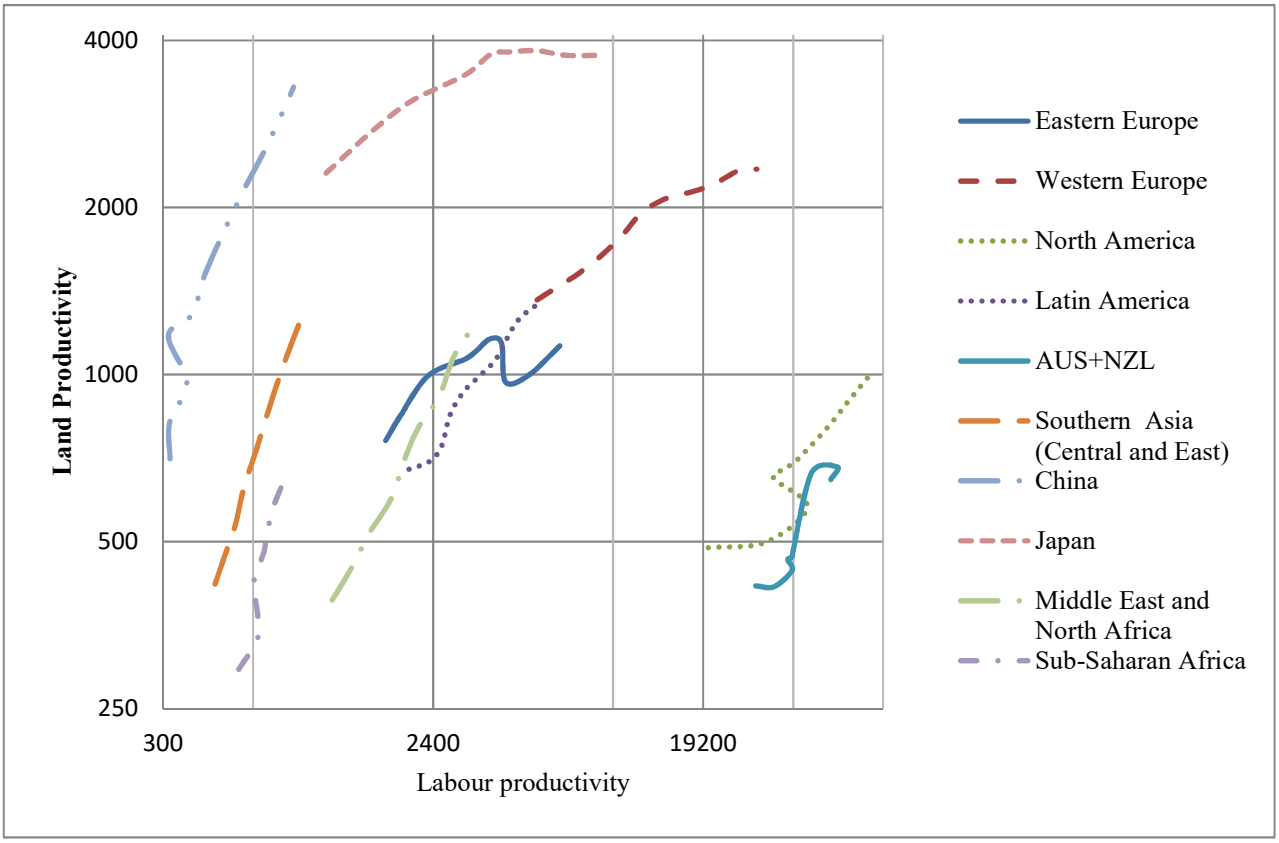
TABLES AND FIGURES

Table 1. Logarithmic growth rates of output, labour and labour productivity, 1965-2005 (%).

	Agricultural production	Labour endowment	Labour productivity
Eastern Europe	0.52	-2.83	3.35
Western Europe	0.98	-3.25	4.23
North America	1.71	-1.45	3.16
Latin America	2.98	0.41	2.57
Australia+New Zealand	1.66	0.22	1.45
Southern Asia (Central and East)	3.05	1.43	1.61
China, mainland	4.32	1.93	2.38
Japan	0.61	-4.73	5.33
Middle East and North Africa	3.08	0.34	2.75
Sub-Saharan Africa	2.67	1.81	0.86

Source: FAO (1948-2004) and FAOSTAT (2014)

Figure 1. Land and labour productivities (world regions), 1965-2005



Source: The same as in Table 1

Table 2. Growth rates of agricultural production, agricultural labour productivity and labour endowment (%).

	Output				Agricultural labour productivity				Labour Endowment			
	1950-1973	1973-1993	1993-2008	1950-2008	1950-1973	1973-1993	1993-2008	1950-2008	1950-1973	1973-1993	1993-2008	1950-2008
Argentina	0.69	1.56	2.96	1.57	1.18	1.54	3.11	1.80	-0.50	0.02	-0.15	-0.23
Brazil	3.99	3.50	4.32	3.91	2.33	3.66	5.58	3.63	1.66	-0.16	-1.26	0.28
Chile	1.28	3.47	2.60	2.37	0.89	1.89	2.63	1.68	0.39	1.58	-0.03	0.69
Colombia	2.47	2.84	2.20	2.53	1.02	1.65	2.10	1.52	1.45	1.19	0.11	1.02
Honduras	3.50	2.37	3.16	3.02	3.34	1.23	3.45	2.64	0.15	1.14	-0.29	0.38
Mexico	5.03	2.61	2.59	3.57	3.45	1.45	3.11	2.67	1.58	1.16	-0.52	0.89
Panama	3.27	2.32	3.34	2.96	1.43	1.12	3.44	1.84	1.85	1.18	-0.10	1.11
Peru	2.11	1.34	5.45	2.71	0.74	-0.96	4.04	1.01	1.37	2.30	1.41	1.70
Uruguay	0.35	1.25	2.68	1.27	1.18	0.81	2.96	1.51	-0.84	0.46	-0.28	-0.25
Venezuela	4.27	2.87	2.64	3.36	3.99	2.26	3.51	3.27	0.28	0.61	-0.87	0.10
LA	2.83	2.71	3.41	2.94	1.48	2.12	3.93	2.33	1.35	0.59	-0.51	0.61

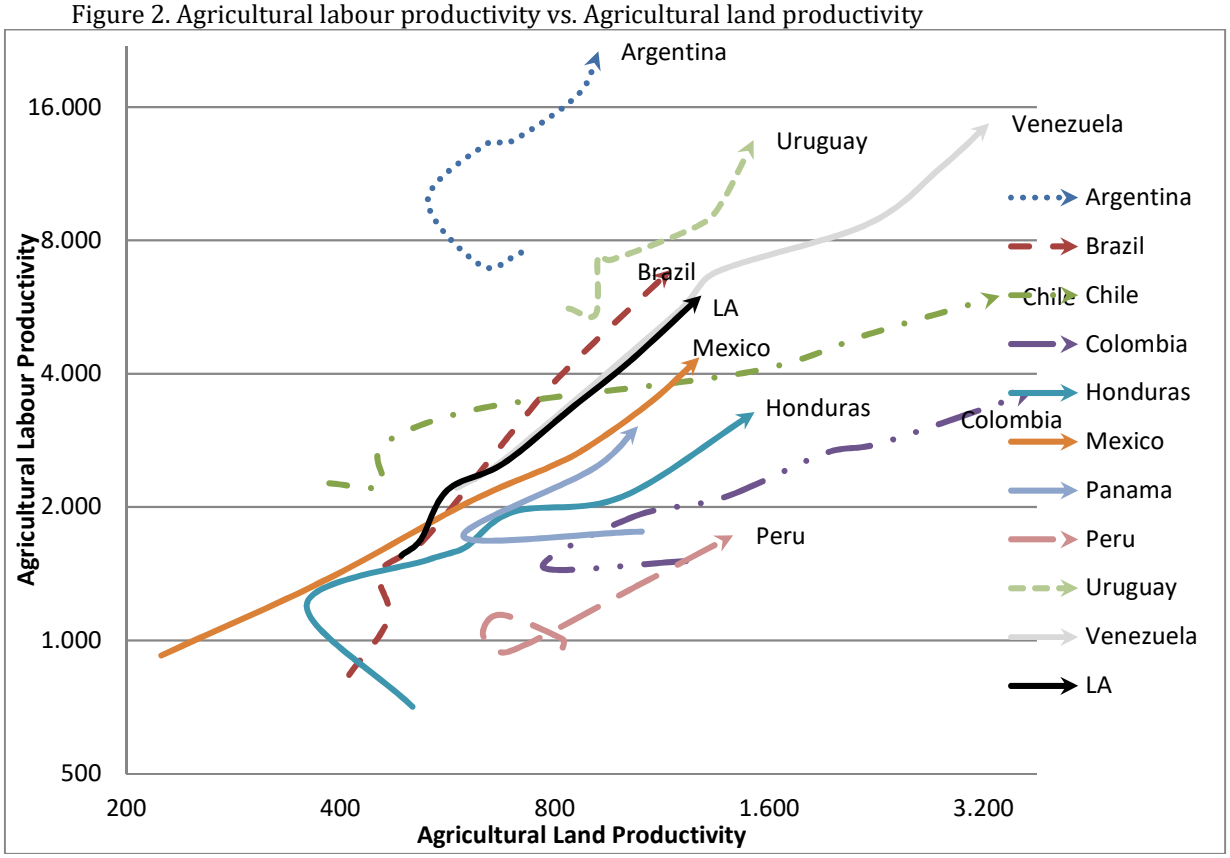
Source: Author's elaboration, from FAOSTAT (2012) and FAO (1948-2004).

Table 3. Labour and Land Productivities and Land-Labour Ratios

	Production ($ 2004-2006 prices) per worker				Production ($2004-2006 prices) per hectare				Hectares per worker			
	1950	1973	1993	2008	1950	1973	1993	2008	1950	1973	1993	2008
Argentina	7,510	9,858	13,402	21,372	717	530	695	920	10	19	19	23
Brazil	836	1,428	2,971	6,861	411	454	698	1,163	2	3	4	6
Chile	2,263	2,774	4,044	5,995	385	459	1,507	3,370	6	6	3	2
Colombia	1,509	1,906	2,652	3,633	1,221	1,035	1,922	3,736	1	2	1	1
Honduras	708	1,528	1,953	3,276	504	536	700	1,525	1	3	3	2
Mexico	925	2,044	2,732	4,356	224	602	889	1,276	4	3	3	3
Panama	1,761	2,445	3,061	5,130	1,059	906	1,184	1,860	2	3	3	3
Peru	964	1,142	942	1,727	820	671	687	1,422	1	2	1	1
Uruguay	5,612	7,362	8,648	13,483	836	919	1,273	1,519	7	8	7	9
Venezuela	2,209	5,528	8,694	14,712	582	1,191	2,194	3,256	4	5	4	5
Latin America	1,554	2,185	3,336	6,012	487	565	842	1,284	3	4	4	5

Triennial averages for the production. Source: Author's elaboration, from FAOSTAT (2012) and FAO (1948-2004).

Figure 2. Agricultural labour productivity vs. Agricultural land productivity



Source: Author's elaboration, from FAOSTAT (2012) and FAO (1948-2004

Table 4. Growth rates of agricultural labour and land productivity and land-labour ratio, 1950-2008 (%).

	Labour Productivity				Land Productivity				Land-Labour Ratio			
	1950-1973	1973-1993	1993-2008	1950-2008	1950-1973	1973-1993	1993-2008	1950-2008	1950-1973	1973-1993	1993-2008	1950-2008
Argentina	1.18	1.54	3.11	1.80	-1.31	1.36	1.87	0.43	2.49	0.18	1.24	1.37
Brazil	2.33	3.66	5.58	3.63	0.43	2.15	3.40	1.79	1.90	1.51	2.18	1.84
Chile	0.89	1.89	2.63	1.68	0.76	5.94	5.36	3.74	0.13	-4.06	-2.74	-2.06
Colombia	1.02	1.65	2.10	1.52	-0.72	3.10	4.43	1.93	1.74	-1.45	-2.33	-0.41
Honduras	3.34	1.23	3.45	2.64	0.27	1.33	5.19	1.91	3.08	-0.11	-1.74	0.73
Mexico	3.45	1.45	3.11	2.67	4.30	1.95	2.41	3.00	-0.85	-0.50	0.70	-0.33
Panama	1.43	1.12	3.44	1.84	-0.68	1.34	3.01	0.97	2.10	-0.21	0.43	0.87
Peru	0.74	-0.96	4.04	1.01	-0.87	0.12	4.85	0.95	1.61	-1.08	-0.81	0.06
Uruguay	1.18	0.81	2.96	1.51	0.41	1.63	1.18	1.03	0.77	-0.82	1.78	0.48
Venezuela	3.99	2.26	3.51	3.27	3.11	3.05	2.63	2.97	0.88	-0.79	0.88	0.30
LA	1.48	2.12	3.93	2.33	0.65	2.00	2.81	1.67	0.83	0.12	1.11	0.66

Source: Author's elaboration, from FAOSTAT (2012) and FAO (1948-2004).

Table 5. Growth rates of Total Factor Productivity and factor endowment per worker (%)

	1950-2008		1950-1973		1973-1993		1993-2008	
	Total Factor Productivity	Factor Endowment per Worker	Total Factor Productivity	Factor Endowment per Worker	Total Factor Productivity	Factor Endowment per Worker	Total Factor Productivity	Factor Endowment per Worker
Argentina	-0.04	1.95	-0.71	2.41	0.07	1.35	0.84	2.01
Brazil	1.90	1.79	0.83	1.75	1.89	1.71	3.56	1.98
Chile	1.35	0.42	0.13	1.17	1.94	-0.41	2.46	0.34
Colombia	1.19	0.35	0.11	1.17	1.54	-0.11	2.39	-0.32
Honduras	0.98	1.68	0.04	3.30	0.70	0.59	2.80	0.65
Mexico	1.99	0.79	3.01	0.76	0.19	1.28	2.84	0.18
Panama	1.26	0.62	-0.04	1.63	1.11	0.01	3.46	-0.16
Peru	1.13	-0.13	-0.36	1.15	0.97	-1.51	3.61	-0.24
Uruguay	0.23	1.15	-0.84	1.88	0.43	0.30	1.61	1.16
Venezuela	2.22	1.14	2.56	1.62	1.67	0.67	2.42	1.03
AL BRA	1.43	0.97	0.74	1.05	1.26	0.80	2.72	1.10
AL MEX	1.04	1.36	0.26	1.53	0.69	1.37	2.72	1.10
AL ARG	0.93	1.47	-0.01	1.80	0.83	1.23	2.50	1.32

Source: Author's elaboration, from FAOSTAT (2012) and FAO (1948-2004).

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Appendix

Table A.1. World Agricultural Production and Productivities, 1965-2005

Labour productivity (Y/L)	1965	1970	1975	1980	1985	1990	1995	2000	2005	Growth Rate (%)
Eastern Europe	1,664	1,870	2,312	3,135	3,694	4,059	4,191	5,004	6,365	3.35
Western Europe	5,347	7,719	10,001	11,905	14,510	17,258	20,593	25,411	29,034	4.23
North America	19,974	31,122	42,842	33,119	36,372	40,202	50,709	59,474	70,666	3.16
Latin America	1,993	2,333	2,562	2,735	3,042	3,433	3,909	4,586	5,572	2.57
Australia+New Zealand	28,794	33,161	38,048	36,875	38,110	38,556	44,393	54,082	51,339	1.45
Southern Asia (Central and East)	447	489	522	556	614	664	731	786	853	1.61
China, mainland	316	315	360	312	376	416	540	677	819	2.38
Japan	1,051	1,531	2,038	3,082	3,749	4,333	5,344	6,696	8,872	5.33
Middle East and North Africa	1,103	1,284	1,457	1,741	1,929	2,148	2,513	2,817	3,308	2.75
Sub-Saharan Africa	537	620	621	604	597	650	663	694	757	0.86
Land productivity (Y/A)										
Eastern Europe	760	845	996	1,073	1,157	1,141	969	997	1,126	0.98
Western Europe	1,363	1,550	1,752	1,952	2,079	2,129	2,195	2,335	2,344	1.36
North America	487	499	577	650	678	707	810	903	1,009	1.82
Latin America	675	697	743	847	932	994	1,070	1,248	1,359	1.75
Australia+New Zealand	416	415	443	464	469	488	667	681	647	1.10
Southern Asia (Central and East)	419	483	534	619	732	838	984	1,097	1,232	2.69
China, mainland	705	821	968	1,175	1,285	1,529	2,075	2,623	3,295	3.85
Japan	2,306	2,772	3,114	3,472	3,778	3,813	3,832	3,760	3,761	1.22
Middle East and North Africa	392	450	514	599	705	805	912	1,078	1,232	2.86
Sub-Saharan Africa	294	334	368	404	417	477	504	568	642	1.95
Land-Labour ratio (A/L)										
Eastern Europe	2.19	2.21	2.32	2.92	3.19	3.56	4.32	5.02	5.65	2.37
Western Europe	3.92	4.98	5.71	6.10	6.98	8.11	9.38	10.88	12.38	2.87
North America	40.97	62.39	74.26	50.96	53.63	56.85	62.64	65.88	70.03	1.34
Latin America	2.95	3.35	3.45	3.23	3.26	3.45	3.65	3.68	4.10	0.82
Australia+New Zealand	69.21	79.97	85.84	79.52	81.23	79.09	66.55	79.40	79.35	0.34
Southern Asia (Central and East)	1.07	1.01	0.98	0.90	0.84	0.79	0.74	0.72	0.69	-1.08
China, mainland	0.45	0.38	0.37	0.27	0.29	0.27	0.26	0.26	0.25	-1.47
Japan	0.46	0.55	0.65	0.89	0.99	1.14	1.39	1.78	2.36	4.11
Middle East and North Africa	2.81	2.85	2.83	2.90	2.74	2.67	2.75	2.61	2.69	-0.11
Sub-Saharan Africa	1.82	1.86	1.69	1.49	1.43	1.36	1.31	1.22	1.18	-1.09

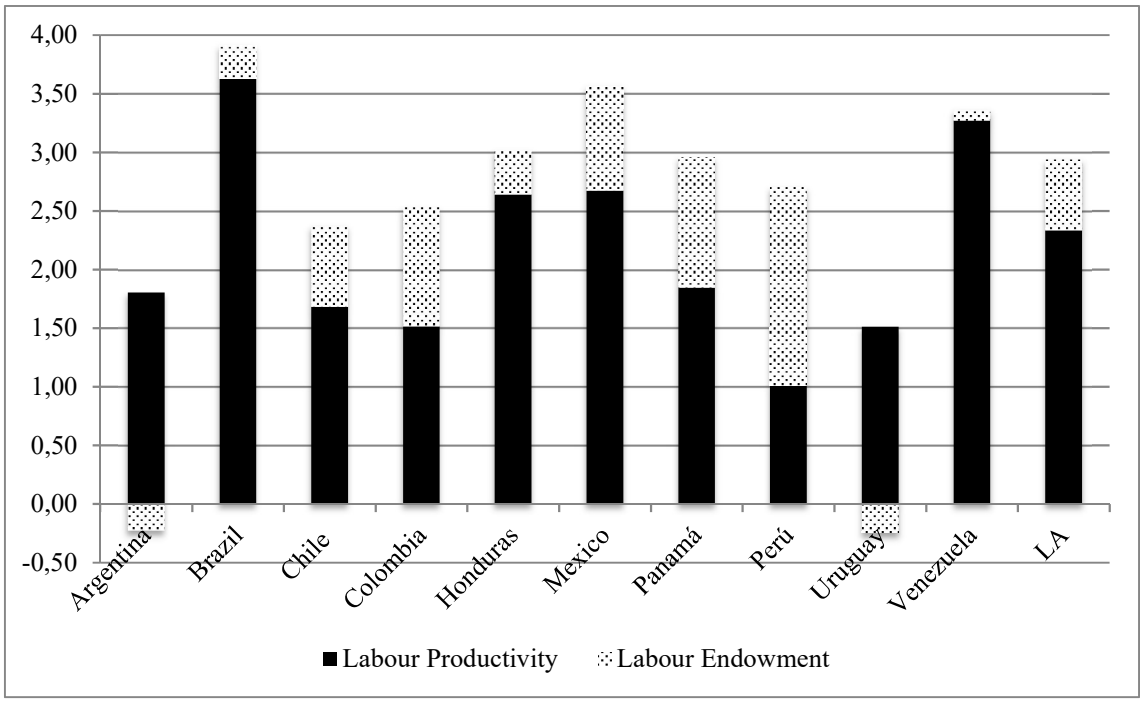
Y/L in US $ 2004-2006 prices per people engaged in agriculture.

Y/A in US $ 2004-2006 prices per hectare of arable land and permanent crops.

A/L hectare of arable land and permanent crops per people engaged in agriculture.

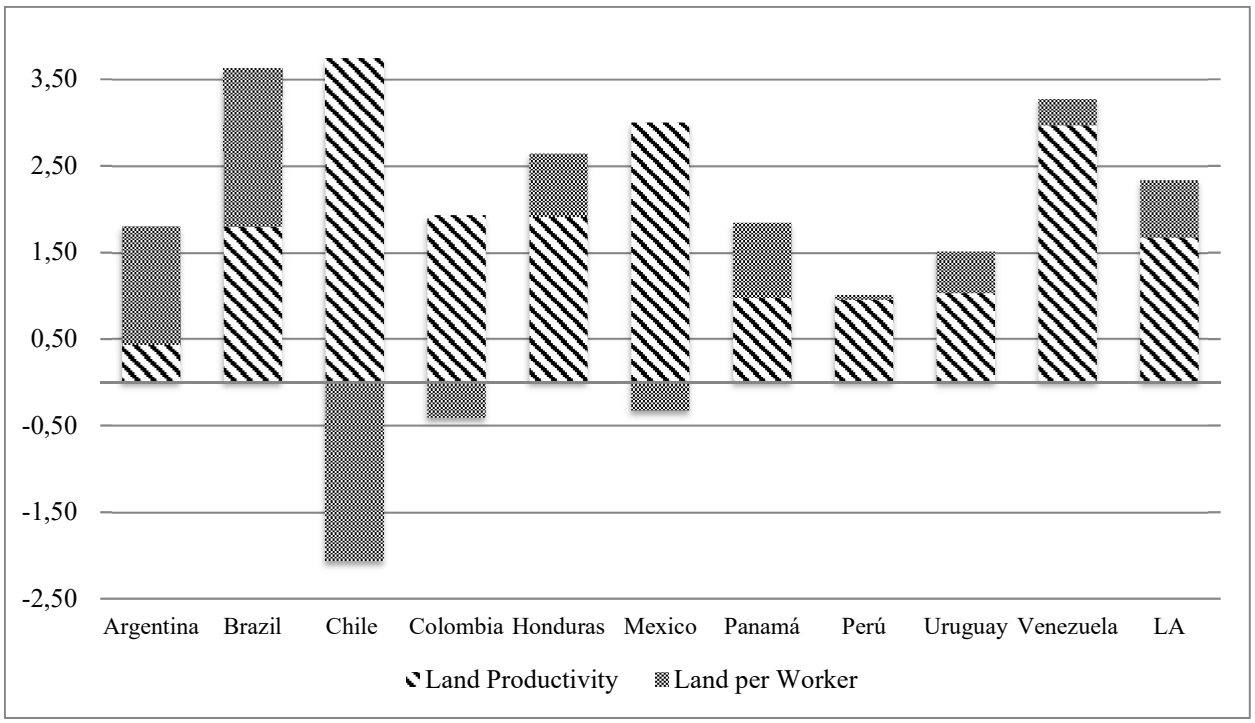
Source: FAO (1948-2004) and FAOSTAT (2014).

Figure A.1 Sources of agricultural output, 1950-2008



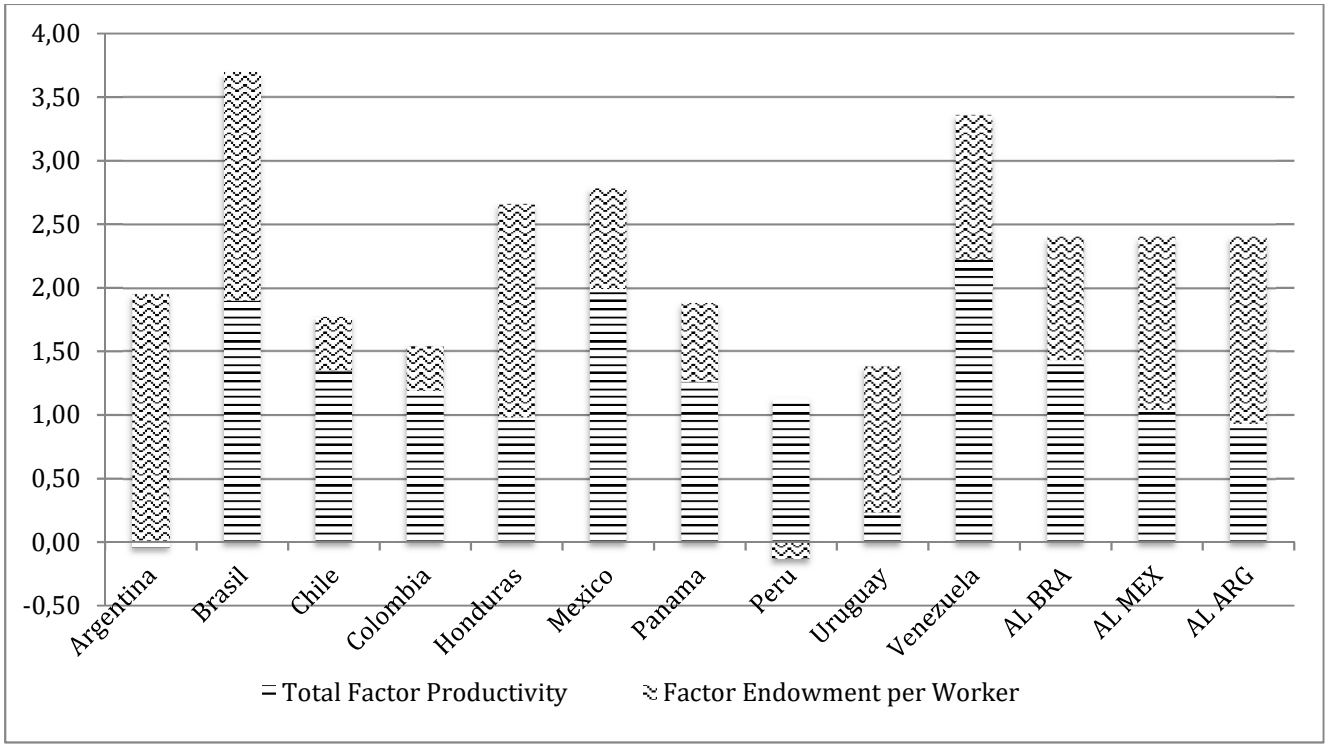
Source: the same as Table 3

Figure A.2. Agricultural Labour Productivity Decomposition, 1950-2008



Source: the same as Table 5.

Figure A.3. Agricultural Labour Productivity Decomposition, 1950-2008



Source: the same as Table 6

Construction of variables

Agricultural production

As we have seen in the main text, from FAOSTAT (2012) we have obtained a series for each country from 1961 valued at international 2004-2006 prices in dollars. In order to complete the data for the whole period of our study, we have assumed that during the 1950s the series followed the agricultural production index which appears in FAO (1948-2004). In this way, we have obtained a complete series for each Latin American country from 1950 to 2008.

Inputs

We have followed the same procedure as in the agricultural production, but with some differences. FAO (1948-2004) does not provide these variables, namely, labour, land, machinery, livestock units and fertilisers, in continuous series for the 1950s. These variables were offered in some specific years during this decade. We have calculated a continuous series for this decade taking into account the data which appears in these yearbooks for each variable and country and, then, we have completed the series with a linear interpolation.

As we have explained in the main text, the data for chemical fertilisers correspond to the period 1961 to 2008 from IFA (2014).

Another exception is the obtaining of the series of the active population in agriculture. When we downloaded the data from FAOSTAT (2012), these data are available from 1980 in the online webpage. So, we followed the same strategy as in the rest of variables but taking into account the data from FAO (1948-2004) from 1950 to 1980. The omitted data were completed.

Estimation of TFP

The estimation of the TFP is obtained from the difference of the agricultural production growth and a combination of the inputs growth. This combination is formed by labour, land -which is a combination of arable land and permanent crops with the irrigated land-, machinery, chemical fertilizers and livestock units. To carry out the combination, the growths of inputs have to be weighted. We have used three different combinations of weightings, taking into account their economic and climatic conditions. One strong point of using

this TFP calculation with unfixed weightings it that it takes into account the evolution of the different importance of the inputs. For our calculation we have considered three types of weightings drawn from studies on Mexico, Brazil and Argentina. We have applied to Argentina, Chile and Uruguay the weightings of Argentina; to Mexico, Colombia, Honduras and Peru that of Mexico; and to the rest that of Brazil. In order to group the countries we have referred to the discussion on the typologies of Latin American economies conducted by Luis Bértola and José Antonio Ocampo in *El desarrollo económico de América Latina desde la independencia* (Fondo de Cultura Económica, México, 2013) on pages 24-29. These authors offer several possibilities taking into account the economy as a whole and the timeframe. In our opinion, for our case it would be appropriate to select what is principally based on agriculture. Therefore, we have classified the countries into three groups:

- temperate climate agricultures: Argentina, Chile, Uruguay
- tropical agricultures with a large Afro-American workforce: Brazil, Venezuela and Panama
- mixed temperate-tropical climate agricultures, with traditional subsistence farming and a predominantly Indo-American workforce: Mexico, Colombia, Honduras, Peru.

Table A3.1. *Weightings corresponding to Mexico*

	Work	Land	Cattle	Fixed capital	Chemicals
1950	0.256	0.489	0.118	0.089	0.048
1973	0.242	0.373	0.200	0.147	0.038
1990	0.117	0.202	0.362	0.289	0.031
2008	0.115	0.225	0.353	0.263	0.045

Source: Authors' elaboration using data from Fuglie (2012).

Table A3.2. *Weightings corresponding to Brazil*

	Work	Land	Cattle	Fixed capital	Chemicals
1950	0.434	0.342	0.126	0.071	0.027
1973	0.434	0.342	0.126	0.071	0.027
1990	0.429	0.137	0.1745	0.144	0.116
2008	0.373	0.083	0.129	0.161	0.255

Source: Authors' elaboration using data from Fuglie (2012).

Table A3.3 *Weightings corresponding to Argentina*

	Work	Land	Cattle	Fixed capital	Chemicals
1950	0.333	0.333	0.188	0.106	0.040
1973	0.340	0.261	0.160	0.122	0.117
1990	0.345	0.207	0.140	0.135	0.174
2008	0.350	0.150	0.118	0.148	0.234

Source: Díaz Alejandro (1970) and Elías (1992).

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