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Energy as an indicator of modernization in Latin America, 1890–1925[1]

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In the absence of comparable macroeconomic indicators for most of the Latin American economies before the 1930s, the apparent consumption of energy is used in this paper as a proxy of the degree of modernization of Latin America and the Caribbean. This paper presents an estimate of the apparent consumption per head of modern energies (coal, petroleum, and hydroelectricity) for 30 countries of the region, 1890 to 1925. As a result, it provides the basis for a quantitative comparative analysis of modernization performance beyond the few countries for which historical national accounts are available in Latin America.

In the interpretation of the process of economic modernization that has occurred over the last two centuries, it is widely accepted that the productivity gains achieved through the development of new energy carriers (from wood to coal, and later to petroleum and electricity) play an important role. From this viewpoint, the industrial revolution has been interpreted as the 'process that allowed the exploitation on a great scale of new energy sources by means of inanimate converters'[2] and it has been argued that coal—and later oil—was a strategic item in the rise and diffusion of industrial civilization.[3]

It is within this context that it has also been claimed that 'economic history makes it evident that the industrial standing of any country may be gauged, with a fair degree of accuracy, from its development of mechanical power'.[4] Of the 33 countries that constitute Latin America and the Caribbean at present, we have series of comparable historical national accounts for only a handful of them.[5]

[1] This article is the result of a research project entitled 'Imports and economic modernization in Latin America 1890–1960', financed by the Spanish Ministry of Education and co-financed by the EU through FEDER. We are obliged to the rest of the team members, X. Tafunell and A. Hofman, for their encouragement and help. Earlier drafts have also benefited from the comments of S. Kuntz, G. Marquez, C. Sudrià, and the participants of the following meetings and conferences: Economic History Society Conference (Leicester), Canadian Network of Economic History meeting (Queen's University), the Cliometrics Conference (Binghamton), the International Economic History Society Conference (Helsinki), the Economic History Association Meeting (Pittsburgh), and the LACEA Conference (Mexico). The authors gratefully acknowledge the research assistance of J. Jofré, F. Notten, and C. Román.

[2] Cipolla, *Historia económica*, p. 57.

[3] Wrigley, 'Supply of raw materials'.

[4] US Department of Commerce, *Fuel and power*, p. 1.

[5] For Brazil and Uruguay, GDP yearly data are available from 1870. For Argentina, Chile, Colombia, Mexico (with gaps), Peru, and Venezuela, data series are available from the 1900s. See Maddison, *Monitoring*, and Thorp, *Progress, poverty and exclusion*. However, before 1930, very little is known of the smaller countries, not to mention other non-independent territories, for which in some cases absolutely no quantitative evidence is available. Bulmer-Thomas, *Economic history of Latin America*, provides two benchmark GDP percentage estimates for all the

Consequently, the comparative analysis of the economic performance of the region as a whole has been limited to the countries for which historical economic indicators have been constructed. The earlier the period under consideration, the more constrained the sample becomes. The lack of quantitative evidence does not only affect the comparative economic history of the region as a whole; it is particularly troublesome for the individual economic histories of the smaller countries. Very little is known about the economic performance of these countries over the very long run.

In the absence of comparable macroeconomic indicators for most Latin American economies before the 1930s, the apparent consumption of energy is used in this article as a proxy of the degree of modernization of Latin America and the Caribbean.[6] For this purpose, this article presents an estimate of the apparent consumption per capita of coal, petroleum, and hydroelectricity in 30 countries and colonial territories of Latin America and the Caribbean in the period 1890–1925. The foreign trade statistics of the principal trade partners of Latin American and Caribbean countries and territories are used to construct the new estimates. To these, the data on home production of coal, petroleum, and hydroelectricity are added where needed. From a conceptual standpoint, the argument is that the apparent consumption of modern energies—which in the period 1890–1925 correspond to mineral coal, petroleum, and the first steps of hydroelectricity—makes evident the pace at which mechanized and industrial activities (modernization) evolve within a country.

Therefore, this research achieves, for the first time, a comparative homogeneous indicator of economic progress for the whole of the region. This is an evident breakthrough in the economic history of Latin America and the Caribbean. Until now, similar coverage was only possible from 1945 thanks to the GDP figures of the United Nations, prepared by the Economic Commission for Latin America (ECLA).[7] Previous statistical compilations, such as those of Maddison, Thorp, and Bulmer-Thomas, offer numerous series of a wide range of indicators, but none covering the entire region with a homogeneous indicator on an annual basis as is the case here.[8]

It is not our own assumption that there is a correlation between energy consumption and economic modernization significant enough to allow consumption to serve as a proxy for modernisation. We are sustained by economic history, applied economics and economic theory. The first section is precisely aimed at showing: (i) that the correlation between energy consumption and economic modernization has been a longstanding proposal in economic history literature; (ii) that the correlation has been proven to exist (it is not an assumed correlation but a real one); (iii) that the applied economics literature now provides enough evidence to show that such correlation is strong enough to allow energy consump-

independent countries and Puerto Rico in 1913 and 1928. Astorga, Berges, and Fitzgerald, 'Standard of living', p. 788, provide estimates for each decade, without adding further countries or years to what has been mentioned. Some alternative GDP estimates for countries of the region can also be found in Hofman, *Economic development of Latin America*, p. 87.

[6] See Carreras, Hofman, Tafunell, and Yañez, 'El desarrollo económico de América Latina', tab. 2.1, p. 15.

[7] United Nations, Economic Commission for Latin America, *Series históricas*; idem, *América Latina y el Caribe*.

[8] Maddison, *Monitoring*, pp. 202–3; Thorp, *Progress, poverty, and exclusion*; Bulmer-Thomas, *Economic history of Latin America*; OxLAD.

tion to serve as a proxy for modernization (with the caveats explained below); and (iv) that even economic theory is taking such correlation into account in some of its models. The rest of the article is organized as follows. In section II, the historiography of estimates of energy consumption for Latin America is surveyed and scrutinized. In section III, before starting to analyse the new annual series, a contrast is made between the trade data for coal and oil for the Latin American countries, and the data offered by their main partners in 1925 for coal and oil, for the sole purpose of establishing the reliability of the data used. In so doing, the foundations of the estimates are made fully explicit. In section IV, the patterns of modern energy consumption in Latin America and the Caribbean are discussed, and the estimated figures of the 30 annual series are shown. The data on energy consumption are used in section V to propose a new periodization of the main phases of Latin American economic modernization between 1890 and 1925. Finally, section VI summarizes the findings and conclusions.

I

The importance of modern energy sources for the economic growth that commenced with the industrial revolution did not escape contemporary witnesses. In his seminal work, Jevons asserted that 'coal, in truth, stands not beside but entirely above all other commodities. It is the material energy of the country—the universal aid—the factor in everything we do. With coal almost any feat is possible or easy; without it we are thrown back in the laborious poverty of early times'.[9] Academics and non-academics soon recognized the crucial role that the new form of energy was to play in their daily life as much as in the progress of the nation. Just a year after Jevons's publication, an editorial in *The Times* insisted: 'Coal is everything to us. Without coal, our factories will become idle, our foundries and workshops be still as the grave; the locomotive will rue in the shed, and the rail be buried in the weeds. Our street will be dark, our houses uninhabitable'.[10] It was clear that the comfort of modern life was intrinsically tied to coal.

At the advent of the new century, the qualitative relationship between energy use and wealth was amply discussed and widely accepted by economists.[11] Nevertheless, the works of Read constituted the earliest attempt to establish a quantitative relationship.[12] With his estimates of energy consumption (the 'world's output of work', as he called it) for 30 countries in 1929, he concluded that 'a general relationship between work done per capita and economic well-being is observable; but a precise correlation is not yet possible'.[13] Of course, the correlation between welfare and energy per capita was difficult to find at that time, since no standard procedure for the valuation of national income was yet available.

Almost simultaneously, in 1934, Mumford published a book that reviewed history from the viewpoint of energy for the first time.[14] Following the ideas of

[9] Jevons, *Coal question*, p. 1.
[10] 'Editorial', *The Times*, 19 April 1866, p. 10.
[11] Hobson, *Work and wealth*; Carver, *Economy of human energy*.
[12] Read, 'World's output of work' (1933). Just over a decade later, Read also published the estimates for 1939; see idem, 'World's output of work' (1945).
[13] Read, 'World's output of work' (1933), p. 55.
[14] Mumford, *Technics and civilisation* (the Spanish translation, Mumford, *Técnica y civilización*, was used for this article).

Geddes, Mumford proposed that industry had in fact been developing steadily over the last millennium.[15] In his view, history could be interpreted in terms of successive episodes of 'energy releases'. Each of them would provide more energy for society, an improvement in the supply regularity, more flexibility in the distribution, and more efficient use. Similarly Cottrell, an American sociologist, described the evolution of social and economic change in terms of energy.[16] He also emphasized the importance of energy transitions, as the shift from animate energy sources (human labour and draft animals) to inanimate energy sources and their associated converters (fossil fuels, steam, and the internal combustion engine). Economic historians such as Cipolla and Wrigley would reformulate some of these ideas, regarding the importance of energy to modern economic development, some years later.

Cipolla proposed a view of human history based upon energy consumption.[17] The history of humankind could be divided into three stages split by two revolutions: the neolithic revolution and the industrial revolution. With the introduction of new energy sources, the industrial revolution dramatically changed the energy budget of human societies. Agricultural societies have a very limited energy supply, mostly from an organic base. Industrial societies have at their disposal greater energy possibilities, chiefly from inanimate sources. The historical significance of these changes, especially from the development of the steam engine, is that humanity progressively obtained higher levels of disposable energy per capita. Part of this translated into more energy consumption per capita (for example, heating, lighting, and transport), but also into more energy per labourer, and consequently, greater labour productivity.[18] As a result of these developments, industrial societies entered into a new cycle of economic growth, which at the same time acted as a stimulus for the development of new energy forms: 'the more energy produced, the more energy was sought out'.[19] The increase in the energy available to industrial society and its effect on productivity implied the expansion of real income per capita, improved welfare levels, and the satisfaction of needs well above the purely basic ones. In summary, 'due to the exploitation of the new forms of energy, the greater abundance of capital, and a more efficient use of production factors, real income is greater in industrial societies than in agricultural societies'.[20]

At the same time as the publication of Cipolla's book, Wrigley published an article in which he started to delineate an analogous thesis.[21] An elaborated version was published years later in the form of the book *Continuity, chance and change*.[22] Unlike Cipolla, Wrigley had the opportunity to include in his later assessments the downward revisions of the growth rates of the classic period of the industrial

[15] Actually, Geddes may have been the first to interpret history in a physical key, that is, including the laws of physics and materials. For the interpretation of Mumford, following ideas from Geddes, see Martínez-Alier and Schlüpmann, *Ecología y economía*, pp. 116–22.

[16] Cottrell, *Energy and society.*

[17] Cipolla, *Economic history* (the Spanish translation, Cipolla, *Historia económica*, was used for this article), pp. 34–87.

[18] Ibid., p. 65.

[19] Ibid., p. 63.

[20] Ibid., p. 79.

[21] Wrigley, 'Supply of raw materials'.

[22] Wrigley, *Continuity, chance and change* (the Spanish translation, Wrigley, *Cambio, continuidad y azar*, was used for this article).

revolution, which appeared after the publication of Cipolla's book.[23] Nevertheless, a 'slower' industrial revolution did not move him an inch from his main line of argument.[24] According to Wrigley, the extraordinary aspect of the rate of growth of product per capita in England in the century between 1750 and 1850 was not that it was so low, but that it was not negative. Given the rate of population growth over the period, output per capita and depressed living standards were to be expected. In order to escape from this danger, and in order to avoid the growth curve becoming asymptotic, it was essential to break free from the constraint imposed by the energy budgets of organic economies, which depended almost exclusively upon annexing as much as possible of the annual inflow of solar energy from plants, humans, and animals. Such economies were incapable of sustaining growth over a prolonged period, since the maximum quantity of heat and mechanical energy that could be secured in this fashion was modest. Escape was possible because a succession of technical innovations meant that coal could be used in a widening range of applications where heat energy was needed, and, at a later stage, in the use of mechanical energy also. The significance of the gradual circumvention of the energy bottleneck was not that it produced a sudden acceleration in the rate of the growth of the economy, or in the level of individual productivity; rather, it removed a barrier that would otherwise have tended slowly to constrict growth. Only at a much later stage in the process by which the organic economy gave way to a mineral-based energy-intensive economy did the full benefit become apparent, in the form of a significantly higher rate of economic growth both in aggregate and per capita.

Most economic historians accept the crucial role played by modern energy sources, especially fossil fuels, in the process of economic development along the lines just described. In fact, primary energy consumption per capita has been signalled as a proximate and measurable determinant of growth in historical exercises.[25] Thus economic history literature endorses, in the main, the use of fossil energy consumption as a proxy of the degree of economic modernization of a group of countries in the absence of more explicit macroeconomic indicators. Support for this approach can also be found in later economic literature in the form of theoretical and applied studies.

Economic literature tended to focus on how energy demand is driven by economic development, and/or how a potential energy shortage may strangle economic growth, rather than how energy contributes to economic development.[26] On the empirical side, there are numerous studies aimed at providing evidence about whether the level of energy input drives economic growth or whether it is the output level that governs the energy input.[27] According to the most recent study, the relationship between energy availability and output levels seems to be quite

[23] Originally in Crafts, *British economic growth*, tab. 2.11, p. 45.

[24] The next few lines of our argument are a summary from E. A. Wrigley, 'The industrial revolution', document prepared for a meeting of the Energy, Pollution and Growth Network (2003), pp. 2–10.

[25] Maddison, 'Growth accounts', pp. 2–6.

[26] On the first aspect, see the survey by Toman and Jemelkova, 'Energy and economic development'. On the second aspect, see Solow, 'Economics of resources'; idem, 'Intergenerational equity'; Stiglitz, 'Growth with exhaustible natural resources'.

[27] There are a lot of papers on this subject. See for example, Kraft and Kraft, 'On the relationship between energy and GNP'; Akarca and Long, 'Re-examination'; Yu and Hwang, 'Further results'; Yu and Choi, 'International comparison'; Erol and Yu, 'Energy and income for industrialized countries'; Abosedra and Baghestani, 'New evidence'.

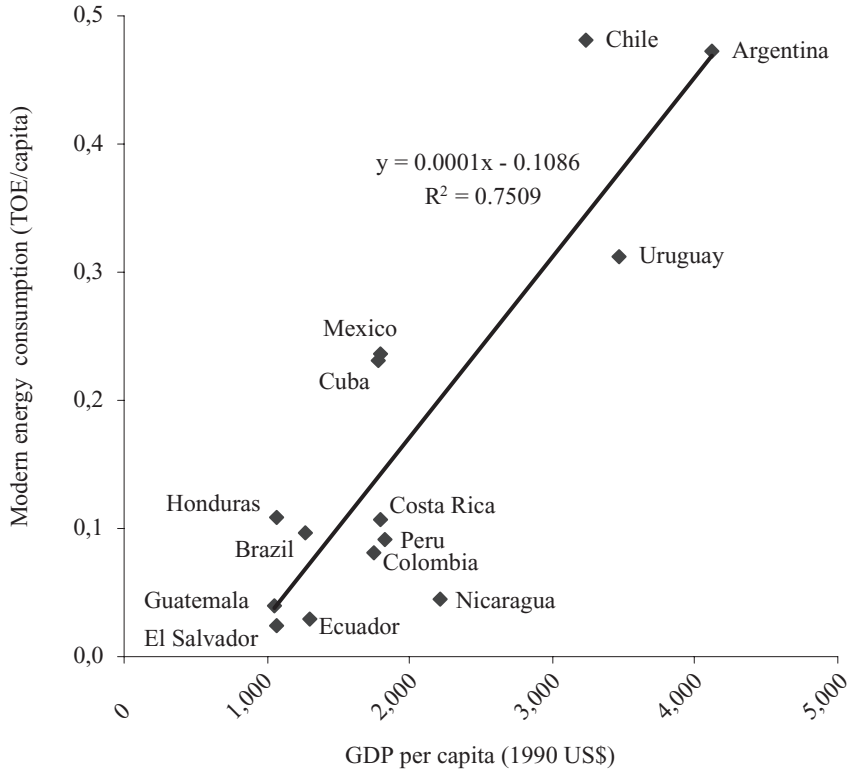

Figure 1. *Modern energy per capita (coal, oil, and hydroelectricity) vs GDP per capita in Latin American countries, 1937*

Note: Brazil data are for 1939.

Sources: Modern energy data from United Nations, Energy Commission for Latin America, *Energy in Latin America*, pp. 132–78; GDP from Maddison, *Monitoring*, pp. 202–3.

strong.[28] Multivariate tests demonstrate that the level of energy use is significant for explaining the level of output.[29] The relevant fact for the purposes of this article is that the overall positive correlation between economic growth and energy growth remains one of the most important 'stylized facts' that can be drawn from history, even if the extent of this correlation and its patterns over time are highly variable.[30]

Although the correlation between economic output and energy consumption is strong and positive, not all forms of energy have the same impact on economic output. Remaining trapped in traditional/organic forms of energy seems to have a negative correlation with the level of development attained by any one country. The explanation probably lies in Wrigley's original idea about the limits of the organic economy, outlined above. Evidence of the positive correlation of modern forms of energy with economic output, and negative correlation of traditional forms of energy and output, for Latin America, is shown in figures 1 and 2.

[28] D. Stern and C. J. Cleveland, 'Energy and economic growth', Rensselaer working paper in economics, no. 0410 (2004), pp. 25–8.

[29] Stern, 'Multivariate cointegration analysis'; Oh and Lee, 'Causal relationship'.

[30] Grübler, 'Transition in energy use', p. 167.

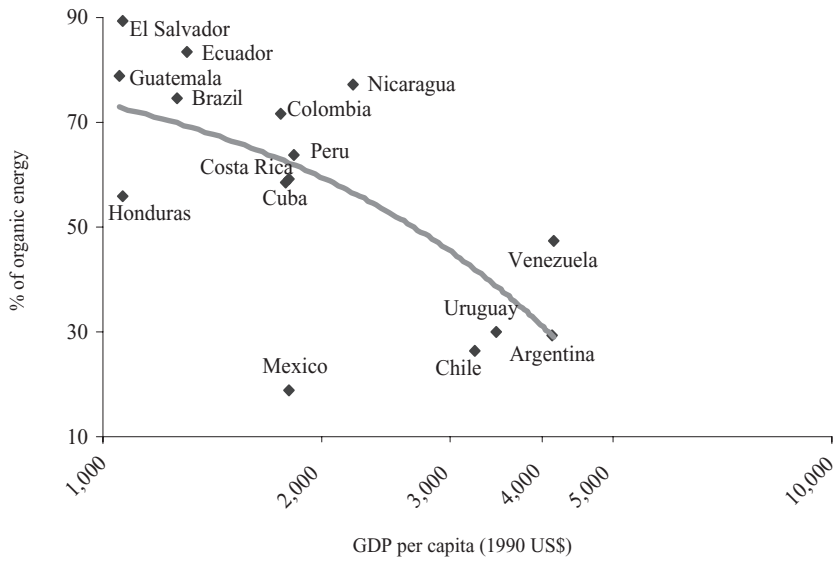

Figure 2. *Ratio of organic energy consumption on total energy consumption and GDP per capita for Latin American countries, 1937*
Source: Folchi and Rubio, 'La especificidad de la transición energética'.

These results, together with the economic history literature, provide support for the view that this article is built on solid ground. In the absence of better economic indicators, modern energy use is a valid guide to determining the modernization level of various countries at a given point in time. Those activities that made use of the brand new technologies of the late nineteenth century and the dawn of the twentieth, with all probability, required coal, petroleum, and/or electricity.

The use of modern energies brought about increases in efficiency and productivity in most sectors of the economy, but especially in industry and transport, and of course provided new ways of lighting any modern city or home. Thus, comparing a wide collection of countries through their apparent consumption of modern energies reveals, more than anything else, the relative degree of economic activity above the subsistence level.

Although energy consumption is an aggregated indicator of economic activity, it should not be used as a direct substitute for major economic indicators, such as income and/or product. Precisely because it does focus on the modern sectors of the economy, energy consumption may exaggerate the relative differences across countries. As a proxy, energy tends to push upwards industrial, mining, commercial, and/or urban countries, and pushes downwards predominantly agrarian and/or rural economies. Yet, in the absence of sufficient data for the reconstruction of the national accounts, the apparent consumption of modern energy offers a good proxy for the trends and evolution of economic prosperity.

II

This is not the first attempt to reconstruct the apparent consumption of energy in Latin America in historical terms. Other studies have provided point estimates and

some historical yearly estimates of energy consumption. Most of them, however, start in the postwar period and provide data for a limited number of countries.

As far as the authors of this article are aware, the first monograph on the subject of energy in Latin America is a report by the US Department of Commerce published in 1931. The report sets out from the idea that the use of coal, petroleum, and water power 'is an index of industrial attainment, and that their availability in a country will strongly affect that country's future position'.[31] The objective of the report was not academic, but was to explore the double role of Latin America as a supplier of raw materials and as a growing market for US products. Nevertheless, the report offers an appealing review of the energy availability for a long list of countries, although it provides unequal levels of coverage and detail. In some cases, information does not go beyond stating the existence or absence of national production of coal and petroleum. For most countries, patchy data on imports, industrial consumption and prices of coal and oil, electric installed capacity, and the existence of public utilities (such as railways and tramways) are provided, mostly for the second half of the 1920s. A benchmark estimate of the coal and fuel oil consumption, and potential and developed water power, is given for 18 countries for the year 1928.[32] Although informative for US merchants, the disparity of data used make the final estimates not exactly comparable, to say the least—as is acknowledged on the first page of the report.

Another benchmark estimate of energy consumption for Latin American countries was the aforementioned estimate by Read. His earlier calculations were predominantly for the US and were mostly based on data for 1924–5. He later included a larger number of countries globally located (30 in total) and employed the latest available figures for peak consumption (usually for 1929). His findings can therefore be taken to represent the high watermark.[33] Read's estimates of 'daily output of work' include the amount of work done by humans, coal, petroleum, and water power, measured in millions of horsepower hours. Among the 30 countries, he listed five Latin American countries. Ranked in decreasing order by 'daily output per capita', these were Chile, Argentina, Mexico, Peru, and Brazil. Read replicated his exercise again a few years later, producing estimates for the year 1939 which did not alter his first Latin American energy ranking.[34]

Prebisch produced the first historical series of apparent consumption of energy for several Latin American countries for the ECLA's *Economic survey of Latin America 1949*.[35] The *Survey*, as the title indicated, had an essentially economic focus. Nonetheless, for each of the four countries analysed in detail (Argentina, Brazil, Chile, and Mexico), there was a section dedicated to energy. Prebisch included the energy section in order to reinforce the 'dependence' argument elaborated throughout the text. No comparative effort was made, however. In fact, the type of energies, the units displayed, and the time spans considered were different for each country, making use of a wide range of compound sources. Moreover, the equivalences established between the different energy carriers and

[31] US Department of Commerce, *Fuel and power*, p. 1.
[32] Ibid., p. 44.
[33] Read, 'World's output of work' (1933), p. 56.
[34] Read, 'World's output of work' (1945), p. 144. However, no coal data could be gathered for Argentina in 1939, according to the author.
[35] United Nations, ECLA, *Economic survey*.

the way apparent consumption was calculated remain unclear, especially for the countries whose total apparent consumption is the only figure displayed (namely, Mexico and Chile). In some instances, the sources quoted are in-house estimates by the ECLA. The consistency of the series overall is doubtful, especially as the ECLA itself declined to use the estimates of the *Survey* in its monograph about energy published less than a decade later.

This monograph, *Energy in Latin America*, was published in 1957. The opening sentence of the monograph makes clear the importance of the matter: 'energy plays a decisive, albeit indirect role, in economic development, since, to the extent that it is available, it stimulates or hinders economic growth'.[36] From this, it derives that 'an increasing and rational use of energy is . . . essential for raising productivity levels and for remedying the technical and economic backwardness of underdeveloped countries in general, and of vast areas of Latin America, in particular'.[37] Furthermore, it asserts that 'the amount of energy consumed in the production process per worker can give a first indication of the degree of development of an economy'.[38] In view of the outstanding role played by energy in economic activity, the main purpose of the study was to describe the characteristics of energy consumption in Latin America and to outline the future requirements.

Energy in Latin America put together basic statistical series on the various aspects of energy consumption for 20 countries in Latin America and the Caribbean. It aimed at covering the period 1925–55, but 'in many cases it was not possible to complete the time series and hence only some characteristic years were presented, even if, on more than one occasion the procedure involved the use of estimates'.[39] For most countries, the series cover the period from the mid-1930s to 1955, and only for seven countries did estimates go beyond 1930. Mention should be made of the absence of Brazil from this last group; data on Brazil are only given from 1939, completely ignoring the aforementioned estimates of Prebisch. For the construction of the series no new data were elaborated, but estimates already published were used. As a consequence, the sources used differ greatly across countries. In the study, the countries are grouped in three categories according to the quality and detail of the statistical information available. The first group contained the best-documented countries: Argentina, Brazil, Colombia, Chile, and Mexico. A sizeable number of statistical compilations and specialized studies about these countries had been published by 1957, although none covering the period prior to 1925. In general, the data provided for these five countries are more reliable, or at least are more sophisticated and more frequently corroborated by alternative sources. The second group includes Cuba, Peru, Uruguay, and Venezuela. For these countries, national yearbooks and trade statistics are combined with international sources, such as the United Nations *Statistical yearbook*, plus some industry publications in the case of the oil-producing countries (Peru and Venezuela) and the reports of the governmental energy departments where they existed. Far less information was available for the third group of countries; namely, Bolivia, Costa Rica, the Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti,

[36] United Nations, ECLA, *Energy in Latin America*, p. 3.
[37] Ibid., p. 3.
[38] Ibid., p. 6.
[39] Ibid., p. 10.

Honduras, Nicaragua, Panama, and Paraguay. Few national statistics were used in these cases. Instead, United Nations statistics were chiefly used; namely, the *Statistical yearbook*, along with the *Statistical papers*.[40]

Perhaps the broadest historical energy study of all was that directed by Darmstadter in 1971.[41] It included data of commercial inanimate energy output, trade, and consumption for about 100 territories covering the benchmark years 1925, 1929, 1933, 1937, 1938, 1950, 1953, 1955, and 1957, and the period 1960–5. Although it only produced two point estimates before 1930, it included 11 Latin American and Caribbean countries (Argentina, Bolivia, Brazil, Colombia, Cuba, Chile, Ecuador, Mexico, Peru, Uruguay, and Trinidad and Tobago); in other words, it is the largest dataset yet compiled for these early dates. It is a careful and detailed study. It offers the series of raw data (including national production, exports, imports, bunkers, and hydroelectricity production) used in order to elaborate the apparent consumption of energy for each country. It makes explicit all the conversion factors used for each type of energy carrier, including hydroelectricity (which was measured by heat content of the power produced rather than by coal-equivalent fuel requirements at thermal generating plants). Perhaps the only weakness of this study, if it may be considered as such, is the massive use of secondary sources for trade data, mostly the United Nations (including the ECLA) and the League of Nations estimates. Equally, for domestic production, third parties' estimates were almost exclusively used; namely, those of the British Institute of Geological Sciences and the US Bureau of Mines.[42]

As the preceding paragraphs have shown, only three studies provide historical annual data for energy consumption in Latin America; namely, the ECLA's *Economic survey* and *Energy in Latin America*, and Darmstadter et al.'s *Energy in the World Economy*.[43] Respectively, they provide data for five, seven, and 11 Latin American and Caribbean countries for the year 1925, the earliest considered. Our endeavour to estimate energy consumption for all Latin American republics for the first quarter of the twentieth century is therefore groundbreaking

III

Before displaying the new annual data on energy consumption, a contrast of the foreign trade data of the Latin American countries versus those of their main partners in 1925 for coal and oil is called upon, in order to establish the reliability of the data used. The choice of the year is in no way arbitrary: 1925 is the only year of our dataset that overlaps with the existing series, none of which covers any

[40] United Nations, Statistical Office, *Statistical yearbook*. United Nations, Department of Economic Affairs, *World energy supplies*; issued annually since 1952, this is the most regular and comprehensive of publications by international bodies dedicated to energy. By using successive editions of this publication, it is possible to construct a limited set of statistical series for the years 1927, 1929, and annually from 1949.

[41] Darmstadter, Teitelbaum, and Polach, *Energy in the world economy*.

[42] For a discussion of sources, see ibid., pp. 835–59.

[43] United Nations, ECLA, *Economic survey*; idem, *Energy in Latin America*; Darmstadter et al., *Energy in the world economy*. Although the oil crisis in the mid-1970s compelled the research agenda to include energy issues, none of the works produced thereafter made any effort to improve the historical data series already mentioned. See United Nations, ECLA, *Latin America and the current energy problems*, and Mullen, *Energy in Latin America*. A brief comment on these and other minor contributions to the most recent energy history of Latin America can be found in M. d. M. Rubio and M. Folchi, 'Energy as an indicator of modernization in Latin America by 1925', Universitat Pompeu Fabra economics and business working paper, no. 868 (2005), pp. 3–15.

previous year. In so doing, the foundations of the new estimates for the period 1890–1925 are made fully explicit.

By 1925, at the end of the period being studied here, most Latin American countries were net importers of coal and petroleum products, mostly from the UK, the US, and Germany; Mexico and Peru also supplied petroleum within the region. Therefore, in order to estimate the apparent consumption of fossil fuels, it seems appropriate to make use of the available trade statistics, and supplement these with home production data in the case of the producing countries. Trade data can be obtained from either the countries from which the fuels were exported, or the destination countries which imported the energy.

Of the 33 countries that constitute Latin America and the Caribbean at present, 18 published trade statistics in 1925, although only 15 offer sufficient detail about the country of origin and the type of products imported. From the exporting countries' side—namely, the US (coal and oil), the UK (coal), and Germany (coal)—information is available, with varying degrees of detail, for all 33 territories.[44] These three main exporter countries are referred to hereafter as 'G3'. It is worth mentioning here the meticulous detail of the US statistics, which have turned out to be crucial for the data reconstruction of the smaller countries and territories, especially those of the Caribbean.

A first look at the data offered by the importing countries reveals some useful trade patterns. As shown in table 1, the G3 provided 98 per cent of the total amount of coal bought by Latin America in 1925. The UK was the country with the greatest share, 69 per cent. The US was next, with a quota of 26 per cent. Germany had a much smaller share, 3.0 per cent.

A closer look at the coal trade patterns modifies the first impression somewhat. The US was the main supplier (85–100 per cent) of coal for Cuba, Ecuador, El Salvador, Guatemala, Haiti, Mexico, Nicaragua, and the Dominican Republic, while for the larger consumers of the Southern Cone (Argentina, Chile, and Brazil) the UK was the main supplier (60–80 per cent). Colombia and Peru showed no preference and imported similar amounts from these two suppliers.[45] One main exception was Bolivia, which imported more coal from the neighbouring countries (mostly Chile) than from the G3 altogether. Coal also entered the Argentinean market from Chile, though none was actually of Chilean origin. Finally, it must be noted that, although it has little relevance for the overall trade, other suppliers were also involved: Australia supplied Chile and the Netherlands supplied both Chile and Argentina.

In the case of petroleum, regional trade played a much greater role. Seven Latin American countries were oil producers by 1925—Argentina, Colombia, Ecuador, Mexico, Peru, Trinidad and Tobago, and Venezuela.[46] Together they accounted for

[44] We have been able to estimate annual series (sets of continuous yearly data) for 30 out of 33 countries (excluding Bolivia, Paraguay and Puerto Rico).

[45] Although we have no direct evidence (none of the domestic data sources have been checked) it seems clear from the indirect sources that the Caribbean was receiving coal mostly from the US from early in the century. The reason for this can be dated back to the coal mining strikes in the UK in the first decades of the twentieth century. The UK did not regain these markets afterwards.

[46] Reported dates of first oil production and exports are: Peru: production 1896, exports from 1897; Mexico: production 1901, meaningful exports from 1911; Argentina: commercial production 1908, very small exports from 1915; Trinidad and Tobago: commercial oil production from 1909, exports almost entirely to the UK from 1911; Venezuela and Ecuador: official start of oil production 1917, exports from 1920 and 1925, respectively; Colombia: production 1922, exports from 1926.

Table 1. *Coal trade patterns: countries of origin of Latin American coal imports in 1925 (15 countries according to their own trade statistics)*

		Main countries of origin (% over all coal products imported)				
Country	*Total coal imports Tonnes (1)*	*UK % (2)*	*US % (3)*	*Germany % (4)*	*Total G3 % (5)*	*Others % (6)*
Argentina	3,178,473	87.0	5.0	6.0	98.0	2.0
Bolivia	15,709	29.0	6.0	3.0	39.0	61.0
Brazil	1,727,050	63.0	36.0	0.0	99.0	1.0
Chile	264,070	79.1	14.5	2.3	95.9	4.1
Colombia	3,263	49.3	50.3	0.0	99.6	0.4
Costa Rica	808	39.0	61.0	0.0	100.0	0.0
Cuba	659,389	1.0	99.0	0.0	100.0	0.0
Dominican Rep.	9,764	0.0	99.3	0.0	99.3	0.7
Ecuador	1,278	6.0	86.0	1.0	93.0	7.0
El Salvador	154	0.0	100.0	0.0	100.0	0.0
Guatemala	264	0.0	100.0	0.0	100.0	0.0
Haiti	156	0.0	100.0	0.0	100.0	0.0
Mexico	65,845	0.8	99.0	0.1	99.9	0.1
Nicaragua	2,646	13.0	86.0	0.0	100.0	0.0
Peru	39,235	45.0	45.0	7.4	97.4	2.6
Total	5,968,104	69.0	26.0	3.0	98.2	1.8

Notes: Cols. 2–6 expressed as % of col. 1. G3 is the sum of cols. 2–4. Chile was Bolivia's main supplier, at 9,317 tonnes; this constituted 59.3% of Bolivia's coal imports. Other suppliers to Argentina and Chile were Australia (9,103 tonnes to Chile), Holland (55,084 tonnes to Argentina and Chile) and Chile to Argentina (8,843 tonnes). Unlisted countries did not produce trade statistics for 1925, except for Paraguay, Uruguay, and Venezuela; in these cases, it was not possible to resolve the country of origin of the merchandise in sufficient detail.

Sources: Domestically produced statistics; Argentina: Dirección General de Estadística, *Anuario del comercio exterior*; Bolivia: Dirección General de Aduanas, *Comercio especial*; Brazil: Directoria de Estadística Comercial, *Comercio exterior*; Chile: Oficina Central de Estadística, *Anuario Estadístico*; Colombia: Departamento de Contraloría, *Anuario Estadístico*; Costa Rica: Dirección General de Estadística, *Anuario Estadístico*; Cuba: Secretaría de Hacienda, *Comercio exterior*; Dominican Republic: Receptoría General de Aduanas, *Report*; Ecuador: Dirección General de Estadística, *Comercio exterior*; El Salvador: Dirección General de Estadística, *Estadística comercial*; Guatemala, Ministerio de Hacienda y Crédito Público, *Memoria de las labores*; Haiti: Financial Adviser-Receiver General, *Annual report*; Mexico: Departamento de Estadística Nacional, *Comercio exterior y navegación*; Nicaragua: Administración de Aduanas, *Memoria del Recaudador*; Peru: Superintendencia General de Aduanas, *Estadística especial*.

15 per cent of the world's petroleum output, while the US represented 72 per cent. In other words, Latin America extracted more than half of the petroleum obtained in the world outside the US. At the same time, Mexico continued to be the second-largest oil producer in the world, a position briefly lost to the Soviet Union in 1927, only to be regained by Latin America in 1928, thanks to Venezuelan wells.

Three countries were the main suppliers of oil products to the region: the US, Mexico, and Peru. A little more than half of the oil imported by Latin American countries had its origin in the US, as can be seen in table 2. Although the UK and Germany are sometimes mentioned as suppliers of oil products in the trade statistics of Latin American countries, in 1925 they provided negligible amounts. The remaining half of the oil was mostly supplied from within the region.

Mexico supplied 40 per cent of the tonnes imported, according to the importing countries' data. Peru, the third main producer of the region, provided 8 per cent. It may be worth mentioning that while the Venezuelan petroleum output was much greater than the Peruvian one, the former massively exported crude to refineries of the Dutch West Indies (Aruba, Curacao). From there it was re-exported, mostly to the US and Europe. Direct exports from Venezuela to the rest of the region remained very low, with the exception of neighbouring Colombia. The list of

Table 2. *Petroleum trade patterns: origin of Latin American petroleum imports in 1925. (15 countries according to their own trade statistics)*

		Main countries of origin (% over all petroleum products imported)				
Countries	*Petroleum imports Tonnes (1)*	*US % (2)*	*Mexico % (3)*	*Peru % (4)*	*Others % (5)*	*Main countries of origin % (6)*
Argentina	689,207	39	30	29		98
Bolivia	22,593	32		9	54[a]	95
Brazil	508,814	41	58			99
Chile	906,661	77	13	10		100
Colombia	9,600	37		5	48[b]	90
Costa Rica	47,272	3	79	3	15[c]	100
Cuba	1,284,027	30	69			100
Dominican Rep.	37,649	42	26		16	84
Ecuador	13,100	12		88		100
El Salvador	22,549	88		12		100
Guatemala	68,458	45	50	4		99
Haiti	6,113	72			17[d]	89
Mexico	366,451	99				99
Nicaragua	14,648	49	32	19		100
Peru	8,084	92			6[e]	98
Total	4,005,226	51	40	8	1	99

Notes: Cols. 2–6 expressed as % of col. 1. Col. 6 is the sum of cols. 2–5.
a Other = Chile.
b Other = Costa Rica (Colombia reports 4,500 tonnes of gasoline from Costa Rica).
c Other = Panama.
d Other = Curaçao (Venezuelan oil), the remaining 10% from Panama and Puerto Rico in equal shares.
e Other = UK.
Sources: See tab. 1.

alternative suppliers is larger than in the case of coal, but they had a small impact on the overall trade and mostly acted as mere intermediaries. So, for instance, the main oil supplier to Bolivia was again Chile, while for Colombia most of the petroleum products came from Costa Rica. This clearly demonstrates the role of intermediary played by some countries in the case of oil (Panama being the other main example).

One main message emerges from this first look at the data. Theoretically, it would suffice to collect data from three exporting countries to cover over 90 per cent of the fossil fuels imported by Latin America. Nevertheless, all of the data available at both ends, importers and exporters, were collected for the comparison exercises in this section, since, a priori, the more data collected, the more refined the new estimates would be. The approach taken presents a number of inconveniences and methodological challenges. These fall into three categories: (1) problems of classification and units of measurement; (2) contrast in volumes between the data provided at origin by the exporting countries and the data registered at the country of destination by the importing countries; and (3) methodological problems in relation to the consumption of home-produced coal and petroleum. Some of these required lengthy and detailed discussions, clearly beyond the scope of a single article, and can be found elsewhere.[47] For this reason, only the main issues

[47] A detailed discussion of these issues can be found in Folchi and Rubio, 'El consumo aparente de energía fósil', pp. 28–53.

and decisions made regarding disagreement of sources and methodology are outlined here.

The total figure of coal and petroleum imports according to their own domestic sources was obtained for 17 countries (those listed in table 2, plus Uruguay and Venezuela). For 15 of these, it was possible to distinguish the country of origin of the products. One way of checking the reliability of the Latin American data is by comparing it to documentation from the exporting countries. Among the main reasons for using all the available data was the general, but not definitively, pessimistic tone of economists, economic historians, and Latin Americanists alike, regarding the poor quality of trade figures in general. The issue of the (in)accuracy of foreign trade statistics still appears in economic literature to the present day.[48] Yet, in historical terms, the accuracy of foreign trade statistics seems to be more robust than is generally thought.[49] Regarding Latin American trade statistics, there is no prevalent view; if anything, traditionally there has been certain pessimism about its quality.[50]

In the absence of evidence in the literature, a test was needed to investigate the level of accuracy of the trade statistics at both ends. There is a wide array of potential explanations for the expected differences between the volume and value of goods recorded at the port of origin and that registered at their destination: different accounting methods (for example, CIF versus FOB, fiscal versus calendar years), pricing methods (official, declared, or fiscal), misclassification of products, different units of measurement, geographical misallocation, and so on. Nevertheless, the data match is surprisingly acceptable.

Consider first the case of the quantities of coal imported from the G3, shown in table 3. The contrast of the volume imported according to both types of sources reveals a very close match (differences of between 2 and 7 per cent) for a first group of countries: Argentina, Brazil, Colombia, Cuba, the Dominican Republica, Ecuador, and Nicaragua. A second group of countries (Chile, El Salvador, and Peru) exhibits a less satisfactory correspondence, with differences between both sources on the 15–35 per cent range. Finally, four countries show vast differences, measured in percentages, between their statistics and those reported by the exporting countries; these are Bolivia, Costa Rica, Haiti, and Mexico. But even for these countries, the actual discrepancies in the number of tonnes imported are too small to have a significant impact on the impression we get as to whether a country was a small, medium, or large consumer of coal, whichever source we look at. When the region is taken as a whole, and the G3's recorded coal exports to Latin America are compared with the total aggregated imports as declared by the destination countries, the gap is reduced to 1 per cent of the total.

In the case of petroleum products, the contrast must be made in absolute and comparable totals. The absolute totals shown in table 4 (panel A) simply contrast the total amount of petroleum registered by the importing country with the aggregation of the exports to that country reported by the US, Mexico, Peru, Argentina, Chile, Germany, and the UK. The amounts recorded in the different

[48] See, for instance, Makhoul, 'Exploring the accuracy'; Parniczky, 'On the inconsistency'; Rozansky and Yeats, 'On the (in)accuracy of economic observations'.

[49] Federico and Tena, 'On the accuracy of foreign-trade statistics'.

[50] Kuntz, 'Nuevas series'.

Table 3. *Imports of coal in Latin America, 1925, volume: difference between importers' and exporters' registries*

	Metric tonnes			*Difference %*	
Country	*Source importers (1)*	*Source exporters (2)*	*I-E tonnes (3)*	*(I-E)/I (4)*	*(E-I)/E (5)*
Argentina	3,111,979	2,925,091	186,888	6.01	–6.39
Bolivia	6,077	664	5,413	89.07	–814.78
Brazil	1,715,203	1,814,136	–98,933	–5.77	5.45
Chile	253,554	195,197	58,357	23.02	–29.90
Colombia	3,252	3,125	127	3.92	–4.08
Costa Rica	808	78	730	90.32	–933.05
Cuba	659,389	701,707	–42,318	–6.42	6.03
Dominican Rep.	9,697	9,484	213	2.19	–2.24
Ecuador	1,187	1,131	56	4.77	–5.01
El Salvador	154	113	41	26.78	–36.57
Guatemala	264	3,287	–3,023	–1,144.81	91.97
Haiti	156	83	73	46.44	–86.71
Mexico	65,746	118,643	–52,897	–80.46	44.59
Nicaragua	2,646	2,476	170	6.42	–6.87
Peru	38,389	32,542	5,847	15.23	–17.97
Total	5,868,500	5,807,758	60,746	1.00	–1.00

Notes: Col. 3: col. 1 minus col. 2. Col. 4: col. 3 divided by col. 1 expressed in %. Col. 5: col. 2 minus col. 1 divided by col. 3 expressed in %.
Sources: Col. 1 domestically produced trade statistics: see tab. 1. Col. 2: sum of the data offered by the main trade partners in coal. Germany: *Der Auswärtige Handel Deutschlands*; US: US Department of Commerce, *Foreign commerce*; UK: Statistical Office of the Customs and Excise Department, *Annual statement of the trade*.

sources are not entirely comparable for they include different things. On the one hand, there may be alternative suppliers included in the total amount reported by the importing countries. These alternative suppliers—Venezuela, Puerto Rico, and Panama—are not included in the figure obtained from the exporters' data. On the other hand, exporters (especially the UK and Germany) may not report minor quantities sold to small countries, but these amounts show up in the Latin American home statistics. Therefore, if we were only to compare these absolute totals (all oil imported by a country as reported on its own trade statistics versus the sum of the exports from the five main oil suppliers as reported in their export trade data), we would find a highly discouraging level of differences.

When the contrast is made solely on the basis of imports for which information is available in importers' and exporters' records, the gap improves for most countries. Table 4 (panel B) reports the results. Comparable totals present the total oils from the same origin. Except in the cases of Colombia, Ecuador, and the Dominican Republic, where a sizeable number of tonnes are missing from the home statistics, for the rest of the countries the match between tonnes reported at the origin and at the destination port is acceptable. Since the countries with the greatest divergences are the small consumers, the gap between the importers' and exporters' data of the total for the region is as small as 2 per cent. The impact of these differences on the final estimates of apparent consumption per capita of individual countries is therefore relatively small.

An important question remains regarding the statistical significance of these gaps. How wide should the difference be in order to be sure that these figures are statistically different? This question goes beyond the scope of this article, and has

Table 4. *Absolute and comparable imports of petroleum products in 1925 data (comparison of domestic and foreign sources)*

	A) Absolute imports of petroleum products			*B) Comparable imports of petroleum products*		
Importer	*Tonnes imported (domestic source) (1)*	*Tonnes imported (country of origin source) (2)*	*Relative differences ((1)-(2))/(1)) % (3)*	*Tonnes imported (domestic source) (4)*	*Tonnes imported (country of origin source) (5)*	*Relative differences ((4)-(5))/(4) % (6)*
Argentina	688,026	670,109	3	677,196	670,109	1
Bolivia	22,027	18,227	17	21,498	18,227	15
Brazil	505,753	552,147	–9	505,753	552,147	–9
Chile	906,641	923,112	–2	906,540	923,112	–2
Colombia	9,232	11,888	–29	4,410	11,888	–170
Costa Rica	47,272	36,799	22	40,275	36,799	9
Cuba	1,281,949	1,352,397	–5	1,281,942	1,352,397	–5
Dominican Rep.	41,983	46,908	–12	30,784	46,908	–52
Ecuador	13,100	27,838	–113	13,015	27,838	–114
El Salvador	22,549	12,072	46	22,536	12,072	46
Guatemala	68,247	50,794	26	68,151	50,794	25
Haiti	7,141	5,165	28	5,446	5,165	5
Honduras		107,916				
Mexico	361,448	324,330	10	361,438	324,330	10
Nicaragua	14,643	11,639	21	9,958	11,639	–17
Panama		832,308				
Paraguay		197				
Peru	8,006	6,743	16	7,443	6,743	9
Uruguay	226,045	183,686	19			
Venezuela	2,287	14,021	–513			
Bermuda		8,910				
Br. Honduras		2,967				
Barbados		712				
Jamaica		7,423				
Trinidad and Tobago		1,154				
British West Indies		85,452				
Danish West Indies		35,370				
Dutch West Indies		3,931				
French West Indies		2,506				
British Guiana		542				
French Guiana		350				
Dutch Guiana		1,537				
Puerto Rico		58,784				
Latin America (17 countries)	4,226,350	4,247,873	–1	3,956,383	4,050,166	–2
Latin America (33 countries)		5,339,148				

Notes: Where no figure is given, this indicates that either (1) the source did not report imports/exports to that country; or (2) the source was not available (in the case of the entire Caribbean, Honduras, and Panama) or it was unsuitable for identifying origins (in the case of Paraguay, Uruguay, and Venezuela). Col. 1 reports the absolute total amount of imports reported in the trade statistics of the importing country. Col. 2 is the sum of all petroleum exports reported by the US, the UK, Germany, Mexico, and Peru. Col. 3 is the % difference between col.1 minus col. 2 divided by col. 2. Col. 4 reflects only the amounts imported from those countries for which actual data exist on the countries of origin, which in turn is added up in col. 5. Col. 6 is the % difference between col. 4 minus col. 5 divided by col. 5. A negative sign in the difference means that tonnes are missing from the importers' reports. A positive sign in the differences implies that tonnes are reported in excess by the importer.

Sources: Cols. 1 and 4 domestic sources: see tab 1. Cols. 2 and 5 trade statistics of the main trade partners: Germany: *Der Auswärtige Handel Deutschlands*; US: US Department of Commerce, *Foreign commerce*; UK: Statistical Office of the Customs and Excise Department, *Annual statement of the trade*; Mexico: Departamento de Estadística Nacional, *Comercio exterior y navegación*; Paraguay: Dirección General de Estadística, *El comercio exterior*; Peru: Superintendencia General de Aduanas, *Estadística especial.*

Table 5. *Old and new estimates of energy from fossil fuels consumed per capita for Latin America in 1925 (tones of oil equivalent per 1,000 habitants)*

	ECLA	ECLA			Darmstadter et al.			New estimates					
								Petroleum	Coal	Total fossil energy	Petroleum	Coal	Total fossil energy
								Domestic sources			Foreign sources		
	Total fossil energy (1)	Petroleum (2)	Coal (3)	Total fossil energy (4)	Petroleum (5)	Coal (6)	Total fossil energy (7)	(8)	(9)	(10)	(11)	(12)	(13)
Latin American Republics													
Argentina	**341.4**	93.8	180.9	**274.7**	166.0	191.0	**257.0**	151.2	181.8	**333.0**	145.1	182.0	**327.1**
Bolivia					10.0	5.0	**15.5**	9.7	4.7	**14.4**	3.0	0.2	**3.2**
Brazil	**65.0**				19.0	51.0	**70.0**	16.7	44.8	**61.4**	15.8	51.4	**67.1**
Chile	**515.0**	223.5	246.0	**469.5**	228.0	219.0	**447.0**	220.1	269.6	**489.7**	201.9	261.0	**463.8**
Colombia					24.0	11.0	**35.0**	21.6	0.3	**21.9**	21.9	0.3	**22.2**
Costa Rica		95.6	1.7	**97.3**				92.8	1.2	**94.0**	79.5	0.1	**79.6**
Cuba					392.0	136.0	**528.0**	378.7	130.5	**509.2**	346.4	137.0	**484.0**
Dominican Rep.								40.0	6.2	**46.2**	35.3	6.1	**41.4**
Ecuador					19.0	—	**19.0**	20.2	0.5	**20.7**	16.9	0.4	**17.4**
El Salvador		16.9	0.1	**17.0**				17.3	0.1	**17.4**	9.1	0.1	**9.1**
Guatemala		30.4	—	**30.4**				45.2	0.1	**45.3**	33.8	1.5	**35.3**
Haiti		2.2	0.04	**2.2**				3.2	0.1	**3.3**	2.1	0.0	**2.1**
Honduras											122.3	1.5	**123.9**
Mexico	**192.0**	72.1	54.2	**126.3**	240.0	70.0	**310.0**	122.3	66.5	**188.8**	159.8	68.5	**227.9**
Nicaragua								22.2	2.7	**24.9**	17.1	2.5	**19.6**
Panama											1,731.7	466.0	**2,197.9**
Paraguay											0.03	0.02	**0.05**
Peru					54.0	18.0	**72.0**	60.2	18.5	**78.7**	59.7	17.4	**77.1**
Uruguay					136.0	153.0	**289.0**	144.0	150.4	**294.4**	107.6	179.0	**287.2**
Venezuela								10.5	10.9	**21.4**	13.9	10.8	**24.7**
Colonies and territories													
Barbados											3.5	146.4	**149.9**
Bermuda											85.3	403.3	**488.6**
British Guiana											0.8	62.5	**63.3**
British Honduras											61.1	9.8	**70.9**
Danish West Indies											1,468.9	1,832.0	**3,301.6**
Dutch Guiana											11.0	12.7	**23.7**
Dutch West Indies											51.4	754.9	**806.2**
French Guiana											12.2	5.8	**17.9**
French West Indies											3.2	128.1	**131.3**
Jamaica											7.2	37.5	**44.7**
Trinidad and Tobago					228.0	25.0	**253.0**	144.0	150.0	**294.0**	117.0	171.0	**289.0**
No of. countries	4	7	7	7	11	11	11	18	18	18	31	31	31

Notes and sources: Col. 1: United Nations, ECLA, *Economic survey*; cols. 2–4: estimated from idem, *Energy in Latin America*; cols. 5–7: Darmstadter et al., *Energy in the world economy*; cols. 8–9 domestic sources: see tab. 1, plus Uruguay: Dirección General de Estadística, *Anuario estadistico*, and Venezuela: Ministerio de Hacienda y Crédito Público, *Estadística mercantil y maritima*; col. 11 foreign sources: see tab. 3; col. 12 foreign sources: see tab. 4. To the trade data in cols. 8 and 11, domestic petroleum production (net of exports) was added from: Argentina, Colombia, Ecuador, Mexico, Peru, and Trinidad and Tobago (petroleum production): American Petroleum Institute, *Petroleum*; Argentina (petroleum exports): Dirección General de Estadística, *Anuario del comercio exterior*; Colombia (petroleum exports): GRECO, 'Comercio Exterior'; Ecuador (petroleum exports): estimated at 90% of production; Mexico and Venezuela (petroleum exports): Rubio, 'Towards environmental historical national accounts'; Mexico, *Anuario de estadistica fiscal*; Trinidad and Tobago (petroleum exports): Mitchell, *Americas, 1750–2000*; Peru (petroleum exports): Superintendencia General de Aduanas, *Estadistica especial*. To the trade data in cols. 9 and 12, domestic coal production (net of exports) was added from: Argentina (coal re-exports): Dirección General de Estadística, *Anuario del comercio exterior*; Chile (coal production): Dirección General de Estadística, *Anuario de Minería*; Chile (coal exports): Oficina Central de Estadística, *Anuario Estadístico*; Brazil (coal production): Martin, *Processus d'industrialisation*; Mexico (coal production): Instituto Nacional de Estadística Geografía e Informática, *Estadísticas históricas*, p. 472; Peru and Venezuela (coal production): Mitchell, *Americas, 1750–2000*; population data from ibid., interpolated with census data in the same source when needed, except for West Indies, Dutch Guiana, Dutch West Indies, and French West Indies, where the source is Bulmer-Thomas, 'Wider Caribbean'. Col. 10 is the sum of cols. 8 and 9. Col. 13 is the sum of cols. 11 and 12.

been discussed elsewhere with very positive results. The conclusion of the several exercises performed is that only in a very few cases can we accept the existence of statistically significant differences between the data provided by the exporters and the data registered by the importing countries.[51]

The aggregation of trade—net of exports—and domestic production of coal and petroleum allows the working out of new estimates of apparent consumption of fossil fuels per capita for Latin America and the Caribbean in 1925. The new estimates for 1925 were calculated for both foreign and domestic sources. The foreign sources provide data for 32 territories; with the domestic sources, alternative estimates can be generated for 17 countries. Table 5 shows the contrast of these two calculations with the estimates previously available for the same year, 1925. The robustness of the new estimates in relation to the old ones supports the new estimates for which no previous reference existed (Barbados, Bermuda, the Dominican Republic, Honduras, Jamaica, Nicaragua, all of the West Indies (Danish, Dutch, French, and British), Panama, Paraguay, and Venezuela).

The proportions of coal and petroleum in the total apparent consumption of energy deserve some attention in relation to modernization issues.[52] The fact that for the Central American countries, coal was mostly irrelevant by as early as 1925 raises an interesting issue. Had these countries been involved in the technologies of the first industrial revolution, they would have used coal. It seems that these countries never made use of the classic steam engine, but made a jump straight to combustion engines, and thus to petroleum products. The US's technological leadership and its influence in this area also support this hypothesis. On the contrary, the countries of the Southern Cone made great use of coal. In fact, Argentina, Chile, Uruguay, and Brazil used more energy from coal than from oil, and together consumed more than half of the coal consumed in the region (Panama excluded). Two possible explanations can be advanced for this fact. On the one hand, these bigger countries initiated their industrialization process during the nineteenth century, thus tying their energy consumption patterns to the prevailing coal technology. On the other hand, path dependence also affected trade. In this regard, the strong historical commercial relationship between Argentina and the UK added a further bias towards coal.

The encouraging results of the exercises in this section seem to support the extension of the new estimates using foreign sources as the keystone for reconstructing backwards to the 1890s, since absolutely no estimates of energy consumption are available before 1925. However, in order to achieve a more complete view of the consumption of modern energies, it is necessary to take into account the newest energy of the time: hydroelectricity.

There is very little information regarding hydroelectric production in Latin America at this early stage; the earliest evidence comes from the United Nations, which produced an estimate of hydroelectric production in Latin America in 1929.[53] The solution to this problem was to project backwards the electricity production of 1929 using each country's stock of electrical generators. Assuming

[51] M. d. M. Rubio and M. Folchi, 'On the accuracy of Latin American trade statistics: a nonparametric test for 1925', Universitat Pompeu Fabra Economics and Business working paper, no. 879 (2005).

[52] On the issue of the exceptionally early transition from coal to oil of the Latin American countries, see Folchi and Rubio, 'La especificidad de la transición energética'.

[53] United Nations, Department of Economic Affairs, *World energy supplies.*

that no electrical machinery was produced in the whole of the subcontinent, trade statistics from the US, the UK, Germany, and Switzerland were used to calculate the quantity of electricity generators imported into Latin America. The value of the stock of imported generators was assessed and deflated with the estimated Swiss export price index for electrical machinery. These series are transformed into hydroelectric production using the factor found for 1929.[54] Nevertheless, the figures for hydroelectric power have almost no impact on the total energy consumption levels of most Latin American countries, except for the smaller Central American countries, especially Costa Rica. This is shown by contrasting the figures for fossil fuel consumption (in table 5) with the ranking of total modern energy consumption (table 6).

The sum of imports established with the G3 data allow us to cover 30 countries and territories; this, together with national production of modern energies (net of exports), including hydroelectric power, constitutes our indicator of apparent consumption of modern energies, divided by population it is the gauge used throughout the rest of this article.

IV

Table 6 offers the ranking of energy consumption per 1,000 habitants for countries in Latin America and the Caribbean in 1890, 1900, 1913, and 1925. Leaving aside the colonial possessions for the moment, the first thing that draws our attention is the wide gap in modern energy consumed across the subcontinent. In 1890, the average Uruguayan consumed 730 times the energy (specifically coal) of an average Salvadorian or Guatemalan. By 1900, almost nothing had changed; but in 1913 and 1925, the difference widened even more once Panama entered the list. Excluding Panama because of its exceptionality (discussed below), in 1890 the four countries above the regional average (weighted)—Uruguay, Chile, Argentina, and Cuba—consumed 17 times more per capita than the 12 countries below the average; the proportion was reduced to 12 times by 1900, and remained thereafter (13 times in 1913; exactly 12 by 1925).

From this depiction, it is clear that the differences in the levels of economic modernization across Latin America were already present by 1890 and changed very little in the following decades. Early integration into world markets seems to have been as important as natural endowment. Among the large consumers, only Uruguay and Cuba had absolutely no national production of modern energies. Yet Uruguay had been present in the world market since the first half of the nineteenth century with its *tasajo* (a dried meat product) exports, and Cuba was the largest supplier of sugar to international markets from the 1830s; Chile was well endowed with mineral coal for home consumption, but also with silver and cereals, and, later, nitrates and copper, for exports. Argentina joined the international trade flows later, but nevertheless forcefully.

Another potential explanation lies with the opportunity cost of the transition from traditional energies of organic origin to modern fossil fuels. While Uruguay and Argentina had no option apart from fossil fuels, because their rich regions of the pampas did not offer much to burn as energy, the cases of Cuba and

[54] We are indebted to X. Tafunell for sharing his estimations of the production of hydroelectricity. See Tafunell, 'La reconstrucción'.

Table 6. *Levels of modern energy consumption per capita in Latin America and the Caribbean. Ranking for years 1890, 1900, 1913, and 1925*

1890		*1900*		*1913*		*1925*	
Country	*TOE/cap.*[a]	*Country*	*TOE/cap.*[a]	*Country*	*TOE/cap.*[a]	*Country*	*TOE/cap.*[a]
Latin American republics							
Uruguay	278.6	Uruguay	360.3	Panama	1,276.4	Panama	2,197.9
Chile	171.5	Chile	189.5	Chile	503.8	Chile	490.3
Argentina	116.9	Cuba	158.3	Uruguay	449.8	Cuba	484.0
Cuba[b]	114.3	Argentina	122.9	Cuba	391.7	Argentina	331.0
Latin America and Caribbean	44.3	Mexico	70.6	Argentina	335.0	Uruguay	287.2
Brazil	33.3	Latin America and Caribbean	63.4	Latin America and Caribbean	142.9	Mexico	251.6
Peru	17.3	Brazil	34.5	Mexico	111.1	Latin America and Caribbean	176.9
Puerto Rico[b]	16.2	Peru	27.5	Peru	91.4	Honduras	127.5
Costa Rica	13.3	Costa Rica	26.4	Costa Rica	89.3	Costa Rica	113.6
Venezuela	11.6	Puerto Rico	16.9	Brazil	76.7	Peru	89.6
Nicaragua	10.4	Dominican Rep.	8.3	Puerto Rico	26.1	Brazil	75.1
Mexico	10.1	Nicaragua	6.4	Guatemala	24.1	Puerto Rico	55.6
Colombia	8.7	Colombia	5.5	Dominican Rep.	16.9	Dominican Rep.	41.4
Dominican Rep.	5.8	Venezuela	5.5	Honduras	11.2	Guatemala	39.5
Haiti	3.1	Haiti	3.0	Ecuador	10.2	Colombia	26.5
Honduras	0.8	Honduras	2.8	Nicaragua	9.7	Venezuela	26.4
Ecuador	0.5	Guatemala	1.5	Venezuela	9.2	Ecuador	21.1
El Salvador	0.4	Ecuador	0.9	Haiti	5.4	Nicaragua	19.6
Guatemala	0.4	El Salvador	0.5	Colombia	3.4	El Salvador	12.6
				El Salvador	1.9	Haiti	2.1
Colonies and territories							
Bermuda	353.7	Danish West Indies	1,543.5	Danish West Indies	2,700.0	Danish West Indies	3,301.6
British Guiana	208.0	Bermuda	1,075.2	Dutch West Indies	784.1	Dutch West Indies	806.2
British Honduras	9.8	French West Indies	82.2	Bermuda	572.5	Bermuda	488.6
		Dutch West Indies	74.1	Trinidad and Tobago	484.6	Trinidad and Tobago	289.0
		British Guiana	65.2	Barbados	289.1	Barbados	149.9
		Dutch Guiana	49.9	British Honduras	106.2	French West Indies	131.3
		British Honduras	28.8	French West Indies	83.0	British Honduras	70.9
				British Guiana	73.5	British Guiana	63.3
				Dutch Guiana	57.9	Jamaica	44.7
				Jamaica	50.4	Dutch Guiana	23.7
				French Guiana	27.3	French Guiana	17.9
Benchmarks outside the region: US and Spain							
US	3,571.6	US	4,913.2	US	7,869.8	US	8,889.9
Spain	123.0	Spain	194.2	Spain	274.3	Spain	255.1

Notes: TOE: Tonnes of oil equivalent.
a TOE/cap. is actually TOE per 1,000 habitants.
b Cuba and Puerto Rico were Spanish colonies up to 1898. The former obtained independence in 1902; the latter remains under US influence. Modern energy includes fossil fuels plus hydroelectric consumption.
Sources: Hydroelectric consumption from Tafunell, 'La producción hidroeléctrica', pp. 79–80. For fossil fuels, sources are the same as those for col. 13 in tab. 5, with the following additions: Chile (coal production): for 1890–1902: *Boletín de la Sociedad Nacional de Minería* (1890–1902); for 1903–7: Oficina Central de Estadística, *Estadística minera*. Population data: as for tab. 5, except for 1890–1900 for the Dominican Republic, Ecuador, El Salvador, Haiti, Nicaragua, and Panama, for which no census data were available; thus the cumulative yearly growth rate of the population data for these countries from Maddison, *Historical statistics*, were used to backcast Mitchell's data. US: Schurr and Netschert, *Energy in the American economy*, p. 235; Spain: Rubio, 'Energía, economía, y CO_2', p. 62.

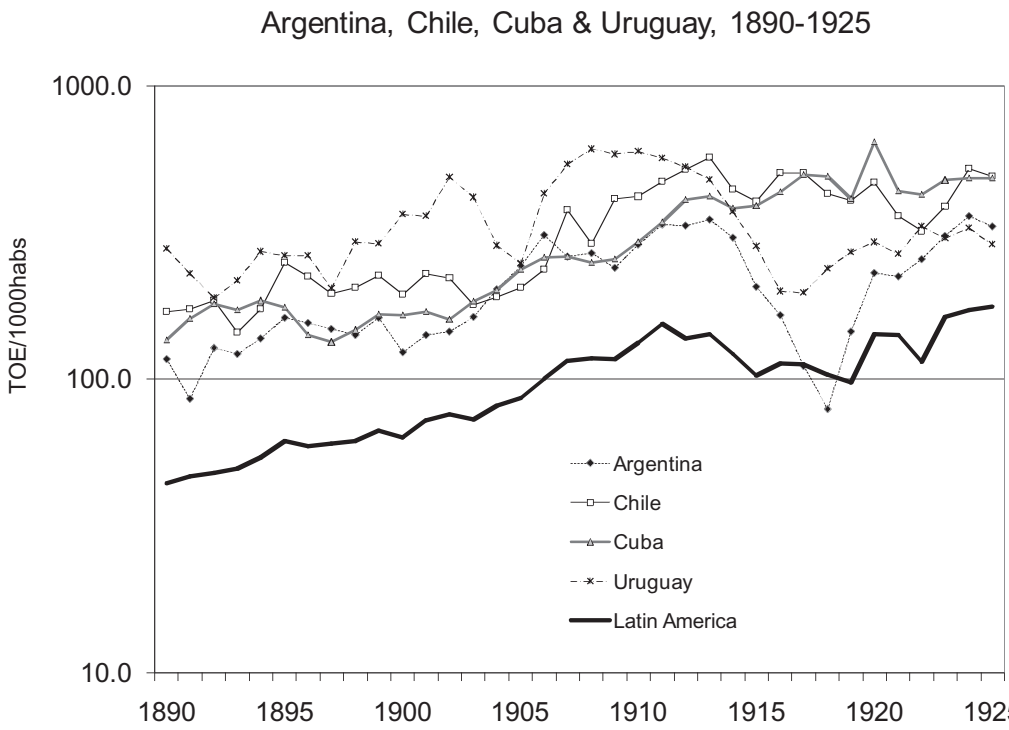

Figure 3. *Energy consumption of large consumers: Argentina, Chile, Cuba, and Uruguay, 1890–1925*
Sources: See tab. 6.

Chile—better endowed with wood and sugar cane for burning—are better explained by the fact that their export activities grew much faster than the organic energy they could provide. In this regard, it is quite possible that the countries with access to the Amazon (Brazil in particular, but also Peru, Ecuador, Colombia, and Venezuela, plus Guyana) had higher opportunity costs for modernizing, given their abundance of wood. In the small economies of Central America and the Caribbean, always towards the bottom of our modernization rankings, the handicaps collude: poor natural endowment, late integration into world markets, and the perpetuation of traditional small economic activities made it possible to continue without much need for modern energies. For these economies, the energy surge came with the delayed arrival of railways; in fact, the largest consumer of modern energies of the time.

It is clear that the differences in the levels of energy consumption per capita were already present by 1890. It is possible to group countries according to their level of energy consumption per capita; such groups were basically the same from the beginning of our period. Uruguay, Chile, Argentina, and Cuba are the four countries at the head of economic modernization (see figure 3). Portrayals of Argentina as a rich and prosperous country are commonplace in economic history literature.[55] What is somewhat surprising here is that Argentina does not take the

[55] Díaz Alejandro, *Essays*; Della Paolera and Taylor, *New economic history*.

first position in our indicator of economic modernization. Energy consumption per capita tends to make industrial, mining, commercial and/or urban countries look better than their actual economic status (more advanced, and in that sense an upward bias), while the energy consumption per capita makes predominantly rural economies look slightly worse than their actual economic status (a downward bias). Therefore, the explanation for the Argentinean case surely lies within the markedly agricultural profile of its economy, which implies relatively low modern energy consumption (limited to the railways and the urban centres). By contrast, the mining intensity of the Chilean economy, which needed to melt its copper before export, and the extensive and dense railway network of Cuba, plus the key role of cities in both countries as bunkering ports on the main commercial routes, help to explain their higher levels of energy consumption. In the Cuban case, the increase of modern energy consumption is also an indication of the replacement of the traditional organic fuel of the sugar industry: bagasse, the part of sugar cane left after the juice has been extracted, which traditionally fuelled the industrial sugar process in Cuba. Bagasse was first replaced by mineral coal and later on by petroleum. For its part, Uruguay appears to have been the largest consumer of modern energies, which in some ways is unexpected. Sharing the traffic of the River Plate with the Argentinean colossus, it is possible that even if only a few of the bunkering activities of Montevideo's port actually corresponded to ships entering or departing from Buenos Aires, the per capita estimate for Uruguay would be reduced, given the large scale of the port's activities relative to the small population of the country.[56]

As noted earlier, the position of Panama is exceptional. With US backing, Panama seceded from Colombia in 1903 and promptly signed a treaty with the US allowing for the construction of a canal and US sovereignty over a strip of land on either side of the structure (the Panama Canal Zone). The Panama Canal was built by the US Army Corps of Engineers between 1904 and 1914. While it was being built, but even more so after it opened, allowing ships to go from the Atlantic to the Pacific, the canal received huge amounts of coal and petroleum for bunkering purposes. With less than half a million inhabitants, it is implausible that the Republic of Panama consumed the equivalent of between half and one million tonnes of oil indicated by the records, however prosperous the former Colombian province might have been. It is not possible at this time to distinguish between the energy consumption of the Republic of Panama and that of the Panama Canal. As a bunkering post, the consumption of the canal was among the highest in the region. Most of the Caribbean colonial possessions must also be considered as bunkering stations of their parent countries; thus their energy consumption (shown in figures 4 and 5) must be interpreted cautiously.

Oil producers within the region deserve special attention. Mexico closed the consumption gap with the leading countries during the 1920s, but still did not reach the top of the list. Petroleum abundance was not *per se* an advantage at that stage—oil-producing countries consumed very little of it, and most of the con-

[56] By 1905, an average round trip between Liverpool and New York consumed 5,000 tons of coal; therefore a few misallocated ships bunkering would make a great difference to Uruguayan energy consumption per capita. A recent research paper by Bertoni and Román ('Estimación y análisis') revised estimated Uruguayan energy consumption downwards, taking bunkering into account, but it still remains among the highest on the continent.

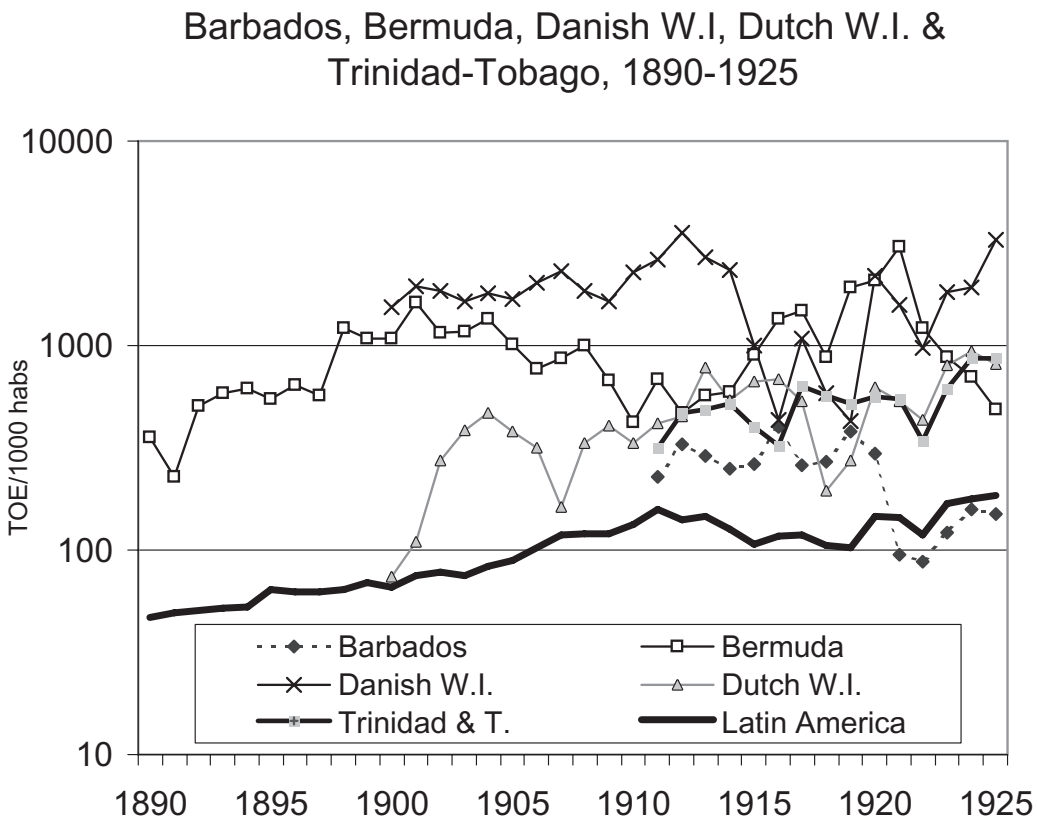

Figure 4. *Energy consumption in the colonial islands of the Caribbean: Barbados, Bermuda, Danish West Indies, Dutch West Indies, and Trinidad and Tobago, 1890–1925*
Sources: See tab. 6.

sumption related to the petroleum industry itself, a clear symptom of the difficulties in modernizing their economies. It was not easy to shake off the burden of the predominance of activities based on organic energies and late integration into world markets, both rooted in the pre-1890 period.

Among the countries in the midrange of table 6 we find Brazil, the largest country in the region by most measures.[57] Although it managed to increase its consumption per capita, Brazil lost position in the ranking, which is probably related to the opportunity cost of switching to modern energies for a country with huge woodland resources. In fact, the only jump for Brazil occurred between 1900 and 1913, and for the last period energy consumption levels fell slightly. The Peruvian case is similar to the Brazilian, one of losing position in the ranking, but differs inasmuch as Peru was the oldest of the oil producers of the region. The evolution of these two countries can be observed in figure 6. While Peru stagnated from 1908, reflecting exhaustion after the effort of the preceding decades of overlapping surges in the demand, production, and price of petroleum, copper,

[57] Leff, 'Economic development'; Summerhill, 'Transport'; idem, 'Railroads'.

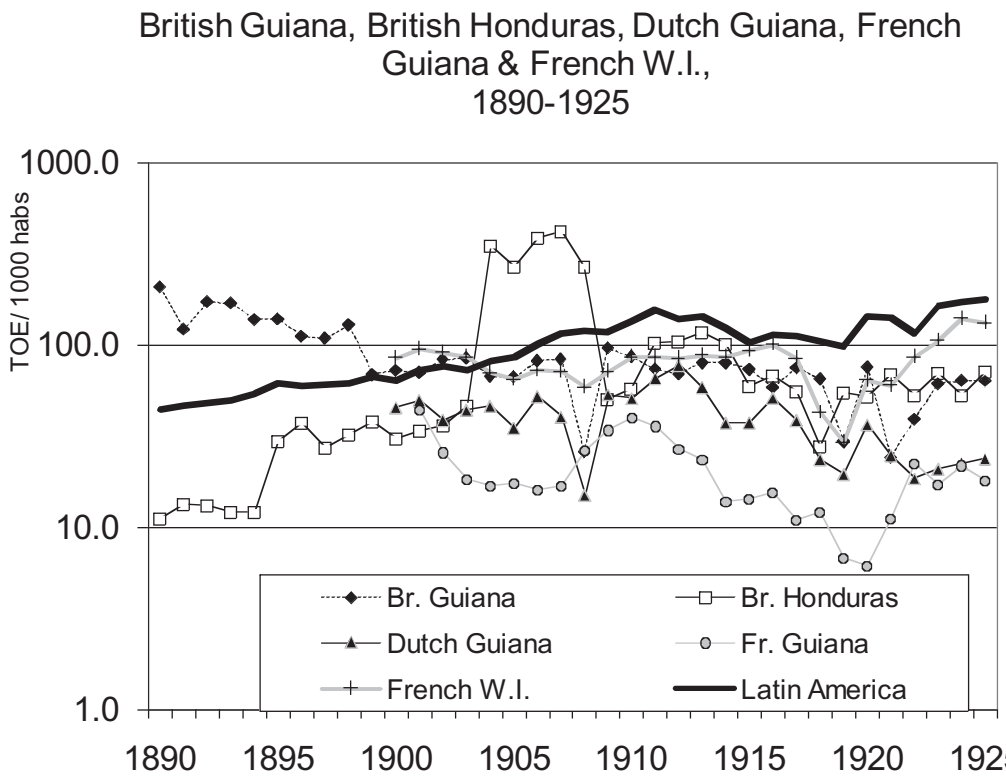

Figure 5. *Medium energy consumers among the colonies and territories: British Guiana, British Honduras, Dutch Guiana, French Guiana, and French West Indies, 1890–1925*

Sources: See tab. 6.

and silver,[58] Brazil's progress was interrupted by the outbreak of the First World War, which severely affected its coffee trade, and did not recover until 1925. In this group of midrange consumers in table 6, we also find Costa Rica and Puerto Rico. The former surpassed Brazilian and Peruvian levels of energy consumption after the First World War, while the latter continued to lose position, being unable to keep pace with Cuba.

At the bottom of table 6, the same countries are systematically found: Haiti, El Salvador, and Guatemala, a group of small and poor economies in Central America and the Caribbean (see figures 7 and 8).[59] Because of its trajectory, Haiti earns the category of 'regional minimum' by 1925, and therefore it can be described as the least developed country in the region. This was not the case at the beginning. Haiti's story is one of decline in the long run, especially from 1896 through 1905, and from 1913 through 1919, barely compensated for by the period in between. On the other half of the island, in contrast, the Dominican Republic moves in the opposite direction: up, with only some minor downward movements;

[58] Thorp and Bertram, *Peru*.
[59] Pérez Brignoli, 'Central America'.

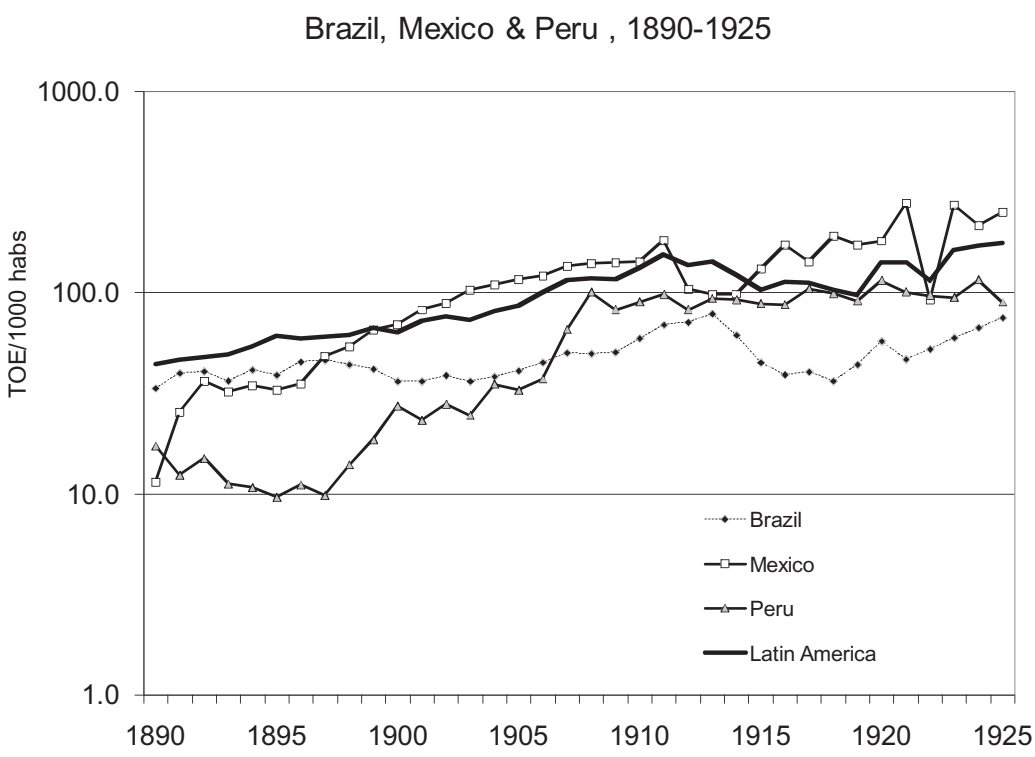

Figure 6. *Energy consumption of medium consumers: Brazil, Mexico, and Peru, 1890–1925*

Sources: See tab. 6.

as does Honduras, which by 1925 had already reached the levels of Costa Rica, in part thanks to the railway construction initiated in 1913, undertaken by US investors.

El Salvador could have turned into another 'Haiti', where lethargy set in. But from 1910, it slowly started its modernization process, upon which the First World War had almost no impact. The explanation for this lies in the construction of railways by foreign investors. The same factor explains the growth of Guatemala from 1895 to 1913, which basically stagnated after experiencing very little or no modernization besides the construction of the railway itself. The only exception in this respect may be Nicaragua, whose levels of energy consumption continued to increase once the expansion of the railway network concluded. This strong relationship between the size of the railway network and modern energy consumption by 1890 can be seen in figure 9.

A final separate group is constituted by the Andean region, Colombia and Ecuador (and the landlocked Bolivia and Paraguay—for which insufficient data prevent the confident offering of time series data at this time). Colombia suffered the secession of Panama and it did not recover until the 1920s, as can be seen in figure 10. Ecuador's story is more like that of Honduras and the Dominican Republic, in that, despite increasing levels of energy consumption per capita, it was not able to move from the bottom of the rankings.

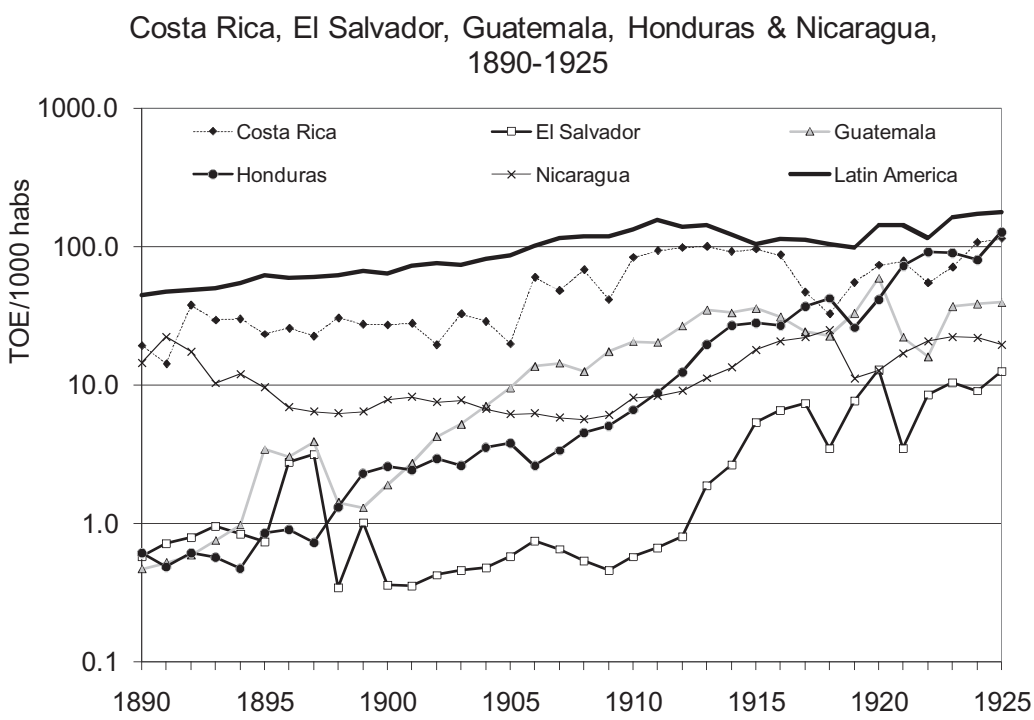

Figure 7. *Energy consumption of Central America: Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua, 1890–1925*
Sources: See tab. 6.

The comparisons of the evolution of energy consumption levels over time reveal clearly that for most of the Andean and Central American regions the first globalization (see section V) was nothing more than a lost opportunity. In contrast, a few other small economies, such as Costa Rica, Panama, the Dominican Republic, Jamaica, and Puerto Rico, managed to find their niche in the world economy. They made the most of it, but the benefits were not always capitalized upon in the longer run. Latin America and the Caribbean fragmented into portions that pursued modernization at very different paces. The emergence at this time of regional clusters is a relevant finding.

Finally, it is possible to make a more precise assessment of the modernization levels of the region in contrast with two other economies: the US and Spain. Comparison to the world leader, the US, indicates that levels of modernization were abysmal even for the most modern of the Latin American countries. The average Latin American consumed less than 2 per cent of the energy consumed by the representative US inhabitant throughout the period. But the US was already the most energy-intensive country in the world. A more realistic comparison can be made with Spain. The leading countries of the region—Argentina, Chile, Cuba, Uruguay, and even Mexico by the mid 1920s—had higher energy consumption per capita than Spain. The implication is that these five were more modern countries than Spain. This proposition is further grounded if we consider that it is fully consistent with the standard knowledge on GDP and migratory

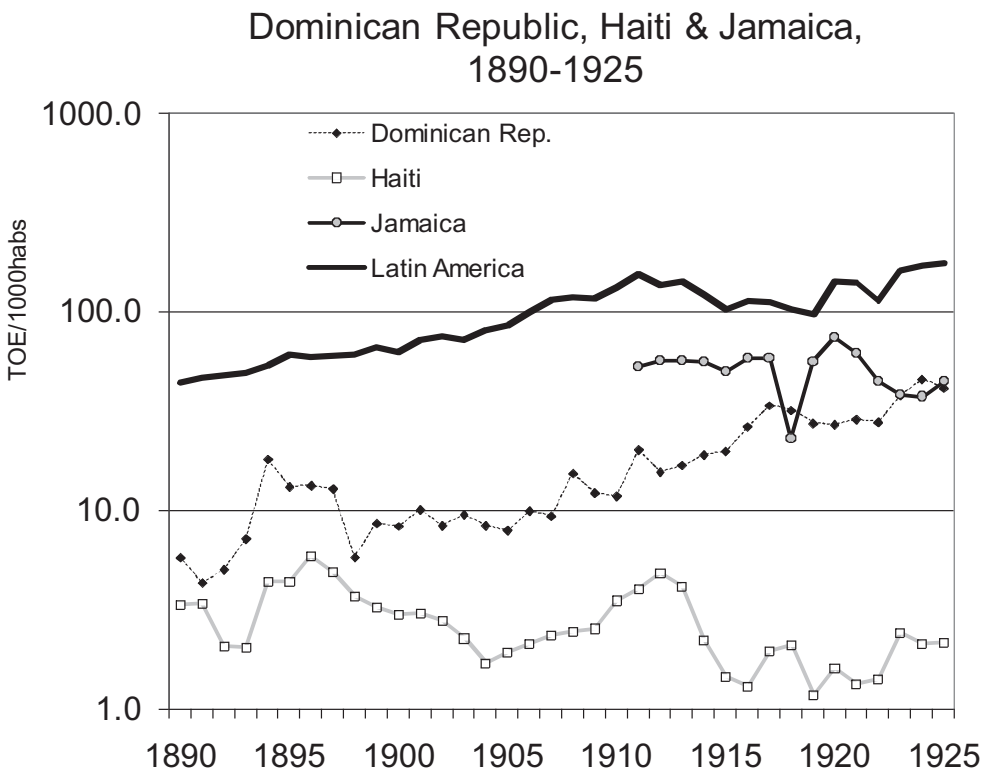

Figure 8. *Energy consumption of two Caribbean islands: Dominican Republic, Haiti, and Jamaica, 1890–1925*
Sources: See tab. 6.

flows over the period. However, this contrast also reveals how far from modernizing most of the rest of the countries of the region were, consuming less than a tenth of the level of a country still on its way to modernity, as was Spain at the time.

V

This section focuses on the different chronologies of economic modernization of the regions. There is a clear-cut difference between the pre-First World War era, with high modernization rates (5.1 per cent yearly per capita modern energy consumption growth), and the war and postwar era, when modernization slowed down (1.9 per cent yearly growth per capita). The first period—from 1890 to 1913—known as the first globalization, were the years of the making of an integrated international economy. According to the best of our knowledge, some Latin American and Caribbean countries fully enjoyed the opportunities provided by increased specialization and integration into the world economy. All these opportunities implied a larger consumption of modern energy sources.

The figures in table 7 provide data to support this view. The whole of the region had an average yearly increase in modern energy per capita consumption of

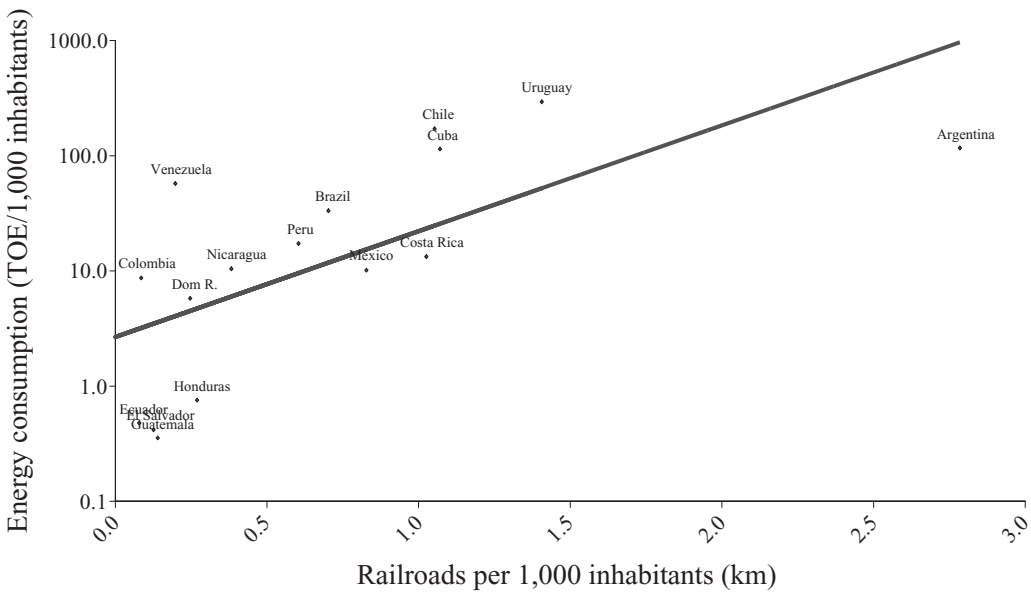

Figure 9. *Energy consumption (tonnes of oil equivalent) and railroads (km) per capita in 1890*

Notes and sources: Per 1,000 habitants in both cases. Railways from Mitchell, *Americas, 1750–2000*; energy: for sources, see tab. 6.

5.1 per cent. It more than trebled during the period 1890–1913. The large Latin American economies had a growth rate in the same range: Argentina, 4.7 per cent; Brazil, somewhat lower, at 3.7 per cent. Mexico, with an 11.0 per cent average early increase in energy consumption per capita, managed to change from being an underperformer in Latin American terms to being an overperformer. These were the years of the '*porfiriato*', up to the abrupt revolutionary interruption of 1911.[60] The 'medium' size progressive economies also performed well: Cuba at 5.5 per cent; Chile at 4.8 per cent; but Uruguay, perhaps the richest by 1890, only 2.1 per cent. These six countries represent 83.8 per cent of total modern energy consumption in Latin America in 1913. But a number of other small countries also show impressive performances. Guatemala shows a 20.1 per cent growth rate; Ecuador, 14.2 per cent; Honduras, 12.4 per cent; Costa Rica, 8.6 per cent; Peru, 7.5 per cent; and El Salvador, 6.9 per cent. All of them, except Peru, were small countries (in population terms), located in the tropical region, and initially very poor. They jumped from extremely low levels of modern energy consumption per capita to simply low levels.

On the other hand, a few countries completely missed their opportunities: Colombia is the most spectacular at –4.0 per cent; followed by Venezuela, at –1 per cent; Nicaragua, at –0.3 per cent; and Haiti, at 2.4 per cent. The Colombian case is especially interesting as it reflects the loss of its wealthiest province, Panama, which was independent from 1903. It is unfair to consider both countries as separate entities, as what remained of Colombia was much poorer by 1903. If Colombia and Panama are considered together, this results in a yearly increase of

[60] The dictatorship of Porfirio Díaz from 1876 to 1911 is known in Mexican history as the *porfiriato*.

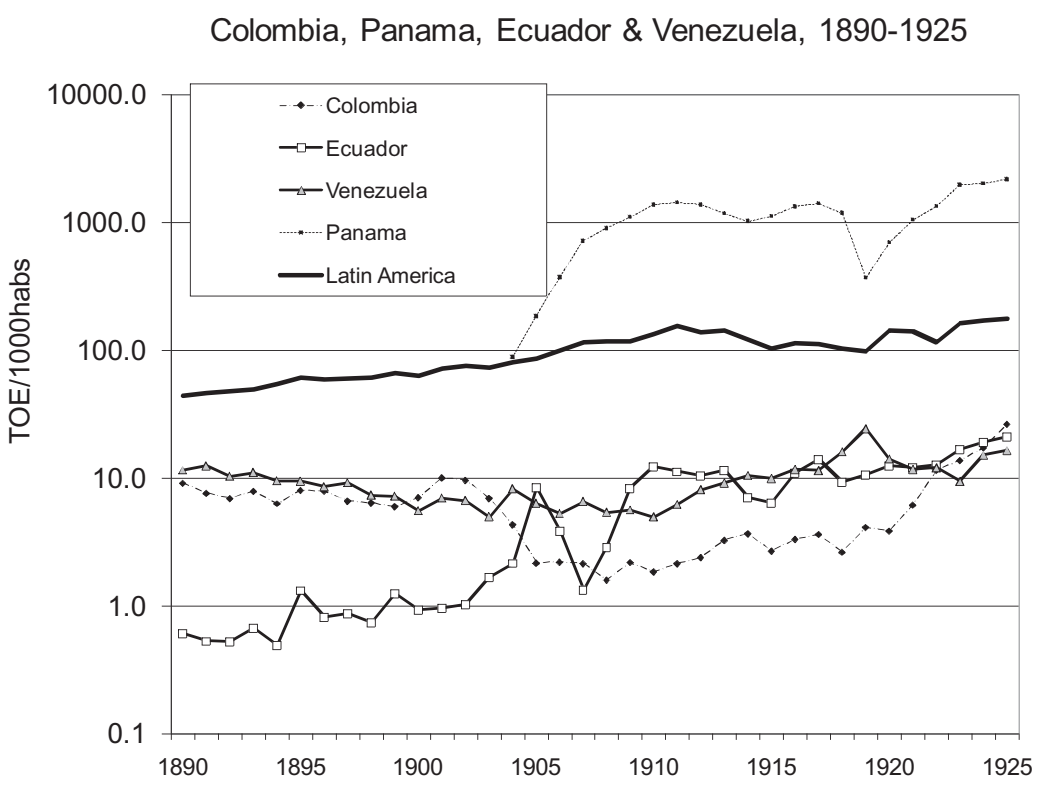

Figure 10. *Energy consumption of the 'Gran Colombia': Colombia, Panama, Ecuador, and Venezuela, 1890–1925*
Sources: See tab. 6.

10.5 per cent; close to the Mexican levels, for instance. The other three cases seem plausible too. By the early 1890s, Nicaragua enjoyed some advantage compared with most Central American economies (except Costa Rica) but this could not be sustained, and there probably was some intraregional convergence. The energy data suggest that such a trend did exist: Guatemala and Honduras overcame Nicaragua and approached Costa Rica. Only El Salvador remained stagnant.

Venezuela and Haiti do not have any excuse for their underperformance. Haiti is the most intriguing country, as it became the poorest one—in per capita energy consumption terms—precisely during these years. At the beginning of the period being studied, Haiti was on the same level as the Dominican Republic—the other half of the island of Hispaniola—or Colombia. By 1913, after more than two decades of low growth, it was close to the bottom. Haiti reached this position during the First World War. The very small colonial territories followed quite different paths, generally positive, but with some curious exceptions, such as British Guyana.

It is worth highlighting the fact that the highest growth rates correspond to the Andean axis, from Mexico to Peru. The temperate southern countries performed well, but were just below the average. Brazil and more obviously Uruguay and Venezuela appear as clear underperformers. The region as a whole managed to

Table 7. *Rates of growth of per capita modern energy consumption (%)*

	1890–1900	*1900–13*	*1913–18*	*1918–25*	*1890–1913*	*1913–25*	*1890–1925*
Latin American republics							
Argentina	0.5	8.0	–29.0	26.4	4.7	–0.6	2.8
Brazil	0.4	6.3	–15.6	12.6	3.7	–0.2	2.4
Chile	1.0	7.8	–5.3	3.3	4.8	–0.4	3.0
Colombia	–4.4	–3.7	–5.1	39.1	–4.0	18.6	3.2
Costa Rica	7.1	9.8	–23.8	25.2	8.6	1.8	6.2
Cuba	3.3	7.2	–0.1	3.1	5.5	1.8	4.2
Dominican Rep.	3.6	5.6	13.6	3.7	4.8	7.8	5.8
Ecuador	5.9	21.0	–3.6	8.1	14.2	3.1	10.3
El Salvador	0.8	11.8	12.9	17.5	6.9	15.6	9.8
Guatemala	15.2	24.1	–33.0	42.2	20.1	4.0	14.3
Haiti	–0.3	4.6	–17.2	0.0	2.4	–7.6	–1.1
Honduras	13.9	11.3	24.7	20.9	12.4	22.5	15.8
Mexico	21.4	3.6	11.5	4.0	11.0	7.1	9.6
Nicaragua	–4.7	3.3	18.6	–5.1	–0.3	4.1	1.2
Panama			–3.2	10.4		4.5	
Peru	4.7	9.7	1.3	–1.2	7.5	–0.2	4.8
Puerto Rico	0.4	3.4			2.1	6.5	3.6
Uruguay	2.4	1.9	–14.5	7.3	2.1	–2.4	0.5
Venezuela	–7.1	4.0	11.8	0.4	–1.0	9.2	2.4
Colonies and territories							
Barbados			–1.5	–8.0		–5.3	
Bermuda	11.8	–4.7	9.0	–8.1	2.1	–1.3	0.9
British Guiana	–11.0	0.9	–2.5	–0.4	–4.4	–1.2	–3.3
British Honduras	11.3	10.6	–26.1	17.2	10.9	–3.3	5.8
French Guiana			–15.0	5.8		–3.4	
Jamaica			–14.5	9.9		–1.0	
Trinidad and Tobago			3.2	6.3		5.0	
Latin America	3.6	6.4	–6.2	8.1	5.1	1.8	4.0
Benchmarks outside the region: US and Spain							
US	3.2	3.7			3.5	1.0	2.6
Spain	4.7	2.7			3.5	–0.6	2.1

Sources: See tab. 6.

increase its modern energy consumption a third quicker than the US; this was a catching-up experience, but it was not spectacular. Nor was intraregional catching up spectacular. For all the rapid growth of the poorer countries that this article reveals, the fact is that the 1890 rankings had not changed much by 1913. Only Mexico made significant progress.

A closer look at the average evolution of Latin America suggests an accelerating trend, particularly after 1902, peaking in 1911. The growth rate for 1890–1902 for the whole region is 4.5 per cent, while for 1902–11 it jumps to 8.1 per cent. A more conventional breakdown into decades—before and after 1900—produces the same acceleration trend, although rather blurred, from 3.6 per cent in 1890–1900 to 6.4 per cent in 1900–13. The acceleration is quite general, with clear upturns for Argentina, Brazil and Chile, all of which jump to the 6–8 per cent range in 1900–13 from 1 per cent per year or less in the last decade of the nineteenth century. The only sizeable economy experiencing the opposite trend is Mexico, which goes down to 3.6 per cent from 21.4 per cent, but this can be explained by the Mexican Revolution. Indeed, growth rates outside Mexico during the Edwardian era are really impressive. Only Uruguay experiences slow growth

(1.9 per cent). The comparison with the US figures underlines the strong dynamism of early twentieth-century economic upswings for the whole of Latin America, even compared with the leading world energy consumer.

It is usually accepted that there is an acute shortage of data on Revolutionary Mexico. The modern energy consumption approach, using exports from the major western economies, allows this problem to be partially overcome. According to this approach, Mexican figures decrease by one-third for 1910–14. Nevertheless, the downward trajectory includes a very good 1911, and the strong recovery after 1914 has to be underlined.

The outbreak of the First World War was a watershed for Latin America, as for the rest of the world. It is fair to mention that the years immediately prior to the war were years of economic crisis or deceleration for some of the large economies (Argentina, Brazil, Mexico, and Uruguay), with a 10.8 per cent fall for 1911–12, only partially recovered in 1913. The overall Latin American and Caribbean performance was quite bad: a 30.2 per cent fall from 1913 to the trough of 1919 (and a 35.1 per cent fall if comparing 1911 to 1919). Contrary to what happened during the prewar globalization years, when almost every country's per capita energy consumption was growing, the war years showed very different country experiences. In the period 1913–18, when most of the impact was felt, countries had yearly growth rates ranging from –33.0 per cent in Guatemala to +24.7 per cent for its neighbour, Honduras. These extremes were not isolated. The largest economies also experienced such a discrepancy. Argentina fell at a 29.0 per cent rate and Brazil at 15.6 per cent, but Mexico grew at 11.5 per cent. Uruguay's rate fell to 14.5 per cent and Chile's to 5.3 per cent, but Cuba remained almost stagnant (–0.1 per cent). The falls were more important than the rises, as happened with the whole of the region (which averaged –6.2 per cent), but what is the most striking is the diversity of the experience, even among close neighbours. Generally speaking, all the economies closely linked with the European markets—mainly the UK, but also Germany and France—suffered the most during the war. All of the large South American economies—Brazil, Argentina, Chile, and Uruguay—fell into this category, as did some others in Central America and the Caribbean, like Guatemala (–33.0), Costa Rica (–23.8), Haiti (–17.2), and Jamaica (–14.5). But these were the only eight economies suffering more than average.

A number of economies enjoyed positive growth during the war years. Below the Honduras maximum rate were Nicaragua (18.6), the Dominican Republic (13.6), El Salvador (12.9), Venezuela (11.8), Mexico (11.5), Trinidad and Tobago (3.2), and Peru (1.3). In the negative range, but above the regional average, were Panama (–3.2), Ecuador (–3.6), and Colombia (–5.1), as were the previously mentioned cases of Chile (–5.3) and Cuba (–0.1).

The fluctuations during the war years reveal a number of features that distinguished each country and region. Argentina reduced its energy consumption at an increasing rate, mirroring wartime economic developments in western Europe: increasingly poor economic conditions and increasingly risky and expensive freight rates. It is not surprising that Argentina's worst year was 1918, when it reached 18 per cent of its 1913 figure. Brazil, on the contrary, suffered a tough decline over the 1914–16 period, but it experienced a less dramatic decline during 1916–18, when the actual minimum was reached at a level of

42.8 per cent of that of 1913. It is likely that Argentina reflected the pattern of the European wheat and meat importing markets, both of which were difficult (politically, socially, and economically) to reduce early on since they were fundamental ingredients of the European diet. On the contrary, Brazil mirrored the European colonial goods importing markets, where coffee or sugar were perceived to be less indispensable and could be cut down from the start of the war. Indeed, the only Latin American countries to suffer a sharp and prolonged decline during the First World War were Argentina, Brazil, Costa Rica, Guatemala, and Uruguay—a total of five, two of which were large economies, and one a medium-sized prosperous economy, while the other two were small and poor, even if promising. However, no other country experienced anything similar to what they suffered.

Mexico fully recovered from the Revolution. The 1911 maximum was difficult to reach, but it is impossible to draw a negative picture for 1914–18. Cuba also enjoyed relatively good years, around 1911–13 levels: not extraordinary, but not bad. Chile had a poor 1915, but the other years were in the 1910–13 range, and much better than 1912. There was an occasional bad year, for example, in Ecuador (1915) or in Jamaica (1918), but the norm was stability or stagnation. It is also difficult to find major growth spurts, although Honduras, Nicaragua, the Dominican Republic, and El Salvador are cases in point. They were small economies, but they undoubtedly enjoyed a golden era during the First World War.

Can we assign any responsibility for what happened to the Panama Canal? As we know, it was inaugurated in mid-1914, and was itself a real watershed in American life. Were the poor performances of the South Atlantic economies and the relatively impressive development of the Pacific Rim linked to the new shipping routes opened by the Panama Canal? It is quite likely. The energy consumption figures suggest that this interpretation could be true. Mexico and the Central American republics which happened to be just in the middle of the new route from the east and west coasts of the US performed quite well. The Andean countries reduced dramatically their distance from the Northern Atlantic world and could enjoy many more business opportunities. On the contrary, Brazil, Uruguay, and Argentina were the net losers.

For a few economies the worst came in 1919. Recovering from the First World War was not easy at all. For the whole of Latin America, 1920 seemed to be the recovery year, but 1921 did not continue the growth trend, and 1922 saw another collapse. Only 1923 provided a better performance than any previous year, including 1911. The following years, 1924–5, confirmed the recovery. As far as it can be seen from the figures, three economies were outstanding during 1920–5: Honduras (25.1), Panama (25.4), and Colombia (47.0). Panama's dynamism had local roots in the success of the Canal, and the combination of coffee exports and early import substitution policies provided similar roots for Colombia. Ecuador (10.1), the Dominican Republic (8.8), and Costa Rica (8.8) also performed quite well during this period.

It is interesting to note that the gap between Latin America and the US did not widen. It is true that the gains made over the first decade of the twentieth century were completely eroded by the war, but the recovery up to 1925 placed Latin America relative to the US at the same level it had been in 1910. The path of its

development is more clearly convergent with that of Spain throughout the period studied. While the regional average energy consumption was below 40 per cent of Spanish consumption in 1890, by 1925 the region had achieved 60 per cent of former colonizing countries' consumption.

VI

In the absence of comparable macroeconomic indicators for most Latin American economies before the 1930s, this article presents an estimate of the apparent per capita consumption of coal, petroleum, and hydroelectricity for 30 countries in Latin America and the Caribbean for every year from 1890 to 1925. This allows a ranking of the Latin American countries to be drawn up and comparisons to be made among them. In order to construct the new estimates, both the statistics of the Latin American economies and that of their principal trade partners by 1925 were contrasted, and then the trade partners' data were used to construct estimates back to 1890. The domestic production of coal and petroleum (both net of exports) and the production of hydroelectricity were added to these data. Energy consumption is used as an indicator of economic modernization.

As a result, the article makes several distinct contributions to the literature. On the one hand, it offers a contrast of the foreign trade statistics of Latin American countries with those of advanced economies (the UK, the US, and Germany), showing that the former are far more reliable than previously thought. On the other hand, the article adds to environmental and energy history studies by providing energy consumption estimates for years for which no estimates previously existed for Latin America. Last but not least, the article contributes to the wider economic history debate in Latin America, providing the basis for a comparative analysis of modernization performance, beyond the countries for which historical national accounts are currently available.

According to the new estimates of energy consumption per capita, and taking them as a proxy of economic modernization, the main findings are that Argentina, Chile, Cuba, and Uruguay were already well ahead of all the others by 1890 (when the new series starts). By contrast, the small Andean and Caribbean economies failed to start modernization until just before the First World War, when foreign investment in railways impacted on their traditional economies. Social archaism and a tiny domestic market were powerful limitations on further progress. Brazil, Mexico, and Peru were around the Latin American average. Despite the existence of modern sectors, these were grounded on mid-nineteenth-century technologies, and therefore they were unable to induce sufficient modernization of traditional activities to improve the performance of the economy.

In a more general way, the article demonstrates that countries differed in their ability to benefit from the opportunities created by the first globalization; that the First World War did not have the same impact across all countries in the region; and that, clearly, Latin American economies had heterogeneous experiences in their recovery from the war. Finally, the entire region, up to 1925, maintained a very low level of modern energy consumption; consequently, the final conclusion is that, despite the undeniable advances made over the first quarter of the twen-

tieth century, the degree of economic modernization achieved by Latin American countries was overall patchy and uneven.

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