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Factor Endowments and Agricultural Productivity in Latin America on the Eve of World War I

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Factor Endowments and Agricultural Productivity in Latin America on the Eve of World War I

Pablo Castro Scavone(*) y Henry Willebald(†)

Resumen

Este artículo cuantifica el desempeño agropecuario en América Latina a comienzos del siglo XX, complementando estudios cualitativos previos mediante un enfoque comparativo e histórico. El análisis abarca diez países –Argentina, Brasil, Colombia, Chile, Cuba, México, Nicaragua, Perú, Uruguay y Venezuela– durante los años previos a la Primera Guerra Mundial. Se identifican tres trayectorias agrarias generales. Argentina y Uruguay presentaron sistemas extensivos, de alta productividad y orientados a la exportación, que impulsaron un desarrollo económico más amplio. Chile, Cuba y Nicaragua exhibieron sistemas más intensivos, pero demandantes de mano de obra, con productividad moderada y progreso tecnológico desigual. Venezuela, México, Colombia, Brasil y Perú mantuvieron un sector agrario tradicional de baja productividad y con limitado potencial de contribuir al crecimiento económico. Estas estructuras contrastantes evidencian la diversidad del capitalismo agrario latinoamericano y contribuyen a explicar la desigual capacidad de las economías nacionales para iniciar procesos de transformación estructural. En conjunto, las diferencias en la dotación de factores jugaron un papel decisivo en la configuración de los patrones de productividad, favoreciendo, en las regiones con abundancia de tierra, tecnologías que ahorraban trabajo.

Palabras clave: agropecuario, productividad de la tierra, productividad del trabajo, América Latina.

Clasificación JEL: N56, Q11, Q16

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Abstract

This paper quantifies agricultural performance in Latin America in the early 20th century, complementing previous qualitative studies with a comparative and historical perspective. The analysis covers ten countries –Argentina, Brazil, Colombia, Chile, Cuba, Mexico, Nicaragua, Peru, Uruguay, and Venezuela– during the years preceding World War I. We identify three broad agrarian paths. Argentina and Uruguay featured extensive, high-productivity, export-oriented systems that promoted broader economic development. Chile, Cuba, and Nicaragua exhibited more intensive but labour-demanding systems, with moderate productivity and uneven technological progress. Venezuela, Mexico, Colombia, Brazil, and Peru maintained low-productivity, traditional agriculture with limited potential for economic growth. These contrasting structures highlight the diversity of Latin American agrarian capitalism and help explain the uneven capacity of national economies to initiate structural transformation. Overall, differences in factor endowments played a decisive role in shaping productivity patterns, with land-abundant regions favouring labour-saving technologies.

Keywords: agriculture, land productivity, labor productivity, Latin America.

JEL Clasification: N56, Q11, Q16

1. Introduction

Given its productive and commercial capacity, Latin American agriculture is destined to play a fundamental role in supplying the world with food and raw materials, while at the same time improving the situation of its farmers is an unavoidable requirement. The region needs responsive and efficient policies and programs that increase productivity in a sustainable –both economically and environmentally– and inclusive –both socially and institutionally– way. To achieve this goal, Latin American countries have sought to advance not only in the formulation of sectoral policies but also in the coordination of efforts among the various organizations that make up the institutional architecture aimed at improving the sector's performance. Supporting these expectations for the 21st century requires an appropriate review and interpretation of the arguments, experiences, and lessons derived from the agricultural history and the comprehension of its development, limitations and advantages in a long run perspective.

Latin American agriculture is heterogeneous, reflecting the wide diversity of landscapes, climates, soils, and local conditions. Its lands offer a multiplicity and diversity of products that make the region one of the world's leading suppliers of cereals, oilseeds, horticulture, fruits, flowers, and meats. However, some common features provide a clear conceptual unity to the region (Solbrig, 2006).

The first and most notable characteristic is the importance of agriculture in Latin American economies. Since colonial times, the region has depended on crops and livestock as its main sources of production, employment, exports, and foreign exchange. Secondly, the unequal distribution of land –known under the *latifundio-minifundio* dichotomy– constitutes a structural feature that has shaped agricultural development throughout the region. Third, the persistence of a large sector of small farmers, weakly integrated into the economy and producing mainly staple foods for local markets. Finally, in the agro-export sector, very few products (or, at times, only one) have prevailed in each country. This dependence on a small number of export commodities has exposed countries to the contingencies of external markets, price fluctuations, and marked boom-and-bust cycles.

Despite the importance of agricultural activity in most of Latin America, the sector has not been able to stimulate the rest of the economy and create sustained forward and backward linkages,[1] a particularly notable aspect during the 20th century. Similarly, the influence of other sectors and broader processes –such as demand dynamics, technological change, structural transformation, and urbanization– on agricultural activity has also been limited. This contrasts with what happened in many parts of the world, where this century was a period of enormous change in the rural sector that distinguishes it from any other time in history (Federico, 2005). Indeed, from very traditional and conservative production methods, agriculture has been transformed into a knowledge- and science-based enterprise, especially since the second half of the 20th century. This process has increased productivity and supported the expansion of

[1] Probably, the exception was Argentina during the Belle Époque and, to some extent, Uruguay.

production to keep up with the greater demand brought about by a growing population. It has also altered people's relationship with the land, as the industrialization of agriculture has increased the linkages and dependence on manufacturing, making agricultural activities more vulnerable to markets and exacerbating the environmental consequences of agriculture (Solbrig, 2006). However, Latin America has not been able to benefit significantly from these changes in supply and demand, nor from the new institutional arrangements or the renewed technological conditions that dominated the 20th century –at least until the end of the century.

Several recent research have addressed this topic in the last decade (Martin-Retortillo et al., 2019, 2022; Salazar, 2024) considering the Latin American agriculture performance since the 1950s or 1960s until the present. Latin American agriculture possesses a set of characteristics that, from a long-term perspective, make it quite peculiar. It exhibits conditions that place it in a typical peripheral economy situation –such as the pace of production expansion– yet with labour productivity growth driven by both increases in land productivity and improvements in the land-to-labour ratio (similar to developed economies). The enormous variety of climates, endowments, types of production, and political-institutional developments prevents the identification of a single "Latin American agricultural pattern", revealing a regional reality that hides significant disparities (Martin-Retortillo et al., 2022). In general, the growth of labour productivity from the second half of the 20th century to the first decade of the 21st has been driven by efficiency improvements and by increased use of productive factors (per unit of labour). In the nearly 60 years covered by these studies, agricultural output grew at a steady annual average of 3%, supported —until the 1980s— by factor accumulation, and —since the 1990s— by substantial improvements in total factor productivity (TFP).

However, for the previous decades, a despite abundant research, such qualitative as quantitative about the sector, it is not possible to make a comparative analysis of the performance of the agriculture in a "Latin American perspective". In light of this limitation, this article aims to make an empirical contribution to filling this gap by offering new insights into the topic. It does so by examining the interaction between factor endowments and agricultural productivity on the eve of World War I (WWI) and by analysing a novel database.

After this introduction, the article is ordered as follows. Initially, we present a historical overview covering the period of the First Globalization to the WWI to contextualize our analysis and proposed our hypothesis (Section 2). Then, we present our conceptual framework and empirical strategy (Section 3) which consist in the application of a standard model and to dealt with two activities: compilation of a database (output, land, labour force) (Section 4) and describing the main relations among variables (Section 5). We work with 10 Latin American countries (Argentina, Brazil, Colombia, Chile, Cuba, Mexico, Nicaragua, Perú, Uruguay and Venezuela), which represent almost the 90% of total GDP and population of the region. We close the paper with some final remarks (Section 6).

For the region as a whole, and for an earlier period than is usually examined, our findings show that agricultural producers responded in ways comparable to those of their counterparts in subsequent decades. Differences in factor endowments shape the link

between factor productivities: where land is plentiful, production choices tend to favour labour-saving technologies, since labour represents the costlier input. On the contrary, when labour is the abundant factor, technological options focus on saving land.

2. Historical overview

In the late 19th century, particularly the final third, Latin America entered a phase of relatively strong growth, driven by its dynamic integration into the global economy. This process resulted from a combination of external and internal factors (Bértola & Ocampo, 2012). Externally, the transport revolution significantly reduced shipping costs and narrowed the economic distance to Europe (O'Rourke & Williamson, 2001). Global demand for raw materials and food reinforced this integration. Internally, political and institutional reforms since independence –notably the liberal economic reforms of the mid-19th century– strengthened institutional stability and supported export growth.

Exports became the main driver of growth, creating backward linkages of varying intensity across countries. Growth was also fuelled by foreign capital inflows and European –and to a lesser extent Asian– immigration, though unevenly distributed (Williamson, 2002). While free trade dominated economic policy, it was often inconsistent and focused primarily on export needs. Policymakers assumed export growth would spill over to the rest of the economy, though this was not guaranteed.

This phase saw significant territorial expansion and the settlement of new regions (Garavaglia & Gelman, 2003; Harley, 2007; Willebald & Juambeltz, 2018). In some areas, larger export activities spurred diversification into handicrafts, infrastructure and finance. Exports –mainly agricultural and mining– led economic growth, while manufacturing and services played marginal roles. From the mid-19th century to WWI, new agricultural exports emerged in response to industrial demand (Bulmer-Thomas, 2003): rubber, wool, cereals, meat, coffee, cocoa, bananas, sugar, among others. By WWI, Latin America specialized largely in tropical crops and temperate products (Ayuda et al., 2024, Bértola & Williamson, 2008).

Export diversification was limited: dominant products declined but were replaced by others, keeping concentration high. In 1870, the main export commodity averaged 50% of exports; by 1913 it had fallen to 42%, rising again to 54% by 1929 (Bértola & Ocampo, 2012). Dependence on a few products and markets made economies vulnerable to external shocks, with little intraregional trade (Carreras et al., 2013).

The best outcomes occurred when exports diversified across several products and markets and productivity gains extended beyond the export sector, although this was not the norm (Bulmer-Thomas, 2003). Export competitiveness hinged on natural resources –the so-called “commodity lottery” (Díaz-Alejandro, 1984– though outcomes depended on how efficiently economies mobilized factors (Bértola & Ocampo, 2012). Resource abundance was dynamic, shaped by prices, technology, institutions, and investment (Willebald et al., 2015) and had different influences on national productive specializations.

Population growth, fuelled by immigration, increased labour supply, though still insufficiently for export demands. Internal mobility remained limited, and coercive labour practices persisted. Elites often favoured European over local labour, seeing it as superior. Selective and mass immigration –notably in Argentina, Cuba, Southern Brazil, and Uruguay– partly alleviated shortages (Bulmer-Thomas, 2003).

Access to land was constrained by poor transport and concentrated ownership (Bértola & Ocampo, 2012; Frankema, 2009) and expanding into "new" lands raised productivity but reinforced inequality. As elsewhere, high land/labour ratios encouraged labour-saving technologies (Martín-Retortillo et al., 2022), including mechanization and chemical inputs, though technical change often favoured land over labour productivity. The rural elite dominated politics, shaping fiscal and factor markets to their advantage.

Capital accumulation was modest and technical progress, when present, was capital-embodied. Banking facilitated some resource mobilization but remained limited and mainly based on rent-seeking relationships (Haber, 2012). Investment in human capital was also weak and the creation of universities and the expansion of technical education were slow and lagged (Frankema, 2009; Maloney & Valencia, 2014).

Governments turned to foreign investment, mostly in railways, utilities, mining, and banking (Esteves, 2012; Stone, 1999). Foreign investment in agriculture was marginal except in plantation crops, in very concentrated locations (*enclaves*) in tropical areas. [2]

Export-led growth required rising exports and productivity, but also transmission of gains to the domestic economy. However, domestic markets lagged behind the export markets (Martín-Retortillo et al., 2018), with exceptions: Brazil and Venezuela were average, Peru, Cuba, and Colombia relied heavily on exports, while the Southern Cone saw stronger domestic markets (Bulmer-Thomas, 2003) and structural change (Bértola & Ocampo, 2012).

Domestic-use agriculture (DUA) –covering all non-export farming– employed the majority of the rural labour force (Bulmer-Thomas, 2003). In some cases (e.g., wheat in Argentina, beef in Uruguay), export and domestic sectors overlapped, allowing some productivity gains to spill over. In Chile, mining demand spurred agricultural change, especially in the north. Generally, DUA met growing demand, but productivity gains rarely spread effectively, contributing to the "structural heterogeneity" and dual economies highlighted by the Structuralist theory (Pinto, 1965, 1970).

Before WWI, export performance closely correlated with per-capita income (Martín-Retortillo et al., 2018), yet disparities emerged: Argentina and Uruguay outperformed relative to exports, while Costa Rica and Cuba underperformed, reflecting differences in how effectively economies leveraged export growth (Bulmer-Thomas, 2003).

Previous literature has emphasized that one of the most characteristic patterns in Latin America is the productive diversity. The heterogeneity of Latin American agriculture

[2] Individual foreigners (especially British, French, Basques and other Europeans) did buy *estancias* or farm plots in temperate regions, but as immigrants settling in the countries rather than as large foreign corporations.

mirrors the region's diverse landscapes, climates, soils, and local realities in terms of productive factors (land, labour, physical, financial and human capital). These different conditions would have been decisive in determining the different technological options in the region and would have led to disparate production performances. Our aim is to propose an empirical approach to quantify these conditions.

3. Conceptual framework and empirical strategy

The impacts of technological change are complex. On the one hand, it can increase productivity, improve food security, and generate economic opportunities; on the other, it can lead to environmental challenges, such as soil degradation and biodiversity loss, as well as social challenges related to inclusion and equity (Daum, 2023; Federico, 2011). To maximize benefits and minimize risks, comprehensive strategies are required that combine innovations, institutional strengthening, and inclusive policies that facilitate the participation of smallholders (Koppel, 1995; Daum, 2023).

In other words, agricultural technology cannot be analysed solely as a technical process. It is a complex socio-economic phenomenon reflecting the interaction between factor endowments, social structures, and institutional capacity. Understanding these dynamics allows for the design of locally adapted strategies that integrate productive, environmental, and social objectives, recognizing that technology alone does not guarantee sustainable development.

Latin American agriculture prior to WWI was characterized by significant productive and technological heterogeneity. Regions dominated by large export-oriented estates coexisted with areas dominated by small, diversified farms aimed at subsistence. This structural diversity profoundly shaped farmers' capacity to adopt new technologies and improve productivity (Solbrig, 2006).

The introduction of innovations did not depend solely on individual choices but on the complex interaction between factor endowments, access to capital, integration into international markets, and local institutional conditions. In regions with a relative scarcity of labour but availability of capital and machinery, farmers tended to adopt labour-saving technologies, whereas in areas with scarce land and relatively cheap labour, technologies that maximized land use (land-saving technologies) prevailed (Hayami & Ruttan, 1985; Ruttan, 1986).

As Solbrig (2006) emphasizes, empirical evidence for the first decades of the "long twentieth century" is limited, meaning many assertions about productive structure and technology adoption are informed conjectures rather than generalizable facts. Nonetheless, these conjectures provide a valuable conceptual framework for understanding the determinants of technological choice and for formulating comparative hypotheses across different regions of Latin America.

In other words, studying the pre-1914 period highlights that mechanization and technology adoption were not homogeneous processes but adaptive responses to the relative availability of factors, capital, markets, and institutions. This perspective offers a foundation for analysing the historical dynamics of labour-saving versus land-saving

technologies in the region, as well as their implications for productivity and agricultural structure. Here, we propose the first steps in this direction offering a first attempt of quantification of the process.[3]

Our conceptual framework is very simple because, mainly, it represents a countable relation. Following Hayami & Ruttan (1985: 119) we know that labour productivity (Y/L) can be portioned into land-labour ratio (A/L) and land productivity (Y/A):

$$\frac{Y}{L} = \frac{A}{L} \times \frac{Y}{A} \qquad (1)$$

Analytically, we mean that the labour productivity in the agriculture depends on how each economy combines endowments (land and labour) and land productivity. In other words, two economies can achieve the same output per worker in very different productive conditions depending on the abundance or scarcity of land and its productivity (which, concurrently, can respond to natural conditions of the soils and the incorporation of technical progress).

Therefore, our working hypothesis is the following. In Latin American regions (in the late 19th century and up to the WWI) where labour was relatively scarce or costly, rural wages were high, and medium- or large-scale farmers had the capacity to invest and access imported technologies and export markets, there was greater adoption of labour-saving technologies (such as harvesting, threshing, and mowing machinery). By contrast, in regions with a relative scarcity of land, cheap or plentiful labour, weak infrastructure, and limited access to capital or lucrative external markets, the dominant strategy was the expansion of agrarian area through intensive use of the agricultural frontier, tenancy, and extensive labour practices ("land-saving").

To test this hypothesis, our empirical strategy includes two stages.

First, we compile and construct a database containing consistent and comparable information on agricultural output, employment in agriculture, and land used for agricultural activities. Constructing long-run series is highly challenging, so our approach is to develop a cross-country database for the previous years to World War I (WWI), for two main reasons. First, around this date, most Latin American economies were undergoing a period of strong dynamism and consolidation under the export-led growth model. Second, in 1914, WWI began, marking the onset of a period of major shocks and profound transformations for Latin American agriculture. Whenever possible, we will use the average for the 1912–1914 three-year period as a reference.

Second, we mobilize this evidence in terms of our conceptual framework, in the context of the historical overview that we presented in Section 2, deriving some conclusions and remarks. We are not innovators in this respect; Bulmer-Thomas (2003:120) presents a table and an analysis similar to us, but with less information and other objectives.

[3] Our approach is not novel; rather, it is part of an established tradition in the literature, with van Zanden (1991) and O'Brien & Prados de la Escosura (1992) serving as key references.

4. Database compilation

We describe the compilation of a novel database that include three variables for the agriculture of ten Latin American countries (Argentina, Brazil, Colombia, Chile, Cuba, Mexico, Nicaragua, Peru, Uruguay and Venezuela): output, labour and land.

As we give priority to present comparable information, we consider statistics derived from databases that have yet discussed the representativeness of the figures and present series for large country-panels.

4.1 Output

For Latin American macroeconomic and long-run series, a commonly used source is MOxLAD database, which we adopt as our main reference. For our ten countries, the database presents information on Agriculture Value Added (AVA) expressed in local currency units (*UML*), in constant prices of 1970. The figure corresponding to this year was transformed in dollars and moved backwards according to the real evolution of the AVA. We transform all data into dollars to facilitate the comparisons. It is true that to improve the contrast between figures, some type of PPP adjustment had been required, but considering that we are working with a sector that produces commodities and raw materials, the problem is not so relevant.[4] We use the AVA average corresponding to 1912-1914 to moderate fluctuations and reduce the risk of to take an anormal year. Some countries require additional comments.

- **Brazil**. AVA series is available since 1920 onwards. This series is spliced with GDP – Agriculture (1939=100) from Instituto de Pesquisa Econômica Aplicada Data Base (IPEAData).
- **Cuba**. AVA series is available since 1946 onwards. This series is spliced with the volume of sugar production (tonnes) from García Molina (2005), considering the absolutely determinant role of sugar industry in Cuban agriculture and the whole economy (Santamaría, 2000; 2002).
- **Nicaragua**. AVA series is available since 1920 onwards. We use the average corresponding to 1920-1922 as reference.
- **Peru**. AVA series is available since 1929 onwards. This series is spliced with the AVA (1979 prices) from Seminario (2006).
- **Uruguay**. AVA series is available since 1935 onwards. This series is spliced with the AVA (2005 prices) from Bértola et al. (2024).
- **Venezuela**. AVA series is available since 1936 onwards. This series is spliced with the AVA (1968 prices) for 1920-1935 and AVA (1936 prices) for 1900-1919, both from Baptista (2006).

[4] Prados de la Escosura (2000) discusses on a similar issue. He solves the problem differently but the motivation is the same: how apply "short-cut methods" of comparability when aggregate PPPs are not available.

4.2 Labour

As previously explained, we give priority to the information provided by MOxLAD, using the economically active agricultural population (EAAP) as our measure of reference. In contrast to agricultural output, the availability of information in this case is significantly more limited, and we faced the challenge of estimating and adjusting the available information. Again, some countries require additional comments.

- **Brazil**. The earliest available data on EAAP and economically active population (EAP) come from census records for the years 1920 and 1940, when the shares of the agricultural sector within the total labour force were, respectively, 70% and 67%. Both are figures consistent with the characteristics of a predominantly agrarian economy. Then, we retropolated the total EAP based on the overall population dynamics (MOxLAD), while the share of the EAAP was estimated according to the rate of change observed between 1920 and 1940. With both records in 1912-1914, we calculated the EAAP in our period of interest. With this procedure, we calculated a share of 71%.
- **Colombia**. The earliest available data on the EAAP and EAP correspond to 1938, when the share of agricultural sector within the total labour force was 73% (a ratio very close to the corresponding to Brazil). Previously, we take advantage of census data corresponding to 1918 (República de Colombia, 1924) and added figures for different jurisdictional government levels (*departamentos*, *intendencias*, *comisarías*). We compiled information corresponding to EAP and the EAAP including labour force developing activities in crops, livestock and other grazing animals. We obtained a ratio of 78% that we assigned to 1912-1914.
- **Cuba**. The early figures of EAAP correspond to 1943 and 1950 and then decennial data onwards. We retropolated the data corresponding to 1943 according to the evolution of rural population, which we estimated considering an urbanization rate (1943, 1931, 1919 and 1907) and total population (both from MOxLAD) and lineal interpolation to obtain annual data.
- **Mexico**. Data available for 1900, 1910 and 1921. So, we obtain the average 1912-1914 by lineal interpolation.
- **Nicaragua**. Data are available from 1940 onwards (decennial) and previously available information is very scarce. We took the estimation presented in Bulmer-Thomas (2003):120, corresponding to 1920,[5] interpolate intermediate years with 1940 and use the average 1920-1922 as reference.
- **Peru**. Data are available from 1940 onwards (decennial). An alternative source is Cruz Saco et al. (2021), which provides annual estimates of the agricultural labour force for the period 1876-2017. Given the relevance of comparative levels for our analysis, we retroprojected the 1940 level (as reported in MOxLAD) using the movement observed in the alternative series.[6]
- **Uruguay**. Data are available from 1950 onwards. An alternative source is Castro Scavone and Willebald (2025), which provides annual estimates of the agricultural

[5] Prof. Bulmer-Thomas (2003): 120 quotes: Cantarero, L. A. (1949). "The Economic Development of Nicaragua, 1920–1947." Ph.D. dissertation, University of Iowa, as source. We could not consult this study but the level dealing with by the author is perfectly consistent with ours.

[6] Levels are similar. In 1940, the figure of MOxLAD represents 96% of the data reported in Cruz Saco et al. (2021) (around 64,500 persons).

labour force for the period 1870–2020 (for two sub-sectors: livestock and crops). Given the relevance of comparative levels for our analysis, we retroprojected the 1950 level (as reported in MOxLAD) using the movement observed in the alternative series.[7]

- **Venezuela**. The earliest available data on the EAAP and EAP correspond to 1925 and 1930, when the shares of the agricultural sector within the total labour force were, respectively, 63% and 58%. These figures are lower than those corresponding to Brazil and Colombia but consistent with the increasing trajectory of other primary industries as oil. Then, we annually retroprojected the total EAP based on the overall population dynamics (MOxLAD), while the share of the EAAP was estimated according to the rate of change observed between 1925 and 1930. With both records in 1912-1914, we calculated the EAAP in our period of interest (in facts, with levels consistent with other economies of the region: 77%; remember that the commercial exploitation of oil consolidated in the beginning of the 1920s; see Rubio-Varas, 2015).

4.3 Land

The extent of productive land in Latin American countries in the early 20th century is inferred from the historical map presented by Bethell (1984: 154), which classifies agricultural land use for the entire region during 1870–1930. This source is employed due to the absence of homogeneous, comparable data for all countries and its suitability for direct cross-country comparisons –an essential requirement for the joint analysis of relative endowments and output. Admittedly, the period proposed by the author is extensive, and changes may have occurred over time. Nonetheless, such characterizations rest on structural forces and on expert assessments that provide an adequate representation, applicable to long time spans.

The original map distinguishes three regions –tropical, grain and livestock, and smallholder producers– and locates the main productions within the territory, including bananas, cacao, coffee, cotton, sugar, tobacco, wheat, henequen, alpacas, goats, cattle, llamas, and sheep.

The category tropical produce estates refers to export-oriented agricultural enterprises that emerged in the lowland and mid-altitude regions of Latin America between 1870 and 1930. These estates specialized in tropical commodities –such as coffee, sugar, bananas, cacao, rubber, henequen, and cotton– whose expansion was driven by rising demand in North Atlantic markets. Typically organized as large-scale plantations or centralized processing complexes, they relied heavily on wage labor or coercive labor arrangements and often operated under foreign ownership or investment. Spatially, they formed a new agrarian frontier on the periphery of traditional hacienda and communal systems, linking Latin American rural economies more tightly to the circuits of global capitalism.

> "On the outskirts of this older society, generally in the lower and medium elevations, very different agricultural enterprises now appeared, brought into existence by the

[7] Levels are similar. In 1950, the figure of Castro Scavone & Willebald (2025) represents 94% of the data reported in MOxLAD (around 14,000 persons).

> enormous demand in the North Atlantic countries for tropical foods and fibres. Coffee plantations spread rapidly … World sugar production at the same time grew enormously … The result, in the sugar cane zones of tropical America, was huge corporate investment, often by foreigners, in more efficient, large-scale centrales that appeared in the Caribbean and Brazil, the Peruvian north coast, and in smaller pockets of production in Colombia, Salta and Tucumán, Argentina, Morelos and the Veracruz coast." (Bauer, 1986: 179).
>
> "Added to these two basic exports were bananas on the littoral of Central America and Ecuador; rubber … and henequen produced by thousands of peons in Yucatán … cotton and wool were shipped from Peru; cacao from Venezuela and Central America…" (Bauer, 1986: 179)

The category grain and livestock estates refers to the extensive agricultural and pastoral systems that developed across the temperate lowlands of the Southern Cone –particularly Argentina, Uruguay, and central Chile– between the 1870s and the early 20th century. These large-scale estates combined traditional ranching structures with increasingly commercialized and export-oriented grain production, responding to rising European demand for wool, hides, meat, and cereals. Characterized by vast landholdings, the adoption of new technologies such as railways and refrigeration, and significant inflows of foreign capital, these estates exemplified the consolidation of a modern agro-export economy based on economies of scale and integration into global markets. In contrast to the tropical plantation zones, they relied on extensive land use and seasonal labor rather than dense, permanent workforces.

> "In Uruguay, foreign sales of wool and other products of sheep-farming tripled between 1876–80 and 1896–1900. While the total volume of Uruguayan production was much smaller than that of Argentina, the industry figured much more prominently in the export lists down to the end of the period. Wool exports from the two countries went mostly to the continent of Europe –chiefly France, Germany, Belgium and Austria. In 1913 a little under a fifth of the wool exported from the River Plate entered the British market.
>
> In Argentina other export industries were experiencing substantial growth as well. Hides, a traditional product, earned about two-thirds the value of wool exports over most of the period and almost doubled in aggregate value from the mid-seventies to 1910–14. It was the development of refrigerated shipping in the 1870s, however, that paved the way for the swift rise of meat shipments from Argentina, and, to a lesser extent, Uruguay." (Bauer, 1986: 165–166).
>
> "It was during the late 1870s that Argentina became a net exporter of grains, a trade which began on a small scale but which quickly gained momentum. Between 1872 and 1895, the amount of pampa acreage under cultivation in all crops, especially grains, grew fifteen times, and in the next decade, the amount of acreage planted in wheat and maize alone more than doubled. Between 1880–84 and 1890–94 wheat was the major gainer, increasing twenty-three times in export value. In the next decade, however, the value of maize exports rose more rapidly, with a nearly sixfold gain." (Bauer, 1986: 166–167).

Finally, the category smallholder producers refers to family-based agricultural units that persisted or emerged in various highland and intermontane regions of Latin America

between 1870 and 1930. Typically located in areas of older settlement but limited market integration, these farms were operated by small and medium-sized proprietors who cultivated food crops and, in some cases, export commodities such as coffee. Their origins were diverse: some resulted from internal colonization and mestizo migration into frontier zones, while others arose from the fragmentation of large estates or the development of local urban markets. Although they represented a minority of the rural population, smallholders played an important economic role as independent producers who combined family and wage labor and maintained relative autonomy from both hacienda and communal systems. Spatially, they occupied parts of the agrarian landscape identified by Bauer (1986, map on p. 154) as smallholder producers, distinguishing them from both the great grain and livestock estates and the tropical produce estates that dominated other regions.

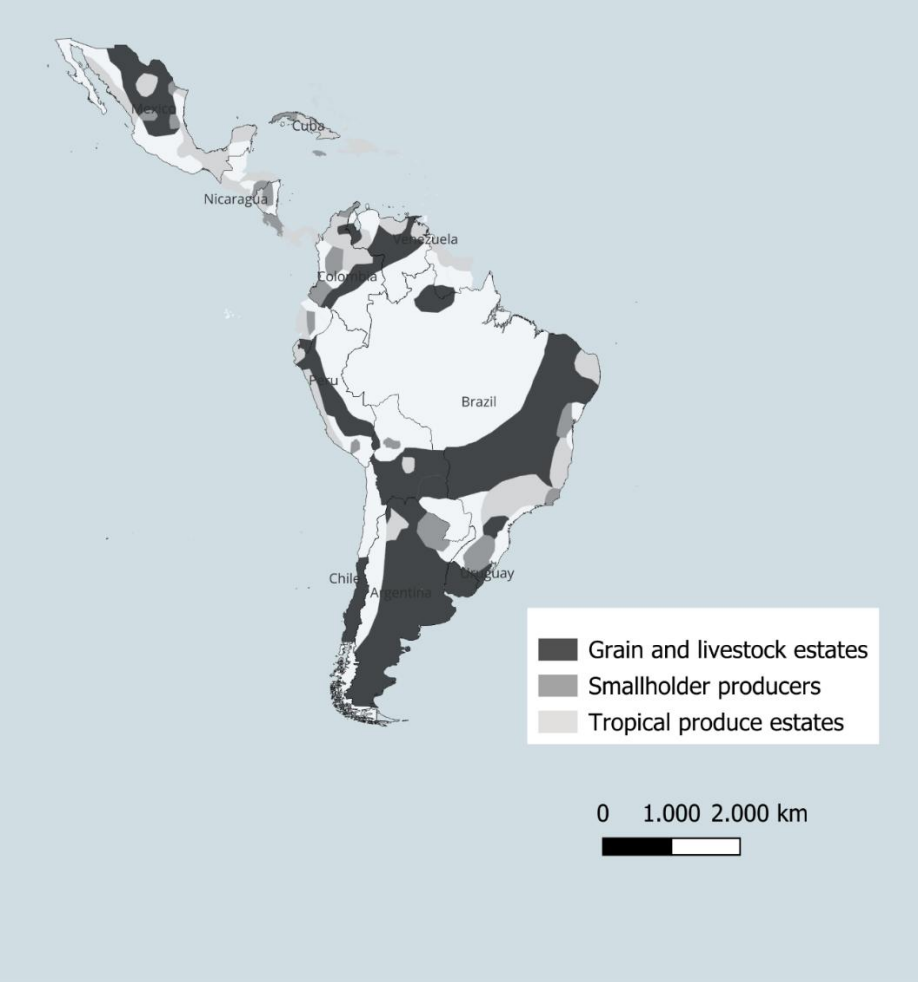
> "We shall look at three types of rural environment in the older zones of settlement [...] where an insular agrarian society was occupied with subsistence or the production of food crops for local markets. In all of these zones, large private estates (haciendas), peasant village communities, and independent family farms were interrelated in a variety of ways." (Bauer, 1986: 156).
>
> "A fairly small but economically important number of rural people were small and medium-sized farmers [...] In a land generally dominated by the large estate, the widespread existence of family farmers is important to notice." (Bauer, 1986: 157).
>
> "The independent family farm seems to have appeared when population or overseas immigrants brought about frontier settlement into a region where there had been no sedentary native farmers [...] or where the land had not been previously granted in large units and where, although a market existed, it still was not strong enough to promote economies of scale." (Bauer, 1986: 157–158).

The characterization provided by Bauer (1986) is appropriate, and the configuration of zones and territories is convincing. However, we lack the cartographic details of the map, having access to only a single figure, which poses a significant challenge because land use needs to be quantified in hectares. Therefore, it is necessary to develop a systematic procedure to address this limitation.

The procedure was carried out in QGIS and involved, first, georeferencing the map using control points located on permanent geographic references (coastlines, river confluences, boundary intersections) and applying a polynomial transformation to minimize the root mean square error. On the georeferenced map, vector polygons corresponding to different productive categories defined in the original legend were digitized, with each assigned a classification attribute. The resulting layer was then reprojected to an equal-area coordinate system (EPSG:6933 – WGS 84 / NSIDC EASE-Grid 2.0 Global) to ensure accuracy in surface measurements. Finally, the area of each polygon was calculated in square meters and converted into hectares, thus obtaining, for each country, an estimate of productive land area that serves as a direct input for the comparative analysis of productive factors (see Map 1).[8]

[8] The data supporting this map are available from the authors upon request.

Map 1. The agrarian landscape of Latin America, 1870-1930



Source: own elaboration base on Bethell (1984):154.

To assess the consistency of the map used to estimate productive agricultural land in Latin America, we compared the areas derived from that map with historical agricultural statistics for a subset of countries: Argentina, Brazil, Chile, Mexico, and Uruguay. For Argentina and Uruguay, we used the *Third National Census of 1914* (Comisión Nacional del Censo, 1919) and the *1916 Agricultural Statistics* (MGAP, 1917), respectively; for Brazil, the *1920 Agricultural Census* (Ministério da Agricultura, 1923); for Chile, the figures reconstructed by Ortiz (2003); and for Mexico, the estimates reported by Villaseñor (2003). Quantitatively, the map identifies 229 million hectares with productive suitability in Argentina compared with the 163 million reported by the census; 337 million versus 175 million in Brazil; 22 million versus 19 million in Chile; 123 million versus 79 million in Mexico; and 18 million versus 16 million in Uruguay. In all cases, the productive area recorded in the census sources is smaller than the area estimated from the map. This difference is expected: census data capture the land actually in use in a specific year, whereas the map reflects a longer-term agrarian structure and thus approximates each territory's agricultural potential within a broader

context of open frontiers and land that was gradually incorporated into production across the region (Willebald & Juambeltz, 2018). Brazil shows the largest discrepancy, likely because extensive regions such as the Cerrado—where agricultural exploitation remained limited in the early twentieth century—were underreported in the census but appear in the map as areas with productive suitability. For the remaining countries included in the map, direct validation is more difficult due to the limited availability of comparable historical agricultural statistics. In many regions, particularly in Central America and the Andes, early twentieth-century censuses exhibit coverage gaps, methodological inconsistencies, or a complete absence of information on cultivated areas, in addition to heterogeneous definitions of "productive land." Moreover, large agrarian sectors operated under subsistence production, communal systems, or informal land-tenure arrangements that censuses recorded only partially, thereby underestimating the land actually in use. In this context, the map provides a clear analytical advantage: it applies homogeneous criteria across the entire region and identifies structural patterns and productive potentialities that fragmented and uneven national statistics cannot capture. Although the quantitative comparison could be carried out only for a subset of countries, the consistency observed between both sources in these cases allows this validation logic to be extended to the region as a whole and supports the use of the map as a comparative indicator of Latin America's agrarian structure.

5 Results

5.1 Use of land

The spatial distribution of land use in Latin America between 1870 and 1930 reveals well-defined regional patterns that reflect the historical specialization of agricultural production. The map illustrates how grain and livestock production tended to concentrate in the temperate zones of the Southern Cone, particularly in Argentina, Uruguay, Brazil and central Chile, where large estates supported extensive cereal and livestock production geared toward export markets. In contrast, tropical crop plantations were concentrated in coastal and lowland tropical areas, such as northeastern Brazil, the Caribbean, and parts of Central America, highlighting the importance of sugar, coffee, cacao, and other warm-climate crops in these regions. Small-scale production, although present in various areas, was more significant in specific parts of the Andes and Central America, associated with subsistence farming and local markets. This spatial configuration is consistent with the export-oriented specialization patterns of the period and provides the geographic basis for the comparative analysis of total agricultural area and its composition presented in Table 1.

Latin America exhibits a diverse pattern of agricultural specialization. Four of the largest agrarian economies –Brazil, Argentina, Mexico, and Peru– encompass the three main categories of specialization, with grain and livestock predominating and smallholders representing a minor share (below 10%). Colombia broadly aligns with this group but displays certain distinctive features: the shares of land devoted to grain and livestock and to tropical crops are relatively balanced, and the participation of smallholders is comparatively higher.

Table 1. Land use in the Latin American agriculture. Total and composition

Country	Land (Mill. has.)	Tropical (%)	Grain and livestock (%)	Smallholder producers (%)	Main products
Argentina	229	0.04	0.88	0.08	wheat, cattle, sheep, sugar, cotton
Brazil	337	0.21	0.70	0.09	coffee, cacao, sugar, cattle, cotton, tobacco
Colombia	66	0.36	0.35	0.29	coffee, cattle, cotton, sugar, bananas
Chile	22	0	1	0	wheat, sheep, llamas
Cuba	11	0.72	0	0.28	sugar, tobacco
Mexico	123	0.44	0.49	0.06	wheat, cotton, sugar, henequen, cattle, cacao, coffee, Sheep
Nicaragua	8	0.46	0	0.54	coffee, bananas
Peru	57	0.27	0.69	0.04	bananas, cotton, cacao, goats, sugar, cattle coffee, alpacas, llamas, sheep
Uruguay	18	0	1	0	wheat, cattle, sheep
Venezuela	50	0.35	0.65	0	coffee, cacao, sugar, cotton, cattle
LATAM 10	**921**	**0.22**	**0.69**	**0.09**	

Source: own elaboration base on Bethell (1984): 154.

At the opposite end of the spectrum, the smallest agrarian economies exhibit more concentrated specialization. In the Southern Cone, Chile and Uruguay focus exclusively on grain and livestock production, whereas in Central America, Cuba and Nicaragua do not engage in these typical template products, instead combining tropical crops with smallholder estates. Finally, Venezuela's agricultural land use is divided between tropical crops and grain–livestock production, with no land allocated to smallholder farming.

5.2 Factor endowments and agricultural productivities

Table 2 presents our results: agricultural output (expressed in constant 1970 prices), production inputs (land in millions of hectares and labour in thousands of persons), and the corresponding factor productivities: output per hectare (1970 dollars per hectare) and per worker (thousands of 1970 dollars per worker). Our data cover 10 countries that represented 87% of total GDP and population in 1910 (Maddison Data Project) which reports a good representation of the whole region (all the largest economies are included).

Table 2. Factorial productivities and endowments in the Latin American agriculture (circa 1913)

Country	Output (1)	Land (2)	Labor (3)	Land productivity (1)/(2)	Labor productivity (1)/(3)	Land/Labor ratio (2)/(3)
Argentina	970	229	1,077	4.23	0.90	0.21
Brazil	784	337	4,426	2.32	0.18	0.08
Colombia	410	66	2,174	6.24	0.19	0.03
Chile	193	22	477	8.85	0.40	0.05
Cuba	123	11	393	11.59	0.31	0.03
Mexico	809	123	3,555	6.56	0.23	0.03
Nicaragua	57	8	151	6.93	0.38	0.05
Perú	188	57	1,270	3.28	0.15	0.05
Uruguay	104	18	178	5.87	0.59	0.10
Venezuela	163	50	568	3.29	0.29	0.09
LATAM10	**3,801**	**921**	**14,269**	**4.13**	**0.27**	**0.06**

Notes: (1) Millions US$ 1970; (2) Millions of hectares; (3) Thousand workers.
Source: own elaboration. See text.

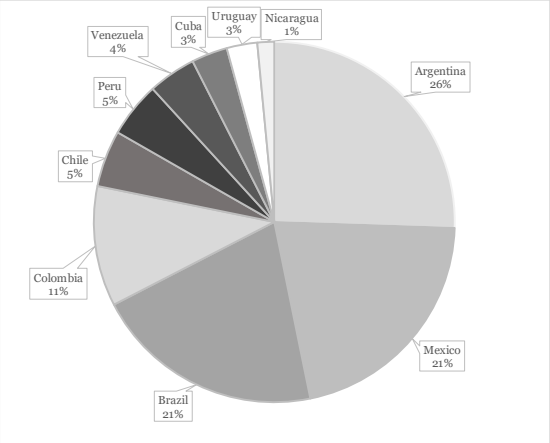
Latin America is a heterogenous region, and our sample take in account this point combining large and small economies, with different modalities of agricultural activities. Figure 1 presents the main descriptive statistics.

Three countries represented two thirds of total agricultural output in the eve of WWI: Argentina, Mexico and Brazil, followed by Colombia (11%) and six small economies with figures lower than 10% (Figure 1.A). The endowments are very varied, with a huge contrast between the extremes of the distribution (0.03 ha per 1000 workers in Cuba vs 0,21 in Argentina) which is consistent with the high geographical diversity of the region (Figure 1.B).

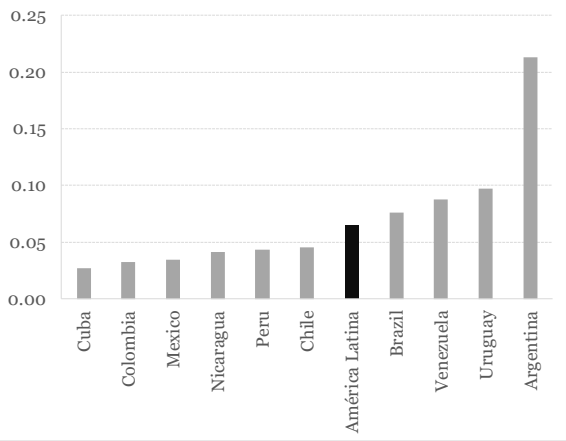
This diversity is also expressed in terms of factorial productivity. Agricultural labour productivity positions Argentina and Uruguay as the leaders (Figure 1.C) and the central economies of South America as the lagged (Peru and Brazil). En facts, agricultural land productivity is the most uniform of our indicators (Figure 1.D) showing Cuba and Chile as the leaders and again Peru and Brazil as the lagged.

Figure 1. Output, endowments and factorial productivities in the Latin American agriculture. Circa 1913

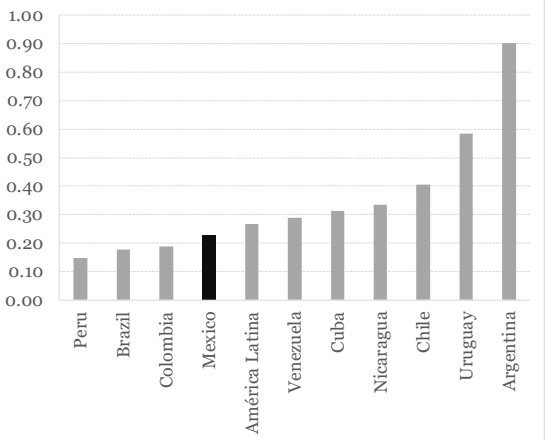
1.A. Output (%)



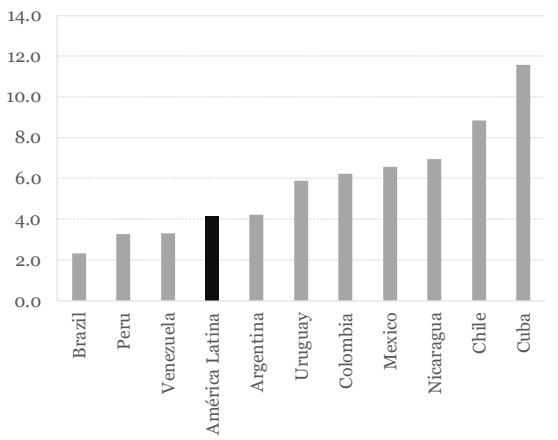
1.B. Endowments



1.C. Labor productivity



1.D Land productivity

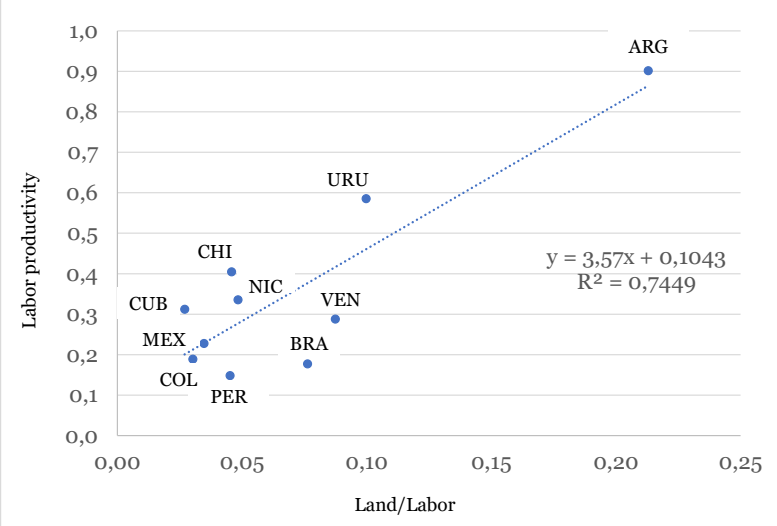


Notes: 1.A: % on total; 1.B: thousands of ha per worker; 1.C: thousands of 1970 dollars per worker; 1.D: 1970 dollars per hectare.
Source: our elaboration. See text.

To advance in this analysis, we consider equation (1) which states that both factorial productivities are not correlated one to one but mediated by the action of the relative endowments; i.e. by the available quantities of inputs which responds to natural, technological and institutional conditions.

We represent the correlation between the land/labour ratios and the labour (Figure 2) and land (Figure 3) productivities to find new evidence. Our results are not surprising.

Figure 2. Labor productivities and land/labour ratios in the Latin American agriculture. Circa 1913



Source: our elaboration. See text.

We find a positive and strong correlation between relative endowments and labour productivity[9] which means that economies abundant in natural resources apt to agriculture (land) promote better conditions to improve the productivity of the scarce input (labour). intense

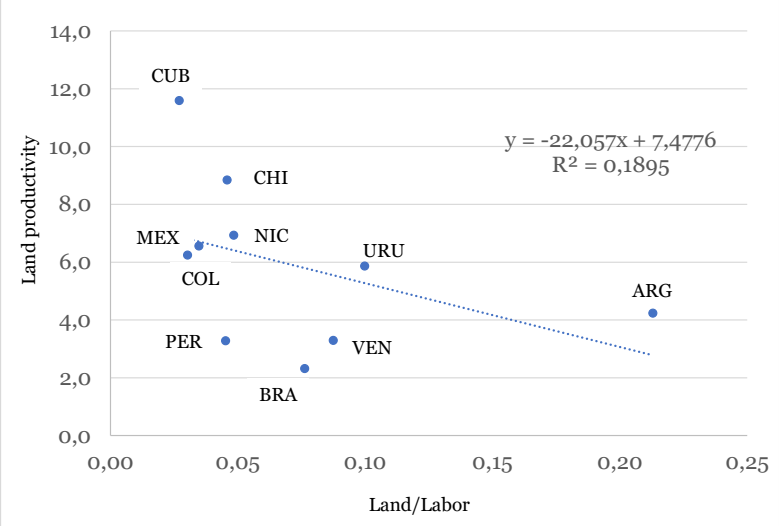
According to the model, this happens more evidently in the most advanced economies of Latin America in that period: the Southern Cone (Argentina, Chile and Uruguay), and two Central American countries: Cuba and Nicaragua. In other words, those places with more intensive grains and livestock estates and plantations (see Map 1) achieved the highest levels of labour agricultural productivity. Argentina has outlier characteristics, which is not surprising, since the importance of extensive livestock farming –as one of the world leaders– and the strong expansion of wheat –to the point of becoming one of the 'breadbaskets of the world'– placed it in a very distinctive position.

In the cases of the agriculture of Mexico and Colombia, the results coincide with the trend and Peru, Brazil and Venezuela show a situation of small land/labour ratios and low labour productivity.

As was expectable, we find the contrary result when we contrast the relative endowments with the land productivity (Figure 3): the correlation between both variables is negative. However, and another time according to the model resultant, the economies over the trend are the same mentioned previously corresponding to the Southern Cone and Central America.

[9] If we drop down Argentina, the R2 coefficient reduces to 0.23.

Figure 3. Land productivities and land/labour ratios in the Latin American agriculture. Circa 1913

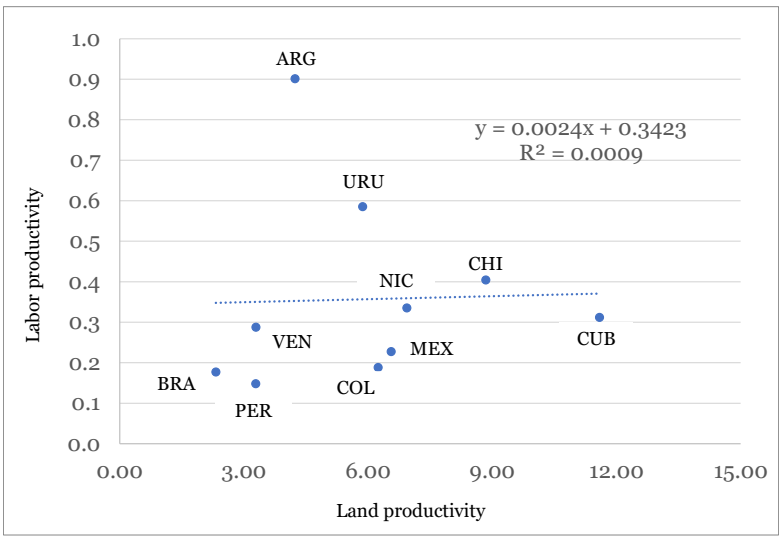


Source: our elaboration. See text.

As in terms of labor productivity the result for Argentina was notable, now the case highlighted is Cuba, with a level of land productivity that multiply the Latin American average by 3. As before, Peru, Brazil and Venezuela constitute the cases of low (relative) endowments and land productivity.

Now we can repeat the exercise with labor and land productivities (Figure 4).

Figure 4. Labor and land productivities in the Latin American agriculture. Circa 1913



Source: our elaboration. See text.

Labor and land productivities are not correlated which is an expression of the previous results; i.e. the relation between productivities is mediated by the factor endowments,

which are determined by natural resources availability together with historical, institutional and technological conditions.

Finally, we can now integrate all the evidence and discern the main patterns that characterized Latin American agriculture on the eve of the WWI (Table 3, Figure 5).

The economies are ranked from highest to lowest labour productivity (Y/L), or more precisely, by their deviations from the Latin American average, as indicated by the values on the line.

Additionally, the two components contributing to this variation are shown: land endowment per worker (A/L) and land productivity (Y/A). In Figure 5, we represent the (additive) contribution of each component to the total deviation and, in Table 3, we present the original values. It is important to use the value of 1 as a reference, as it distinguishes between being above or below the regional average in Table 1 (for all figures) and in Figure 5 (for Y/L).

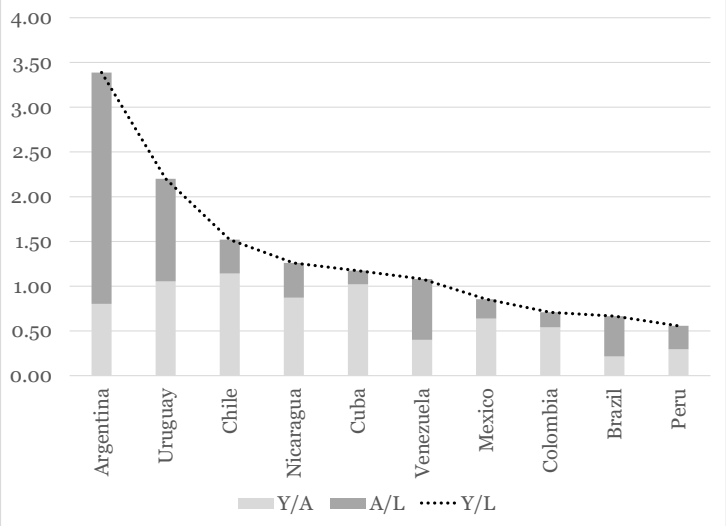
Table 3. Endowments and factorial productivities in the Latin American agriculture. Deviations respect to the Latin-American average. Circa 1913

Country	Labor productivity	Land productivity	Land/Labor ratio
Argentina	3.39	1.03	3.30
Uruguay	2.20	1.42	1.55
Chile	1.52	2.14	0.71
Nicaragua	1.26	1.68	0.75
Cuba	1.17	2.81	0.42
Venezuela	1.08	0.80	1.36
Mexico	0.85	1.59	0.54
Colombia	0.71	1.51	0.47
Brazil	0.67	0.56	1.18
Peru	0.56	0.80	0.70
LATAM 10	**1.00**	**1.00**	**1.00**

Source: our elaboration. See text.

Economies whose labour productivity exceeds the regional average (Argentina, Uruguay, Chile, Nicaragua, Cuba, and Venezuela) combine different contributions from these two components. Argentina and Uruguay exhibit high indicators in both dimensions. Venezuela's position is driven by relative land endowment, while Chile, Nicaragua, and Cuba rely on land productivity. Conversely, economies falling below the Latin American average display a similar diversity. Only Peru shows indicators below the continental average in both dimensions. Mexico and Colombia exhibit high land productivity, whereas Brazil's performance is driven primarily by land endowment per worker.

Figure 5. Endowments and factorial productivities in the Latin American agriculture. Deviations respect to regional average and contributions per component. Circa 1913



Source: our elaboration. See text.

Therefore, on the eve of the WWI, Latin American agriculture exhibited marked structural contrasts that allow us to distinguish several agrarian systems. These contrasts emerge from the joint observation of output per worker (Y/L), output per unit of land (Y/A), and land per worker (A/L), which together capture the degree of extensiveness or intensiveness in production and the sector's potential for technological and structural change.

At one extreme stood Argentina and Uruguay, representing extensive, high-productivity systems based on large estates and export-oriented livestock and cereal production. Their combination of high output per worker (3.39 and 2.20 times the regional average, respectively) and large land-labour ratios (3.30 and 1.55 times the Latin American levels) reflected an abundance of land and a relatively scarce labour force. These conditions favoured mechanization, the use of capital, and integration into world markets, giving rise to agrarian systems that generated forward and backward linkages and supported broader economic modernization –at least in Latin American terms.

A second, intermediate pattern included Chile, Cuba, and Nicaragua, where agricultural structures were generally more intensive. These economies exhibited higher output per unit of land (Chile 2.14, Cuba 2.81, Nicaragua 1.68 times the average) but smaller land-labor ratios (0.71, 0.42, and 0.75, respectively).

While Cuba's sugar plantations represented a capitalized but labor-intensive form of large-scale agriculture, Nicaragua relied more on mixed farming with a significant presence of small and medium-sized holdings. Chile, in turn, displayed a distinct configuration: the coexistence of large estates (*latifundia*) with a dense stratum of tenant and smallholder farms produced a dual agrarian structure that combined extensive and intensive features. The country's relatively high land productivity reflected both the

diversification of production –grains, vineyards, and horticulture in the central valley– and the widespread use of labour within a system still marked by traditional relations of dependency. Although Chile's agriculture was more diversified and commercially oriented than in most tropical economies, technological progress remained uneven, and the sector's contribution to broader structural transformation was constrained by persistent social and institutional legacies from the colonial era. In this sense, Chile can be interpreted as transitional case between the first group (conforming the "Latin-American Southern Cone") or this other group of more intensive agriculture.[10]

In all three cases, production was more labour-demanding and less mechanized than in the Southern Cone. Despite maintaining active export sectors, these economies did not achieve the same capacity to generate widespread structural change as Argentina and Uruguay.

Finally, Venezuela, Mexico, Colombia, Brazil, and Peru formed a group of low-productivity, traditional agrarian systems, characterized by weak technological adoption, limited market integration, and institutional or geographic constraints. Their relatively low output per worker and per hectare reflected the persistence of traditional conditions of production and the slow diffusion of innovations, restricting agriculture's role as a driver of overall economic development.

Taken together, the evidence suggests the coexistence of three broad agrarian paths before 1914: (i) extensive, high-labour-productivity export systems (Argentina, Uruguay); (ii) more intensive structures with moderate productivity (Chile, Cuba, Nicaragua); and (iii) low-productivity, traditional systems with weak structural linkages (Venezuela, Mexico, Colombia, Brazil, Peru). These patterns capture the diversity of agrarian capitalism in Latin America and help explain the uneven capacity of national economies to initiate processes of structural change in the early 20th century.

6 Final remarks

The main contribution of our paper is to provide basic statistics that allow for a comparison of the productive performance of Latin American agriculture in the early 20th century. While several of our findings are not entirely new, our contribution lies in quantifying certain issues that have often been addressed only qualitatively.

We knew that Uruguay and Argentina constitute peculiar cases in Latin American agriculture. In a recent study on this topic for the period 1950-2008, Martin-Retortillo et al. (2022) identified both countries as being exceptions in the region, underpinned by an early demographic transition, a profound urbanization process and economic factors:

> "Argentina and Uruguay specialised in livestock and cereal production (typical outputs of temperate climates) and showed great dynamism during the First

[10] It is not the first time that Chile has been placed in an intermediate position within a typology. In a pioneering work on comparative analyses of settler economies, focused on the *southern hemisphere* (what we would now call the *Global South*), it was stated that "Chile and South Africa are limiting cases of settler societies, since in each case a 'new' society was established in a confined area, but then expanded to incorporate large indigenous populations." (Denoon, 1983:60).

> Globalisation era [...]. This dynamism enabled high levels in land and labour productivities to be reached" (Martín-Retortillo et al., 2022: 14).

Our results confirm these presumptions. The same can be said about the cases of Peru, Brazil and Mexico, because they are lagged economies that just showed evidence of a progressive take-off of their agricultures from the 1960s onwards.

The relatively favourable situation of Cuba has also been previously analysed in terms of the coordination between different stages of the production chain (Santamaria, 2002) and the introduction of technical progress in agriculture (Fernández Prieto, 2005). Our results confirm this, which, in other terms, could be extended to Nicaragua with the growth of the banana industry.

Our results confirm, for the region as a whole and for an earlier period that is regularly studied, that the agrarian producers of that period reacted similarly to their colleagues in the subsequent decades. The relationship between factorial productivities is mediated by the different factor endowments; in places where the land is abundant, the production options will tend to incorporate labour-saving technologies (because labour is the more expensive input).

Those results are consistent with the current evidence. Purchasing power wages in Latin America (United Kingdom 1905=100) in 1910-1914 were led by Uruguay (85), Argentina (83) and Cuba (75) (Bértola & Ocampo, 2013: 110). Of course, these are average wages and not rural salaries, but the differences illustrate our point.

Certainly, the options for incorporating machinery and equipment depended on the technology available at the time. On the one hand, harvesters, threshers, seed drills, and similar devices were introduced in Latin America from the late 19th century and played an essential role in the process we are discussing. The incorporation of tractors became the dominant technology after WWI. On the other hand, the possibilities of technological incorporation also depended on the production-mix and the "commodity lottery".

The specialization in cereal production opened up more opportunities to introduce technical improvements and mechanization than large plantations, which for a long time relied on hand harvesting. A similar contrast applies when comparing sheep shearing or dairy production with cattle raising for meat production.

In this regard, the present article provides a historical overview that should be complemented by case studies or by the identification of typologies that allow for a more nuanced understanding of the differences and similarities highlighted in our characterization.

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