Décimas Jornadas de Investigación en Historia Económica
Montevideo, 10 y 11 de julio de 2014

Do energy natural endowments matter? New Zealand and Uruguay economic performance in a comparative approach (1870-1940)

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Abstract

Settler economies are characterized for the abundance of natural resources. However, natural capital is not homogeneous between countries and it can induce different consequences in terms of economic performance. This paper discusses the effect of natural resources on economic performance as a part of the debate about the "curse of the natural resources hypothesis", and it focuses the analysis on a couple of settler societies –New Zealand and Uruguay– considering energy natural resources. Literature about economic development of settler economies that identifies differences within the "club" with disparities in terms of natural resources is very scarce. Our proposal is to look for diversities in energy natural endowments (basically coal endowments and suitable conditions for hydroelectric generation) to explain (at least partially) different welfare levels between both economies. Despite many similarities –referred to productive structure, movements in productive factors and insertion in the international markets– New Zealand and Uruguay presented, during the 19th century and the first decades of the 20th century, huge differences in income per capita levels. Therefore, we need to study other spheres of economic system to find new answers in this matter. Analytical framework associated with the curse of the natural resources offers some interesting lines of argument for our concern. Differences in favour of New Zealand to the production of coal and natural conditions to generate electric energy with low costs explain those disparities. Our findings are new evidence that support the blessing hypothesis of natural resources.

Keywords: settler economies, curse of the natural resources hypothesis, coal production, hydroelectric generation
JEL Classification Number: N50, N70, Q41

We thank to Carolina Román and Jorge Álvarez by their attentive reading of previous versions of this paper. We also want to thank the comments of participants of several conferences where initial versions were presented, especially Luis Bértola and María Inés Moras (9as Jornadas Anuales de Investigación, AUDHE, Uruguay, Agosto, 2013) and Marc Badía-Miró, Manuel llorca, Pablo Castillo, Xavier Taffunel, César Yañez and Cristián Ducoing (Segundo Congreso Chileno de Historia Económica, Valparaiso, Setiembre, 2013). We are solely responsible for the remaining errors.

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Introduction

Settler economies are characterized for the abundance of natural resources. However, the stock of natural resources is not homogeneous between countries and it can induce different consequences in terms of economic performance. This paper discusses the effect of natural resources on economic performance as a part of the debate about the "curse of the natural resources hypothesis", and it focuses the analysis on energy natural resources. Literature about economic development of settler economies that identifies differences within the "club" with disparities in terms of natural resources is very scarce. Our proposal is to look for diversities in energy natural endowments (basically coal endowments and suitable conditions for hydroelectric generation) to explain (at least partially) different development levels between economies.

Settler societies of the 19th and 20th centuries seem to share common features that make them a comparable group of economies. Settler "club" includes that group of countries that Lewis (1983, p. 209) calls *"template economies"* and Foreman-Peck (1995, p.105) identifies with *"the group of non-European countries which in the twentieth century can be classified as developed"*.[1] Their economic and social development often presented parallel paths, as a result of similar dynamic relations between waves of immigration, marginalization of native people, European capital importation, land abundance, free labour (at least after the mid-19th century), socially-useful political institutions[2] and development of neo-European cultures (Lloyd & Metzer, 2013). By the late 19th Century the settler economies were well integrated into the world economy and the "success" was achieved independent on the size of the country. In this paper we choose the small economies of the "club" –New Zealand and Uruguay– that in spite of having many similarities –referred to productive structure, movements in productive factors and insertion in international markets– they presented huge differences in terms of income per capita and productive diversification even in the golden age of the settler economies (during

[1] The author includes Argentina, Australia, Canada, Chile, New Zealand, South Africa, the US and Uruguay into the list. When the author stays "*twentieth century",* he refers to the period from 1900 to the First World War.

[2] Institutions designed to develop the economy rather than extract rents for some domestic or foreign elite.

the First Globalization). Therefore, we need to study other spheres of economic system to find new answers in this matter. New Zealand and Uruguay have a long tradition in the comparative analysis. In the 1970s and 1980s we attended an important wave of studies about the comparative evolution of these countries: Barrán & Nahum (1978); Denoon (1983); Kirby (1975) and Rama (1979). However, the interest in comparative approaches had a reversal during the 1990s, when the economic recommendations were in more general terms (with minor emphasis on specific advices) and focused on commercial liberalization and monetary policies.

The comparative work took a renewed impulse in the starting of the 21st century. Probably the combination of a broader debate in Economics –that incorporated actively concepts as institutional and technological change– and the increasing discussion about the development model in Australasia and Rive Plate motivated the resurgence of the topic. Articles as Álvarez (2007 a, b); Álvarez & Bortagaray (2007); Álvarez et. al (2011); Bértola & Porcile (2002, 2007); Carbajal & De Mello (2007); Greasley, Madsen & Oxley (2000); Duque & Román (2007); Willebald (2007, 2011) illustrate the new interest in the comparative Economic History of Australasia and the countries of the River Plate.

The "golden age" of the settler societies coincided with the First Globalization era (1870-1914), a process characterized by the integration of the markets of goods and productive factors, convergence, free trade and peace. In the 20th century the main challenge for these economies was how to deal with the transition from settler society to some form of post-settler configuration and the different trajectories and degrees of success that the process has produced. As it is usual in the literature, our empirical evidence contemplates the period 1870-1940 to cover a complete economic cycle, from the expansion that started in the 1870s-1880s and the prosperity that went with the boom prices previous to the World War I (WWI), until the moderation of the 1920s and the posterior contraction and recession of the 1930s.

After this introduction, we present some of the main stylized facts of the period (Section 1) and consider, in a comparative perspective, economic growth, convergence –relative to the "core" of the world economy and within the "club" of the small settler economies– and structural change (in terms of the domestic economy and the trade structure). Then, we review the debate about the different economic performances within the "club" to differentiate particular conditions to economic development (Section 2). This evidence opens the possibility to propose conjectures and possible explanations for the unequal performances and we present our analytical framework and strategy to test our hypothesis (Section 3) and answer our main question: were energy natural resources different in New Zealand and Uruguay? We propose a descriptive and comparative analysis of "natural endowments" to produce energy (Section 4) and then we consider technological and market conditions prevailing to advance in some possible responses (Section 5). The last step refers at development of dairy sector, certain energy intensive manufactures and use of railways as expression of differences in intensity use of energy in both countries (Section 6). The paper concludes with final remarks and our agenda (Section 7).

According to our analysis, the discrepancies in favour of New Zealand to produce coal and natural conditions to generate electric energy with low costs explain the differences between both countries in terms of welfare and productive structure. New Zealand's advantage in energy endowments would explain –at least partially– the development of a dairy sector, certain energy intensive manufactures and a more efficient use of railways. Our findings support the hypotheses that proposes the relevance of having a significant mining sector to understand the differential development between Australasia and the River Plate (Álvarez et al., 2007), the importance to consider the different quality of the natural resources and, finally, the significance to incorporate geographical and climatic conditions to explain the energy dependence of Uruguay (Bertoni, 2011).

1. Some stylized facts

The period 1870-1914 was a real "golden age" for settler economies. At the root of the expansion was the Industrial Revolution, a process founded in a deep technological progress that changed the social and economic relationships in a world scale. The integration of the commodity and factor world markets during the first great globalization boom was one of the more important processes of the world economy in the last two centuries. Liberal dismantling of mercantilism and transport revolution worked together to generate global markets during the 19th century. The decline in the transport costs was constant in the century, but there was an anti-globalization policy reaction after the 1870s that was not large enough to cause a return to the 1820 levels of economic isolation. Mass migration remained free by the end of the century (although the immigrant subsidies disappeared) and global capital markets became steadily more integrated as European investors believed in important growth prospects overseas.

The recent studies by Lindert, O'Rourke, Taylor and Williamson on globalization, growth and inequality set a prolific line of research and debate about a topic that have a great importance to understand the expansion of Atlantic economy (Lindert & Williamson, 2001; O'Rourke, Taylor & Williamson, 1996; O'Rourke & Williamson, 1994, 1999; Taylor & Williamson, 1997; Williamson, 1995, 1996, 1999, 2002).

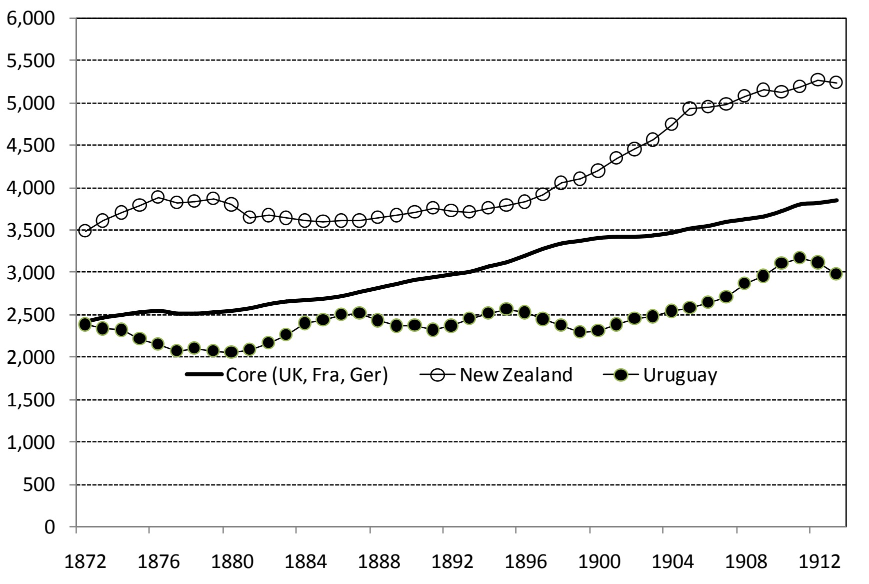
In this conceptualization, the template regions, with scarce population, exposed to the effects of the First Globalization, took advantage of being endowed with abundant natural resources and received the "blessing" of their natural capital. These economies grew quickly from the last decades of the 19th century to the WWI encouraged by the international conditions of a dynamic demand and the flows of productive factors (labour and capital). However, "the blessing was diabolical"[3] because was associated with a persistent worsening in the income distribution (see Willebald, 2011). Economic growth and inequality were mediated for the combination of technological and institutional factors that delineate several differences within the "club".

It is real that our countries presented similar development patterns but, when we focus on specific features, important differences emerge. Berger & Willelbald (2011), Willebald & Bértola (2011) and Willebald (2011) state that while the intensity of the First Globalization and its consequences for the settler economies followed a broad common pattern, the countries reacted in different ways, and this probably determined their economic performance in the subsequent decades. These economies based their production on primary activities but in spite of this, at around the time of WWI, they achieved levels of development close to the "core". However, income per capita was higher and inequality was worsening less in ex-British possessions (Australia, New Zealand, Canada) than in the South American Southern Cone

[3]Here we are paraphrasing Barran y Nahum (1978):189.

(Argentina, Chile and Uruguay), and in the former group economic specialization was relatively less concentrated on primary activities. In terms of the curse/blessing of natural resources, the ex-British colonies were more blessed and less damned by their abundance of resources than the other ex-colonies.

Figure 1
INCOME PER CAPITA IN NEW ZEALAND, URUGUAY AND THE "CORE"
1990 Geary-Khamis dollars, 5-year moving averages (centred in mid-year)

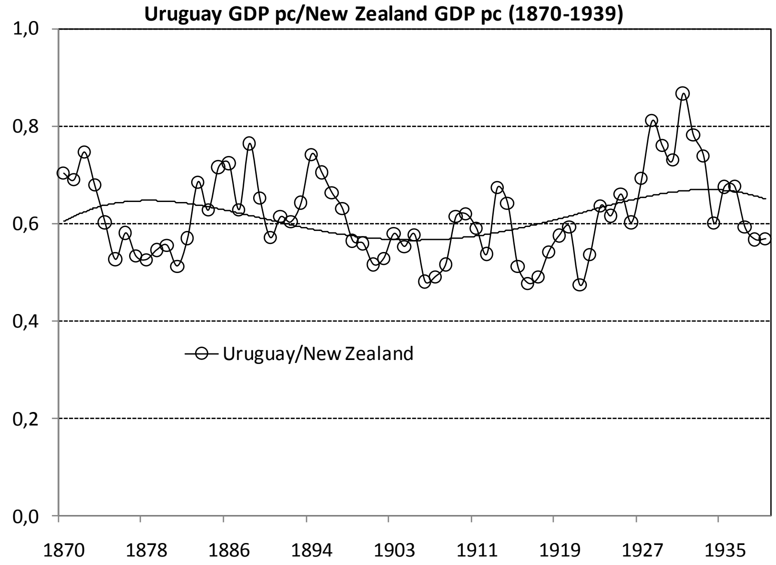


Source: Maddison (2001, 2003).

We consider this assertion and consider the economic performance of New Zealand and Uruguay. Effectively, both economies ended the 19th century with income levels very close to the "core" of the world economy (considering the average of UK, France and Germany's GDP per capita) but the direction of the gap is illustrative. Both economies were rich in relative terms but the differences in favour of New Zealand were huge (Figure 1).

Both economies experienced trajectories of strong expansion in the period but they did not mean a catching-up process within the "club" (see Figure 2). From 1870 to 1939, the Uruguay income per capita represented 62 per cent of the New Zealand's one (average) with an irregular trajectory and without a defined tendency.

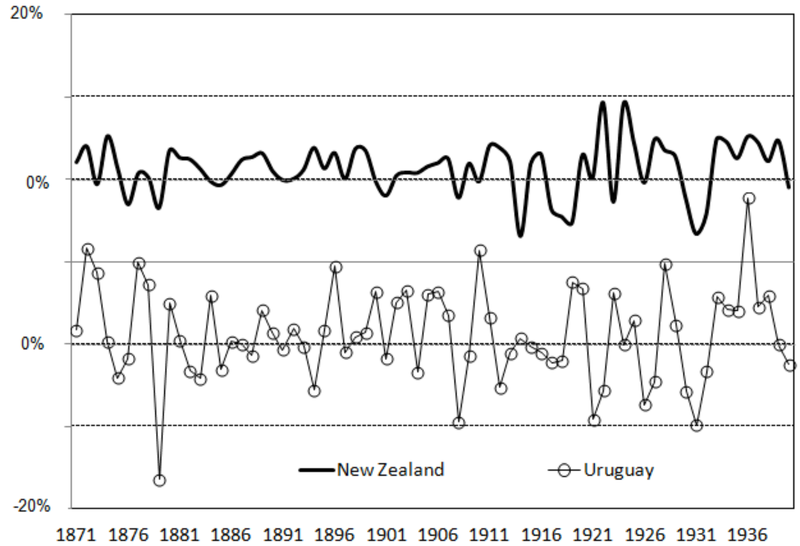
Figure 2
CATCHING-UP PROCESS WITHIN THE "CLUB": NEW ZEALAND AND URUGUAY
Uruguay GDP pc/New Zealand GDP pc (1870-1939)



Source: Maddison (2001, 2003).

In particular, the irregularity was one of the main features of the economic evolution of Uruguay (Bértola & Lorenzo, 2004) in the long-run. In Figure 3, we chart the annual GDP per capita growth rates for both economies and the differences in terms of variability are very significant.

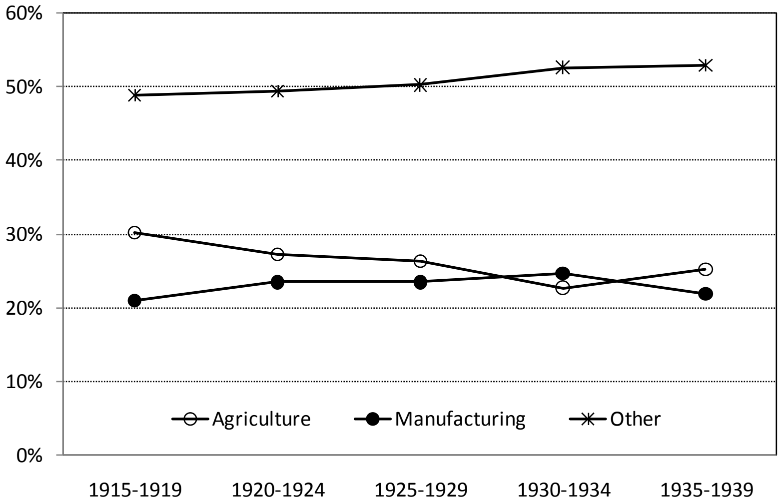
Figure 3
ANNUAL GROWTH OF INCOME PER CAPITA IN NEW ZEALAND AND URUGUAY
In percentage



Source: Maddison (2001, 2003).

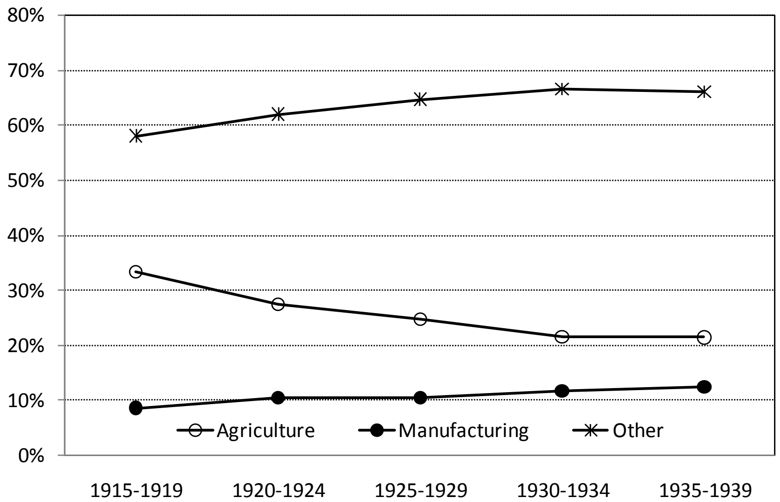
With regard to productive structure, both economies showed a high and decreasing share of agriculture value-added during the first decades of the 20th century with similar levels and dynamics. However, the main difference derived from the other activities. In particular, the manufacturing represented a marginal participation in the productive structure of Uruguay and, on the contrary, it signified a relevant activity in the New Zealander economy after the WWI (Figures 4 and 5).[4]

Figure 4
NEW ZEALAND: PRODCUTIVE STRUCTURE
Shares on total GDP, current prices



Source: Lineham (1968).

Figure 5
URUGUAY: PRODCUTIVE STRUCTURE
Shares on total GDP, current prices

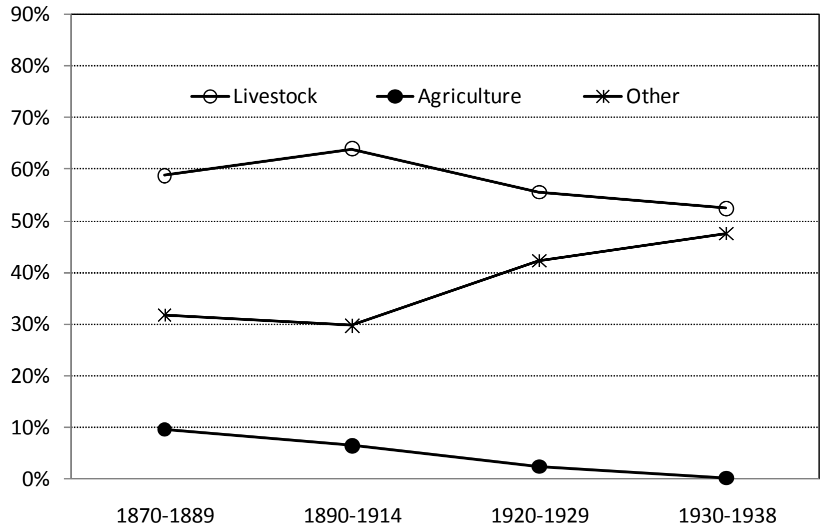


Source: Bértola (1998), Bertino & Tajam (1999), Bonino, Román & Willebald (2011).

[4] Strictly, our category "Other" corresponds to the rest of the sectors; by construction it can include a set of varied activities (not only services).

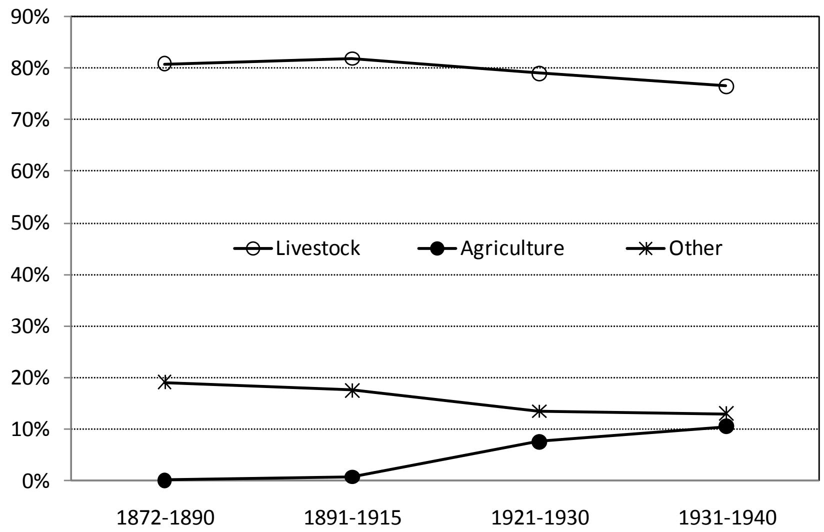
These features in the productive structure ran concurrently with the exporter structure. While in New Zealand the share of exported commodities different from livestock and agriculture goods increased from the end of 19th century, Uruguay intensified its dependence on primary products (see Figures 6 and 7).

Figure 6
NEW ZEALAND: TRADE STRUCTURE
Shares on total exports, current prices



Source: Willebald (2007).

Figure 7
URUGUAY: TRADE STRUCTURE
Shares on total exports, current prices



Source: Willebald (2007).

Therefore, within a similar development pattern, New Zealand constituted a richer and more diversified economy that, probably, presented more suitable conditions to face the structural change that rose with the change in the techno-economic paradigm of the 1920s.

2. Debate about different economic performances within the "club"

In recent literature, the discrepancies in terms of development within the "club" have been explained by the institutional matrix that produces a set of organizations, rights and privileges; the stability of the structure of exchange relationships in political and economic markets; and a state that provides (or not) a set of political rules and promote the enforcement of rights. In general, studies contrast the experience of Latin America vs. North America and they propose concepts as disorder vs. order in the economic change (North et al., 2000), the "South American way" (Landes, 1998, p. Ch. 20), cultural heritage (North, 2003) and different ways of organizing a society (a social order) identified with a "limited access order" (North et al., 2010). The application of these concepts to contrast the South American Southern Cone countries with the ex-English colonies is straightforward. Referred to Uruguay and New Zealand, some scholars demonstrate that the divergent path *"can be explained by the existence of different institutions governing the agricultural sectors of the [two] countries, which in turn generated different distributions of both land property rights and product shares in the agricultural sector"* (Álvarez et al., 2011, p. 165) (see, besides, Álvarez & Willebald, 2011). However, differences in terms of natural resources have presented scarce attention up to now. In some sense, this is the "natural" result of comparing economies that, precisely, define a "club" because they share the feature of abundant natural resources. Nevertheless, some exceptions can be mentioned.

On the one hand, Álvarez, et al. (2007), p. 12, state *"Australia, and to a lesser degree New Zealand, had a significant mining sector, and this meant more diversified exports and also a supply of raw materials and energy for the country's own industry. Mining explains why GDP per capita in Australia was initially so much higher than in Argentina (around 1880)."* (own translation). On the other hand, Willebald (2011) focuses on the different types of land to explain differential performances within the settler "club". That economy that expands its frontier by the best lands "received" the blessing of the abundance of natural resources in terms of growth, but faced the curse of a deeper worsening in the income distribution in the agriculture (Willebald, 2013).

Land quality determines, technically, the appropriability conditions of the natural resources, and the quality of the institutions (in terms of their capacity to moderate concentrated rent appropriation) conditioned the long-run performance of the period.[5] Our aim is to contribute in this line of research to find new elements in the comparative analysis of the "club" and the energy resources offer a good argument.

Bertoni (2011, p. 18) states *"Uruguay is a small country […and] it does not have very steep slopes to make possible waterfalls potentially usable to the energy generation. As agents chose this kind of generation, the required waterfall had to be created artificially. In addition, the territory has an extensive hydrographic system but the hydraulicity is random because the water caudal is consequence of an extremely irregular pluvial regime […]. The inexistence of fossil fuels completes a complex scene from the point of view of the natural resources related to energy supply"*. Was Uruguay damned by their (absence) of energy natural resources? Can this shortage contribute to explain, at least partially, the differential economic performance compared to New Zealand?

3. Framework and analytical strategy

After the outstanding articles of Sachs & Warner (1995, 2001), the studies that deal with the –sometimes paradoxical– inverse relationship between abundance of natural resources and economic growth have grown profusely and have been extended to other expressions of the development as inequality, specialization and well-being. However, the debate continues open.

Van der Ploeg (2011) presents a review of the recent debate and identifies eight arguments that support the curse of the natural resources hypothesis. First, the abundance of natural resources induces the real appreciation of the national currency, the decline of the tradable sectors, the expansion of non-tradable activities (deindustrialization) and the productive contraction after the initial boom (*Dutch disease*). Second, if it is the manufacture –and not the agriculture or the primary

[5] Denoon (1983), Dieguez (1969), Duncan & Fogarty (1984) and Platt & Di Tella (1985) suggest similar elements in their analyses of comparative development for some members of the club, but without stressing the point.

activities– the economic activity that generates processes of learning by doing and spill-over of human capital, the sudden windfalls of the natural resources that pressure on the “primarization” of the economy can affect the economic growth. Third, the “curse” is conditioned to the existence of weak institutional arrangements (in terms of the definition of property rights, contract enforcement, rule of law and maintenance of the reduced elite in the government) that complicate the economic development. Fourth, the empirically observed resource curse seems to be mostly driven by presidential countries and non-democratic regimes because these systems are less accountable and less representative and thus offer more scope for resource rent extraction. Fifth, usually, resource dependence elicits corruption and rent seeking via protection, exclusive licenses to exploit and export resources by the political elite, oligarchs and their partners to capture wealth and political power. It also crowds out social capital, erodes the legal system and elicits armed conflicts and civil wars. Sixth, the high volatility of the prices of the commodities can drive to sudden booms and busts that harm investment, exports and output. Seventh, the political economy of massive resource rents combined with badly defined property rights, imperfect markets and poorly functioning legal systems provide ideal opportunities for rent seeking behavior of producers, thus diverting resources away from more productive activities. Eighth, in general, a sudden resource bonanza tends to erode critical faculties of politicians and induce a false sense of security.

In spite of these considerations, it is the author by himself who argues about the conditionality of these relationships and the importance of not understanding the “curse” as an ineludible final. The variety of experiences seems to be more the norm that the exception and the experiences of Botswana, Norway or the Scandinavian and Southeastern countries are evidence of transforming the (supposed) curse in blessing. From the point of view of the Economic History these concerns acquire more relevance because the historical specificity of the curse –and the blessing– seems evident. Depending on the historical stage and the prevailing institutional and technical conditions the types and the quality of the natural resources probably had affected differently the economic development of countries and regions.

A possibility to represent this historical specificity of the role of the abundance of natural resources in the economic development is to propose concepts of the Neo-Schumpeterian and Evolutionist Schools. Perez (2002, 2009) identifies five technological revolutions and techno-economic paradigms in the world history of the last 250 years: the great British leap (the "Industrial Revolution" from the 1770s onwards), the Victorian Boom (the age of the steam and railways, from the 1830s onwards), the Belle Époque (the age of the steel, electricity and heavy engineering, from 1870s onwards), the Age of Oil, the Automobile and Mass production (from post WWI to seventies) and the current Information Technology Revolution. There is a time of widespread application of the new paradigm for innovation and growth across the whole economy and of spreading the social benefits much more widely while, at least partially, reversing the income polarisation of the "installation period". Investment is led by production capital, usually favoured by government policies and supported by a more regulated financial system. This period ends with the maturity of the technological revolution and its paradigm, the exhaustion of their potential for further innovation or productivity increases and the saturation of markets. All that sets the conditions for financial capital to look for other outlets, among which are the loans to faraway countries and the funding of new –potentially revolutionary– technologies.

However, the appearance of revolutionary new technologies will not automatically guarantee the adoption from branch to branch and on a world scale. Diffusion in the early phase demands a simple vehicle of propagation, accessible to millions of individual decision agents and coherent with their decision-making criteria. That vehicle is long-term cost effectiveness. Although many of the products of each technological revolution can be inaccessibly expensive at first, at the core of each of these great waves of innovation there is a key input, which is very cheap, offers to remain cheap and, in conjunction with a constellation of generic innovations, radically transforms the relative cost structure confronting entrepreneurs, managers and engineers. Precisely, steam applied to transport and electricity were two of the main key inputs of the techno-economic paradigm that dominated the economic evolution of the word economy during the second half of the 19th century and the First Globalization. Therefore, asking about the relationships between the abundance of natural capital and the types of natural resources that an economy possesses show how, potentially, economies are "prepared" for a new techno Argentina, Australia, Canada, Chile, New Zealand, South Africa, the US and Uruguay economic paradigm.

According to Smil (1994), p. 157, the access to fossil energy and electricity brought enormous advances in agriculture and fast growth to industrializing economies. But even if the productive specialization has been based on agriculture, this approach is applicable. As has noted by Smil (1994) p. 189 *"fossil fuel and electricity are essential inputs in modern farming"*. Additionally, it is necessary to consider the indirect energy costs of modern industrial food processing as packaging refrigeration, etc. (Smil, 2010, p.11). Certain economic activities need fossil fuels and/or electric power to develop all their potentialities and then technological change can lead to an energy constraint. Therefore coal, oil or hydro energy abundance could constitute a differential factor to explain the economic growth.

In sum, the access to modern energy is a condition to encourage the dynamic of the techno-economic process that prevailed from the middle of the 19th century and early decades of 20th century and our questions are summed up by the followings. Did our economies have similar conditions to face the new techno-economic paradigm? Were they prepared to generate energy in quantity and quality required by the economic process? Or, on the contrary, were their energy conditions a bound for economic development?

Considering the significant differences between New Zealand and Uruguay in terms of income level, welfare and productive diversification, and the importance of energy natural resources for the generation of abundant and cheap energy, our hypothesis is that New Zealand was more blessed than Uruguay in terms of energy resources and this would explain, at least partially, the discrepancies in terms of economic development. To test this hypothesis, our analytical strategy involves a descriptive and comparative analysis including two stages. Initially, we compare "natural endowments" to produce energy that, potentially, would imply counting with adequate conditions for taking advantage of the opening of a window of opportunity (Perez & Soete, 1988) related to a new techno-economic paradigm. Therefore, we consider a couple of main issues: (i) coal production; and (ii) suitable conditions to generate hydroelectric energy. The main consequence of these differences should be lower costs of generation and lower prices of energy in New Zealand than Uruguay. Then, our second analytical stage is to consider three topics to represent the main expressions of this process in terms of: (i) investment; (ii) operation costs; and (iii) prices for users, which represent the technological and market conditions prevailing.

The materialization of natural endowments in terms of economic development needs making a use of those resources, in suitable technological and market conditions, and to apply them conveniently to transform the productive potential in an effective output. The conformation of a "modern" productive structure requires the existence of enough energy sources, in competitive costs, opportunely exploited to generate higher incomes and increasing welfare. Considering the classical sectorial classification in agriculture, manufacturing and services we can select productive activities characterized by the high energetic use and deal with some of the main differences between countries in terms of: (i) dairy industry; (ii) metal products, engineering and transport equipment together with diverse manufacturing indicators; and (iii) railways.

Therefore, if (a) the conditions for facing the opportunity that represents a new techno-economic paradigm were clearly different and, simultaneously, (b) those representative industrial branches of high intensity in the energetic consumption present huge discrepancies between economies; we will conclude that the non-convergence is explained, at least partially, by a natural "blessing" in New Zealand that Uruguay never enjoyed.

4. Were energy natural resources different? A statistical appraisal

4.1. Coal

Shortage or abundance of certain natural resources can be considered a determinant for the adoption and diffusion of technology associated with the modern economic growth. Particularly, mineral fuel existence by using directly in economic activities or to electric power generation is a relevant resource in this matter, but the waterfalls constitute a determinant factor as well. In the period that we analyze both countries did not have availability of oil. The presence of coal reserves is the first difference in terms of the energy source endowments between New Zealand and Uruguay. Uruguay has no coal reserves. According to Oxman (1961, p.8) the country had only a few deposits of peat, a very poor fuel because it has low carbon content (from 45 per cent to 60 per cent comparing with lignite, the lowest rank of coal which possesses around 60-75 per cent). On the contrary, New Zealand had diverse types of coal and the reserves were estimated around to 2,400 million of tons in the early 20th century (Table 1).

Table 1
NEW ZEALAND COAL RESERVES ESTIMATED
ca. 1920

Class of Coal	**Proved** 1/ Imperial Tons	**Probable** 2/ Imperial Tons	**Possible** 3/
Anthracite	Very little	Very little	Small.
Bituminous	187,000,000	477,000,000	Moderate.
Semi-bituminous	68,000,000	196,000,000	Moderate.
Brown	194,000,000	728,000,000	Large.
Lignite	161,000,000	420,000,000	Large.
Totals	610,000,000	1,821,000,000	Large.

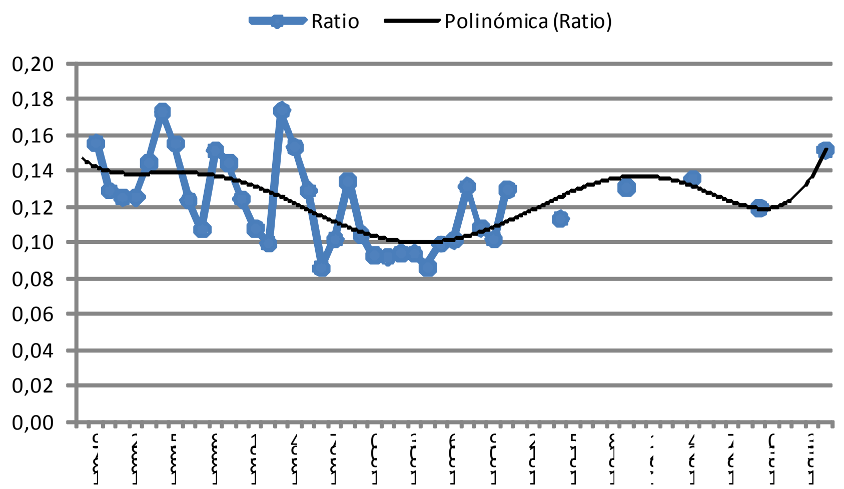
1/ Estimated quantity and grade of that part of coal for which the size, grade and distribution of values, together with technical and economic factors, are so well-established that there is the highest degree of confidence in the estimate. The term should be restricted to that part of a deposit being mined, or being developed and for which there is a mining plan.
2/ Estimated quantity and grade of that part of coal for which the economic viability has been demonstrated by adequate information on engineering, operating, and legal factors, at a confidence level that will allow positive decisions on major expenditures.
3/ Estimated quantity and grade of that part of an inferred reserve that are determined from limited sample data for which geology, grade continuity, and operating parameters are based, to a large extent, on reasonable extrapolations, assumptions, and interpretations.

Sources: New Zealand Official Yearbook (1919); Society of Petroleum Engineers (http://www.spe.org/)

Data about coal mining activity in New Zealand are available from 1867 onwards (Bloomfield, 1984, p.154) but it was just from 1878 when this activity evidenced a dynamic development. Between 1878 and 1910 the output of coal increased from 162.218 tons to 2.197.362 tons (New Zealand Official Yearbook, 1911), which meant an annual growth rate of 8.5 per cent but after WWI the industry maintained the production with oscillations. On the other hand, the import of coal increased dramatically from 232.400 tons on 1910 to 572.600 tons on 1925 (Bloomfield, 1984:201) to substitute the domestic production. However, in any case the coal produced into the country covered around 80 per cent of domestic demand. As consequence of this asymmetric energy endowment between Uruguay and New Zealand the coal consumption showed a dramatic gap (Figure 8). Along fifty years the coal consumption in Uruguay was located around 10-15 per cent of New Zealand's and this fact could explain the differential energy availability between countries. The persistence of this gap in favour of New Zealand suggests a structural feature.

All coal consumed in Uruguay was imported and therefore the availability was dependent on international prices and market situation, included the problems of provision in war times. If economic modernization including modern farming activities needed an increase of energy intensity then New Zealand had a clear advantage over Uruguay. The coal availability could encourage the industrialization process, to provide fuel to trains and to generate electricity.

Figure 8
Uruguay. Coal consumption ratio (New Zealand = 1)



Source: New Zealand Official Yearbook; Bertoni & Román (2013)

4.2. Hydroelectricity

Energy modernization process of the last decades of 19th and early 20th century implied the intensive introduction of electricity in diverse economic and social activities. The electric power diffusion and the heavy engineering application imposed a new pervasive techno economic paradigm (Freeman, 1989; Pérez, 1983). Since the 1880s, the technical system of the electricity challenged the coal and steam paradigm that had led the modern economic growth from the beginning of 19th century until then. The electric power offered the possibility to separate the production of goods from energy generation and allowed the expansion of the mechanization in new manufacturing branches.

Electric power is a secondary energy source, which means that we get it from the conversion of other primary sources of energy, and thermal and hydropower generation were the technological alternatives to produce electricity. Therefore, those countries with abundant coal, oil reserves or hydropower capacity had relative advantage to incorporate the new technical system[6] and, in consequence, to introduce themselves into the new techno economic paradigm. Bertoni (2002, p.41) estimated the per capita consumption of electric power in different small countries during the early decades of the 20th century. Table 2 shows the difference between New Zealand and Uruguay in three benchmarks (1913, 1920, and 1930). In the first year, the electricity consumption was similar in both countries but as we observe the following figures are clearly divergent.[7]

Table 2
ELECTRICITY CONSUMPTION PER CAPITA
In KWH

	1900	**1913**	**1920**	**1930**
NORWAY	20	765	1386	2290
SWIZERLAND	52	352	614	1085
SWEEDEN	18	219	377	710
BELGIUM		146	139	452
NEW ZEALAND		**14**	**80**	**417**
FINLAND	5	51	78	298
DENMARK		29	69	139
URUGUAY	**2**	**17**	**33**	**70**

Source: Bertoni (2002:41) Cuadro Nº IV.3.

[6] As stated Myllyntaus (1999, p. 94): "In the early twentieth century, contemporaries had already observed that countries with considerable hydropower resources tended to have more electricity to consume than other countries".
[7] In 1920, the ratio between both indicators was 2.4 in favour of New Zealand and it increased until 6 in 1930.

By 1930 both countries showed very different degree of development of hydroelectricity power. As New Zealand had already built several hydroelectric dams, Uruguay did not have anyone. We consider that this disparity responded to different hydropower potential.

Hydroelectric energy is produced by the force of falling water. Production of this energy is dependent on both the available flow and the height from which it falls. Water represents potential energy when it is accumulated behind a high dam. It is transformed into mechanical energy when the water rushes down the sluice and strikes the rotary blades of a turbine. The amount of electricity which can be generated at a hydroelectric plant is dependent upon two factors: (i) the vertical distance that the water covers when it falls, which it is called the "head"; and (ii) the flow rate (measured as a volume per unit of time). In absence of historical statistics to estimate the hydropower according to these criteria, we can use as indirect evidence the topography characteristics and quantity and regularity of rain.

Uruguay has a dense hydrographic network with two main rivers: Uruguay and Negro. The former is the border with Argentina so its potential hydropower is shared between both countries. The river Negro is, unquestionably, the most voluminous flow of water which irrigates the country; it runs from east to west and “cuts” the country in two regions (south and north). Low hills and broad grassland are topographic characteristics of Uruguay and as consequence the caudal of the flows of water is closely related with rainfalls. In general, rainfalls are abundant but they are irregularly distributed along the year and even between years; we can observe years with heavy rainfalls and others with scarce precipitations (it is not strange that large regions of country suffer important droughts). Absence of natural lakes and high elevations allow an easy displacement of rainfall water and this creates uneven conditions to storage it. Therefore, investment in hydroelectric plants must create these conditions, with high costs, and the history of sector always showed the necessity of thermal plants as backup power (see Figure 1, Panel A).

On the contrary, in New Zealand, the generous reserve of water-power is obviously a result of the topography and rainfalls. A large proportion of the country is mountainous and much of the mountain area is high (Ogilvie Buchanan, 1930, pp. 444-

446). New Zealand presents a high degree of regularity of rainfall and river flows and, in addition, lakes –the best natural regulator of river flow– are numerous and many of them are of considerable size (Ogilvie Buchanan, 1930:449)[8] (see Figure 1, Panel B).

Figure 1

Panel A. Uruguay: Rincón del Bonete

Rincón del Bonete. Emplazamiento general. Iniciación de los trabajos en la margen derecha.

Source: http://cw5o.cx.uy/?4,2

[8] According to Te Ara-The Encyclopedia of New Zealand, *"New Zealand is a land of lakes… Excluding offshore islands, New Zealand has 775 lakes… Lakes cover about 1.3 per cent of the land area"* (http://www.teara.govt.nz/en/lakes).

Panel B. New Zealand: Lake Coleridge Power Station

The Lake Coleridge Hydro-Electric Plant, showing the Rakaia River, Tail Race, Power House and Pipe Lines.
(65 miles west of Christchurch)

Source:http://ketechristchurch.peoplesnetworknz.info/site/images/show/1742-lake-coleridge-power-station#.U4eAdCh2AdU

Source: http://www.ipenz.org.nz/heritage/itemdetail.cfm?itemid=2407

Like the topographic factors are a static condition we start the exploration of the incidence of hydropower endowment on economic development comparing the rainfalls in both countries.

Table 3 shows the average annual rainfall in Uruguay and New Zealand in the first decades of the 20th century. Here we can observe two important differences. On the one hand, Uruguay had lower and more irregular rainfalls than New Zealand along the period. In average, the precipitations were between 25 and 30 per cent lower and the standard deviation (an indicator of variability) was five times greater in Uruguay than in New Zealand.

Table 3
URUGUAY AND NEW ZEALAND: AVERAGE RAINFALL
In mm

	Uruguay	**New Zealand**
Years	**mm**	**mm**
1901	727.8	1,388.7
1902	928.7	1,289.8
1903	977.6	1,403.9
1904	742.8	1,591.9
1905	756.6	1,199.1
1906	638.9	1,165.2
1907	550.5	1,309.3
1908	920.2	1,157.5
1909	868.3	1,317.3
1910	676.9	1,241.4
1911	1,271.0	1,224.9
1912	1,496.8	1,216.9
1913	1,075.2	1,216.9
1914	2,399.7	1,216.9
1915	1,068.5	1,118.4
1916	574.4	1,138.0
1917	706.6	1,259.4
1918	856.3	1,294.0
1919	1,207.0	1,278.8
Average		
1901-1915	**1,006.6**	**1,270.5**
1901-1919	**970.7**	**1,264.7**

Uruguay			
Standard deviation		Variation coefficient	
1901-1915	459.40	**1901-1915**	45.6
1901-1919	426.21	**1901-1919**	43.9

New Zealand			
Standard deviation		Variation coefficient	
1901-1915	120.35	**1901-1915**	9.5
1901-1919	110.66	**1901-1919**	8.8

Note: New Zealand 1912-14: average ten years.

Sources: Uruguay: Dirección General de Estadística (1921) "Anuario Estadístico 1919". Montevideo.
New Zealand: The New Zealand Official Year book (several years).

The absence of natural lakes in Uruguay induces higher difficulties to manage the irregular rainfalls and imposes the necessity to build artificial lakes to storage water, and the contemporaneous people were aware of the dimension of the problems. By 1925 the Uruguayan technicians said that to build a hydroelectric plant in the river Negro would imply the creation of "the largest artificial lake of world".[9]

If we accept that hydroelectric power has a close relationship with the rainfalls, New Zealand would have had a clear potential advantage respect to Uruguay. Ogilvie Buchanan (1930) offers an extraordinary overview about the potential hydropower in New Zealand in the second decade of 20th century. For Uruguay, Oxman (1961) offers a similar picture to the 1950s. From the information provided by both authors we propose a comparison of the hydropower potential and the information is presented in Table 4 (see detailed data in Table 5).

We can observe that New Zealand had twice the hydroelectric potential than Uruguay in its territory. This figure represents the nominal potential energy not taking into account the effect of irregular rainfall that we consider before. Further the topographic characteristics in Uruguay did more expensive the works in hydroelectric plants in Uruguay.

Table 4
POTENTIAL HYDROPOWER IN NEW ZEALAND AND URUGUAY
In MW

Uruguay		New Zealand	
Río Negro	493	North Island	475
Río Uruguay	700	South Island	2.088
Other sites	39		
	1.232	TOTAL	**2.563**

Sources: Ogilvie Buchanan (1930) and Oxman (1960).

[9] See, for instance, Libro del Centenario (1925):266.

Table 5

POTENTIAL HYDROPOWER SITES IN NEW ZEALAND AND URUGUAY

Uruguay		**New Zealand**		
Location	**KW**	**Location**	**HP**	**KW**
Río Uruguay – Salto Grande (Ayuí)	1,400,000	**North Island**		
Río Queguay (Barra Viraró)	15,000	Kaituna	65,000	48,490
Aº Cuñapirú (Los Cuervos)	10,000	Horahora	15,000	11,190
Río Negro (Rincón del Bonete)	128,000	Wairoa	4,200	3,133
Río Negro (Baygorria)	105,000	Arapuni	163,000	121,598
Río Negro (Paso del Puerto)	140,000	Aratiatia	136,000	101,456
Río Negro (Yapeyú)	120,000	Waikaremoana	129,000	96,234
Río San Salvador	910	Tariki	26,000	19,396
Río Santa Lucía (Piedra Alta)	1,360	Makohini	75,000	55,950
Río Tacuarí (La Cachoeira)	2,500	Mangahao	24,000	17,904
Río Cebollatí (Sierra del Tigre)	9,000	**South Island**		
	1,931,770	Rotoroa	60,000	44,760
Salto Grande (only 50 per cent) 1/	-700,000	Clarence	100,000	74,600
	1,231,770	Waimakariri	30,000	22,380
		L. Coleridge	81,000	60,426
		L. Tekapo	400,000	298,400
		L. Pukaki	50,000	37,300
		Kurow	37,000	27,602
		Teviot	30,000	22,380
		Waipori	26,800	19,993
		L. Aunoto	100,000	74,600
		L. Monowai	16,000	11,936
		L. Hall	48,000	35,808
		L. Hilda	55,000	41,030
		L. Manapouri	840,000	626,640
		L. Te Anau	600,000	447,600
		L. Hawea	80,000	59,680
		L. Ohau	125,000	93,250
		Wataroa	80,000	59,680
		Wanganui	40,000	29,840
			3,436,000	**2,563,256**

1/ Only 50 per cent because Salto Grande is on River Uruguay and the power station is a shared with Argentina.
Fuente: Oxman. R. (1960:53)

Source: Ogilvie Buchanan. R.(1930): "Hydro-Electric Power Development in New Zealand". *The Geographical Journal*. Vol. 75. No. 5 (May. 1930). pp. 444-457.

5. Were technological and market conditions different? Investment, operation costs and prices

The materialization of the natural endowments in terms of economic development needs making a use of those resources, in suitable technological and market conditions, and to apply them conveniently to transform the productive potential in an effective output. How were these technological and market conditions in both countries?

To answer this question we consider three main issues that represent costs and prices related with the generation and consumption of electric energy: (i) investment; (ii) operation costs; and (iii) prices for users, which represent the technological and market conditions prevailing in each economy. We propose comparisons for years with equivalent information in both countries and elaborate indicators to contrast specific aspect related with the generation and consumption of electric energy (Table 6).

Table 6

Technological and market energy conditions

In Uruguayan pesos ($)

	New Zeland	**Uruguay**
Capital_Hydro-electric power station	**1918**	**1923**
Capital expediture ($)	3,953,340	15,000,000
Installed HP (number)	24,000	32,000
Capital per installed HP ($)	165	469
Capital_Thermal power station	**1911**	**1912**
Capital expediture ($)	628,683	1,550,503
Installed HP (number)	8,080	15,694
Capital per installed HP ($)	78	99
Operation costs	**1911**	**1912**
Expenditure ($)	298,999	537,380
Generated KWH (number)	18,392,733	16,281,410
Cost of generation per KWH ($)	0.016	0.033
Prices	**1912**	**1912**
Retail rates by category:		
Lighting ($/KW)	0.059	0.120
Power and heating ($/KW)	0.014	0.051

5.1 Investment to the generation of electricity

Electricity generation result from diverse sources of primary energy conversion and it implies transmission and distribution networks' construction to arrive at consumers.

Endowment, technology and economic and institutional factors determine the cost of installation but beyond these conditions, generation always requires important investments.

Uruguay did not have generation of hydroelectricity until 1945 but the studies about the possibility began early in the 20th century. Then we found appraisals of investment requirements to build hydroelectric stations and we use this information to compare these preliminary conditions with investments in equivalent plants in New Zealand effectively built. Thus we define the capital necessary for hydro-electric power plant as that investment amount to install hydroelectricity in terms of monetary unit per installed power (Table 6, first panel).

As we assume that generation technology was standardized, the main reason to explain the differences in investment would be associated with civil works necessary to create falling water in Uruguay. In fact, historical sources indicate that it was necessary building a wall with a length of 1.4 kilometres to obtain a fall of 20 meters.[10] An additional factor is the distance to transport electricity from the power station to consumers. We observe that in New Zealand the average distance was one a half of Uruguayan mean. In consequence, we find greater sunk costs in Uruguay than New Zealand in terms of power lines, which add to higher investments for generation.[11]

As in the previous section we present natural condition differences between New Zealand and Uruguay in terms of hydroelectric potential, now we base exclusively on technical factors to find that investment for generating hydroelectricity is three times more expensive in Uruguay than New Zealand.

Finally, both countries had thermal electric power around 1911-1912 and we compare effective investment completed to generate electricity by steam technology. Capital thermal-power station refers to installation cost (Table 6, second panel). Information reveals that thermal plants were cheaper than hydroelectric one.[12] This is more important in Uruguay, where the opportunity cost to build hydro-plant was five

[10] Libro del Centenario (1925), p. 267.
[11] Average distance from plant to consumers in North Island was 141 km and 127 km in South Island while in Uruguay it was 270 km.
[12] Estimation are consistent with those reported by contemporary New Zealand; see: (http://atojs.natlib.govt.nz/cgi-bin/atojs?a=d&d=AJHR1904-I.2.2.2.2&e=-------10--1-----..-0--).

times higher it may explain the lag to incorporate this technology of generation in the energy matrix. In comparative sense, the small differential –around 25%– is explained by mature character of technology used in both countries however New Zealand again shows advantage over Uruguay.

5.2 Operation costs for the generation of electricity

Initially, these discrepancies in the capital expenditure can explain differences in the operation costs but this depends on the production efficiency. The cost of a kilowatt per hour (KWH) can be interpreted as a measure of these differences and we calculate this indicator in both countries including generation, distribution, management and other expenses.[13]

In NZ the cost corresponds to all the electric current system, including thermal and hydroelectric generation because we are interested in welfare (the costs that will determine the consumption price). In the case of Uruguay, we consider the operation costs of the larger thermal power station, localized in Montevideo (very close to the port and, in consequence, with the lower transport cost of the main input; which is coal or fuel oil) and probably the most efficient plant. In this sense our comparison considers the best case of Uruguay –in terms of operation costs– with the average of New Zealand.

In Table 6 we present the total KWH generated in each country (1911 for New Zealand and 1912 for Uruguay) and the total operation costs related with these generations. The cost per KWH in New Zealand is a half of that corresponding to Uruguayan power station. Theoretically, it is reasonable waiting for similar differences in the final prices.

5.3 Use and prices of electricity

The final use of energy is applied for residential and industrial consumption and, in consequence, we can represent welfare and productive conditions. With this objective, we consider retail rates ($/KW) for two categories: lighting and power and heating. Our initial expectation is fulfilled (see Table 6, the last panel).

[13] We exclude capital expenses as interest and sinking fund, depreciation and reserve fund.

The retail rate for lighting is, as before, 50 per cent cheaper in New Zealand than in Uruguay but the power and heating final price is a quarter of that paid in Uruguay. In other words, a typical consumer in New Zealand faced lower retail rates but the producers dealt with comparative rates still lower.

6. Was the productive structure different? Differences in energy intensity

It is possible to identify different sectorial intensities in the use of energy. The conformation of a "modern" productive structure requires the existence of enough energy sources, in competitive costs, to justify the exploitation of the corresponding natural resources. Considering the classical sectorial classification in agriculture, manufacturing and services we can select productive activities characterized by the high energetic use. We decide on dairy industry; metal products, engineering and transport equipment together (with diverse manufacturing indicators); and railways, as representative industrial branches of high intensity in the energetic consumption.

Since the early 1800s the dairy industry in New Zealand has gone from farmers keeping a few domestic cows on bush blocks to being a world leader nowadays (Stringleman & Scrimgeour, 2012). However, an in spite of counting with (apparent) similar natural resources, the development of that activity was late in Uruguay (Bertino & Tajam, 2000) and it was not until the 1960s that we can identify a real dairy area where farming and manufacture worked articulately. Table 7 offers an overview of the dairy industry in the eve of the First War World. The differences in favour of New Zealand were enormous.

In New Zealand, with five times the number of milking cows of Uruguay, the producers obtained almost three times more litres per cow than in Uruguay. These differences expand in the manufacturing stage where the production of cheese in New Zealand multiplies per ten and of butter per 172, and they replicate in trade matter because the exports of milking products in Uruguay were marginal in the period.[14] The fact of the higher differences correspond to the butter production is symptomatic of the huge difference in terms of the use of energy. Butter production relies on the

[14] Even Uruguay had to import butterfat from Argentina during many years because the domestic production resulted insufficient to cover the internal demand (Bertino & Tajam, 2000).

existence of an effective cold chain from the farming to the manufacturing, packing and storing and this process uses energy intensively.

Table 7
DAIRYNG INDICATORS
ca. First War World

		New Zealand		Uruguay	
Milking output					
Milking cows		1911	634,000	1913	131,031
Total litres		1917	1,821,579,117	1913	124,298,091
Yield per cow/day 1/		1917	9.5	1913	3.4
Dairyng produce					
Butter					
	Output (tons)	1908	20,099	1908	117
	Factories	1908	196	1908	15
Cheese					
	Output (tons)	1908	15,763	1908	1,738
	Factories	1908	147	1908	124
Dairyng exports					
Butter					
	Output (tons)	1908	11,683	1908	22
Cheese					
	Output (tons)	1908	14,265	1908	50

Source: see Appendix 2.

In the long run, both economies have been characterized by a clear primary specialization based on the exploitation of natural resources. However, New Zealand advanced more early in the industrialization process and evidenced signs of structural change from the begging of the 20th century (Willebald, 2013). In the eve of the WWI, industrial branches typically characterized by the high use of energy as metal products, engineering and transport equipment represented the 15 per cent of the total manufacturing value-added (Rankin, 1991).[15] By contrast, even in the mid-1930s, these branches had not achieved that level in Uruguay (12 per cent in 1936). These differences had clear expressions in the installed capacity of the manufacture (see Table 8).

[15] Average 1910-1915.

Table 8
MOTIVE POWER EMPLOYED IN MANUFACTURING

Country	Year	Number of Works 1/	Steam	Water	Gas	Oil	Horse	Hand	Electricity	Total	Amount of Horse-power
			Number of Engines, &c., driven by:								
New Zealand	1910	3,519	2,218	229	853	231	4	61	1,084	4,680	99,959
New Zealand	1900	3,163	1,359	216	400	31	72	0	15	2,093	39,052
Uruguay	1908	3,435	890	50	138				104	1,182	34,510

		Engines/ Worker	HPower/W orker
New Zealand	1910	1.3	28.4
New Zealand	1900	0.7	12.3
Uruguay	1908	0.3	10.0

1/ It refers to the number of establishments.
Source: see Appendix 2.

With a similar number of works –3,519 in New Zealand (1910) and 3,435 in Uruguay (1908)– New Zealand tripled the amount of horse-power. This discrepancy means that the New Zealander manufacture had 1.3 engines by work against only 0.3 in Uruguay and 28.3 HP per productive unity against 10 in Uruguay. Evidently, the use of energy in the Uruguayan manufacturing was clearly lower.

Table 9
RAILWAYS INDICATORS
Data corresponding to 1913 1/

	New Zealand	Uruguay	NZ/Uy
Length			
Km	4,593	2,536	1.81
Km/000 pop	4.1	2.2	1.90
Km/Km2	0.017	0.014	1.18
Rolling-stock 2/			
Locomotives	534	179	2.99
Passenger Vehicles	1,363	159	8.60
Trucks and Vans	20,251	3,472	5.83
Goods and livestock traffic			
Tonnes	6,346,066	1,432,590	4.43
Tonnes/km	1,382	565	2.45
Tonnes/Truck	313	413	0.76

1/ New Zealand: 1913; Uruguay: avg. 1912-1913, 1913-1914.
2/ Number of vehicles.
Source: see Appendix 2.

Finally, New Zealand presented a more developed railways system (see Table 9). The length of the rails almost doubled the Uruguayan one and the use of the infrastructure was clearly higher. The quantity of locomotives was 534 in 1913 and only 179 in Uruguay and this difference multiplied in terms of vehicles and trucks. The result was to fright four times the cargo of Uruguay and with a more intensive use of the rails (1,382 tonnes/km/year against only 565). In contrast, the railways in Uruguay had to use more intensively each truck, probably inducing inefficiencies and excessive wearing out.

7. Final remarks and next steps

Settler economies are characterized for the abundance of natural resources. However, natural capital is not homogeneous between countries and it can induce different consequences in terms of growth, income levels and productive structure.

Literature about economic development of settler economies that identifies differences within the "club" with disparities in terms of natural resources is very scarce. Despite many similarities between New Zealand and Uruguay –referred to productive structure, the dynamics in the flows of productive factors and the modality of participation in international markets– both countries presented, during the 19th century and the first decades of the 20th century, significant differences in income per capita levels. Consequently, we need to study other spheres of economic system to find new answers in this matter. We look for diversities in energy natural endowments (basically coal endowments and suitable conditions for hydroelectric generation) to explain different development levels between both economies.

We discuss the effect of natural resources on economic performance in terms of the debate about the "curse" (and the "blessing") of the natural resources hypothesis. We focus our analysis on a couple of small economies –New Zealand and Uruguay– that make up the group of economies of recent European settlement (settler economies) and we consider, specifically, the energy natural resources. We use concepts derived from the Neo-Schumpeterian and Evolutionist Schools to incorporate one of the main constraint of that approach represented by the absence of historical specificity. We consider the concept of technoeconomic paradigm to overcome this weakness and regard the idea of "key factor" as a main analytical category.

According to our analysis, the discrepancies in favour of New Zealand to produce coal and natural conditions to generate electric energy with low costs –and offering energy in low prices– explain those differences. New Zealand's advantage in energy endowments would explain –at least partially– the development of a dairy sector, certain energy intensive manufactures and a more efficient use of railways. Our findings support the hypotheses that propose the relevance of having a significant mining sector to understand the differential development between Australasia and the River Plate, the importance to consider the different quality of the natural resources and, finally, the significance to incorporate geographical and climatic conditions to explain the energy dependence of Uruguay.

We insist with the partial character of our study because we propose to concentrate our considerations only on those "key factors" that proposes the Neo-Schumpterian analysis. In next stages of the research we will complement our proposal with some topics related to the institutional arrangements that dealt with the conformation and use of the energy systems in both countries. In particular, two issues are particularly relevant in this respect. On the one hand, we will ask about the participation of the state in the exploitation and in the use of energy sources and, basically, in the types of properties that characterized the system. On the other hand, we will study the entrepreneurship organization in the side production to evaluate how relevant were different types of productive organizations to achieve scale economies and generate spill-over effects (basically the contrast between cooperative and capitalist organizations).

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Appendix 1: Technological and market indicators

1. Capital of hydro-electric power station

Capital expenditure considers investment in land, buildings, machinery, plant, main transmission-lines, interest and amortization expenses and the assistance to local authorities and power-users (included land expropriation) in the year of the beginning of operations estimated for the creation of a complete electrical scheme. The transmission line distance to the nearest city is the average of the corresponding positions of powerhouses weighted by installed capacity (HP).

New Zealand 1918

It corresponds to the estimations of Mr. Evan Parry (NZ Yearbook, 1920) about Mangahao generating-station with a plant capacity of 24,000 hp.

Uruguay 1923

It corresponds to the estimations of Ing. J. T. Case (Ulem & Co) (Libro del Centenario, 1925, p. 267-268) about Rincón de González generating-station (on Río Negro) with a plant capacity of 32,000 hp.

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EL LIBRO DEL CENTENARIO DEL URUGUAY, 1825-1925 (1925). Montevideo, p. 267.

2. Capital of thermal power station

New Zealand 1911

Census 1911 informs about the total capital expenditure (land, buildings, machinery and plant) for electric generation and the total horsepower installed in steam stations. We use the technical coefficient presented in Appendix to the Journals of the House of Representatives (1904) to estimate the capital corresponding to steam generation. According to this publication, the cost of steam plant would be approximately about half of the hydraulic plant therefore we consider that the total capital of the electric system is distributed a third for steam and two third for hydro.

Uruguay 1912

Administración de las Usinas Eléctricas del Estado (UEE) is a state enterprise with the monopoly of the generation, transmission and distribution of electricity from 1912 onwards. The activity report (Memoria) corresponding to 1912 informs about capital expenditure of the Usina Eléctrica de Montevideo (Montevideo electrical power station) and the horsepower installed.

ADMINISTRACIÓN DE LAS USINAS ELÉCTRICAS DEL ESTADO (1914): Memoria. Ejercicios 1911-1912 y 1912-13. Montevideo, Balance General en 30 de Junio de 1912, p. 9; Información General sobre el Desarrollo de los distintos Servicios, Table, p. 58; Gastos en el Ejercicio 1911-1912, p. 55; K.W.H. producidos, perdidos y consumidos y porcentaje de pérdida, p. 43; Información General sobre el Desarrollo de los distintos Servicios, Table, p. 41.

CENSUS AND STATISTICS OFFICE OF THE DOMINION OF NEW ZEALAND (1911): *Results of Census of Population and Dwellings Dominion of New Zealand*. Wellington, Electric Current, Table XXIX, (http://www3.stats.govt.nz/historic_publications/1911-census/1911-results-census.html#d50e621202).

THE JOURNALS OF THE HOUSE OF REPRESENTATIVES (1904): Session I, D-01a, Appendix, p. 35 (http://atojs.natlib.govt.nz/cgi-bin/atojs?a=d&d=AJHR1904-I.2.2.2.2&e=-------10--1-----..-0--)

3. Operation costs

Operation costs refer to complete electrical system (steam and hydro power) including generation, distribution, management and other expenses (excluding capital expenses as interest and sinking fund, depreciation and reserve fund).

New Zealand 1911

Census 1911 informs about the total expenditure by this concept and the generated KWH.

Uruguay 1912

The activity report (Memoria) of UEE informs about operation costs corresponding to the Gastos en el Ejercicio 1911-1912 (p. 55) and the generated KWH (p.43).

4. Prices

We consider prices corresponding to individual power station and representative of the price paid by consumers in big localities (more than 50,000 served persons).
It refers to the number of establishments

New Zealand 1912

NZ Yearbook (1913) informs about retail rates charged for particular lighting and power, heating and tramway purposes corresponding to Dunedin power station.

Uruguay 1912

The activity report (Memoria) of UEE informs about retail rates charged for particular lighting and motive power corresponding to the Usina Eléctrica de Montevideo (Montevideo electrical power station).

CENSUS AND STATISTICS OFFICE OF THE DOMINION OF NEW ZEALAND: *The New Zealand Official Year-Book 1913*. Wellington. Section XIII. Mining, Water-power (http://www3.stats.govt.nz/New_Zealand_Official_Yearbooks/1913/NZOYB_1913.html#idsect1_1_181531).

5. Exchange rate

Exchange rate Uruguayan pesos per Sterling Pound from Uruguayan Yearbooks corresponding to Montevideo Stock market.

URUGUAY. DIRECCIÓN GENERAL DE ESTADÍSTICA (several years). *Anuario Estadístico*. Montevideo.

Appendix 2: Productive structure indicators

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