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Biomass Energies in Industrializing Catalonia:

The Changing Role of Firewood and Charcoal in the City and Province of Barcelona (1780-1960)

Marc Maynou Felker

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Director: Iñaki Iriarte Goñi

Director: Enric Tello Aragay

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Abstract

There is a debate in the international literature between two differing conceptions of the Energy Transition: the so-called «energy ladder approach», according to which societies transit from qualitatively inferior forms of energy to superior forms as their income increases, versus the energy aggregate or «energy stacker», in which the consumption of fossil energies is added to that of organic energy sources regardless of changes in income. Our objective is to ascertain which is the dynamic which better reflects Barcelona's trends of consumption during its industrialization. Although there are many studies on the perspective of energy in general, research on biofuel consumption seems lacking in this particular case study. When we look for sources to undertake that particular approximation, we find that few documents point to the quantities of biofuels consumed; however, there are records of both the quantities which entered the city and the prices of these commodities. Therefore, we combine both sources of information to generate a set of estimation of consumption rates through time, thus analysing the pace and intensity of the Energy Transition. We then present several insights on the changing nature of supply, demand and their spatial relationship. Our main conclusions are the following: first, that the historical experience of Barcelona is better explained by the Energy Stacker Model than by the Energy Ladder Approach, although dynamics characteristic to both models are present. Second, in Barcelona's context energy consumption was not only determined by supply and demand of energy carriers, but by the availability of the necessary energy converters too.

Abstracte

Hi ha un debat a la literatura internacional entre dues concepcions de la Transició Energètica: l'anomenada «visió escalar»de la transició, segons la qual les societats transiten des de fonts d'energia qualitativament inferiors cap a formes superiors a mesura que la seva renda incrementa, versus la «visió additiva o agregada», segons la qual el consum d'energies modernes s'afegeix al de les energies orgàniques tradicionals. El nostre objectiu és dirimir quin d'aquests models explica millor el cas de Barcelona durant la seva industrialització. Tot i que hi ha molts estudis sobre el consum d'energies en general, no n'hi ha sobre els combustibles basats en la biomassa des d'aquesta perspectiva. Hi ha poques fonts que permetin un tractament adequat del problema, especialment pel que fa al tema del consum; tanmateix, hi ha algunes fonts registrant les quantitats entrades a la ciutat de Barcelona, així com dels preus que s'en pagaven. Així doncs, combinem ambdós tipus de fonts per a generar un conjunt d'estimacions de consum a través del temps, analitzant així el ritme i la intensitat de la Transició Energètica. Posteriorment, presentem algunes aproximacions respecte a la natura cambiant de l'oferta, la demanda i la seva relació espacial. Les nostres conclusions són dues: primer, que *l'experiència històrica de Barcelona s'explica millor segons la visió agregada de la Transició Energètica que no pas segons la visió escalar, encara que hi ha dinàmiques característiques d'ambdós models. Segon, que en el context de Barcelona el consum d'energies no només estava determinat per l'oferta i la demanda dels portadors d'energia, sinó també pels convertidors d'energia necessaris per a consumir-la.*

Abstracto

Existe un debate en la literatura internacional entre dos concepciones de la Transición Energética: la llamada "visión escalar" de la transición, según la cual las sociedades transitan des de formas de energía cualitativamente inferiores hacia formas superiores a medida que la renta incrementa, versus la "visión aditiva o agregada", según la cual el consumo de energías modernas se añade al de las energías orgánicas tradicionales. Nuestro objetivo es dirimir cuál de estos modelos explica mejor el caso de Barcelona durante su industrialización. Aunque haya estudios sobre el consumo de energías en general, no existen estudios específicos sobre los combustibles basados en la biomasa desde esta perspectiva. Existen pocas fuentes que permitan un tratamiento adecuado del problema, especialmente con relación al consumo; empero, hay fuentes que registran las cantidades entradas a la ciudad de Barcelona, así como los precios pagados. Así pues, combinamos ambos tipos de fuentes para generar un conjunto de estimaciones de consumo a través del tiempo, analizando así el ritmo y la intensidad de la Transición Energética. Posteriormente, presentamos algunas aproximaciones respecto la naturaleza cambiante de la oferta, la demanda, y su relación espacial. Nuestras conclusiones principales son dos: primero, que la experiencia histórica de Barcelona se explica mejor desde la visión agregada de la Transición Energética que desde la visión escalar, aunque existan dinámicas características de ambos modelos. Segundo, que en el contexto de Barcelona, el consumo de energías no sólo estuvo determinado por la oferta y la demanda de los portadores de energía, sino también por los conversores de energía necesarios para su consumo.

Acknowledgments

First and foremost, I would like to thank my esteemed supervisors, Dr. Iñaki Iriarte and Dr. Enric Tello, for their continued support, good advice, and –especially– their outstanding patience during this long journey. It is no understatement to affirm that this wouldn't have been possible without you, and I will be eternally grateful for your help and assistance.

This work has been carried out with the support of an ADR predoc grant of the University of Barcelona. I would like to thank the Arxiu Històric de la Diputació de Barcelona for granting us access to the various documents, both in their physical and digital form, which we used to construct the BOPB series, as well as the personnel of the Faculty of Economics and Business Archive at UB for their help in browsing its contents, especially at the time of the pandemic. I would also like to express my sincere thanks to the members of the Department of Economic History, Institutions, Politics and World Economy, who have collectively introduced me to the discipline of Economic History. Additionally, I would like to thank all the members of the Sustainable Farm Systems project, as they have shown me both the intricacies and the potential of Environmental History.

Querría también dedicar unas líneas para los compañeros del Programa de Máster en Historia Económica, así como del programa de Doctorado: tanto para los que aún andan por el Departamento como para los que hace tiempo que partieron a destinos remotos del globo. Las charlas, discusiones, y las bromas han hecho mucho más interesante y amena nuestra vida cuotidiana de doctorandos, y he aprendido mucho de todos vostros. És moment també de dedicar un agraïment als companys valencians, que de conèixer-nos al Màster vam anar a viure junts; no puc deixar-me tampoc d'esmentar la colleta de gentilhòmens que vam crear i que tantes discussions –en el millor sentit de la paraula– ens ha portat i portarà.

No vull descuidar-me de ningú, així que seguiré amb els genèrics – vosaltres ja sabeu qui sou! Gràcies a tothom amb qui m'he fet en la meva estada a Sant Celoni, especialment a la colla d'escaladors i boletaires, que m'heu ensenyat el respecte per la natura no des de la teoria, sinó des de la pràctica. Gràcies també a tota la colla d'amics de Sant Esteve i de Palau: quinze anys desprès seguim tots igual, i això s'agraeix! Un agraïment sincer també a tots els meus camarades: sou referents, exemple d'honor i integritat, i un front davant les vicisituds del fat.

Finalment, m'agradaria agraïr a la meva família el seu suport continuat durant tot aquest procés, especialment als meus avis: sortosament ens veurem més sovint a partir d'ara. A Magyarországi családomnak is szeretnék köszönetet mondani: nagyon hálás vagyok nektek, és remélem hogy most már gyakraban tudunk találkozni. Gràcies també als meus pares i el meu germà, que m'han ajudat a créixer i a forjar el meu caràcter. Gràcies també a la Mar, que m'ha hagut d'aguantar durant tot aquest temps.

Jenő nagyapámnak szeretném dedikálni ezt a doktori dissertációt: nincs olyan nap, hogy ne gondolnék rád és minding próbálom követni a példádat.

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1. Introduction: Research question, approach and method

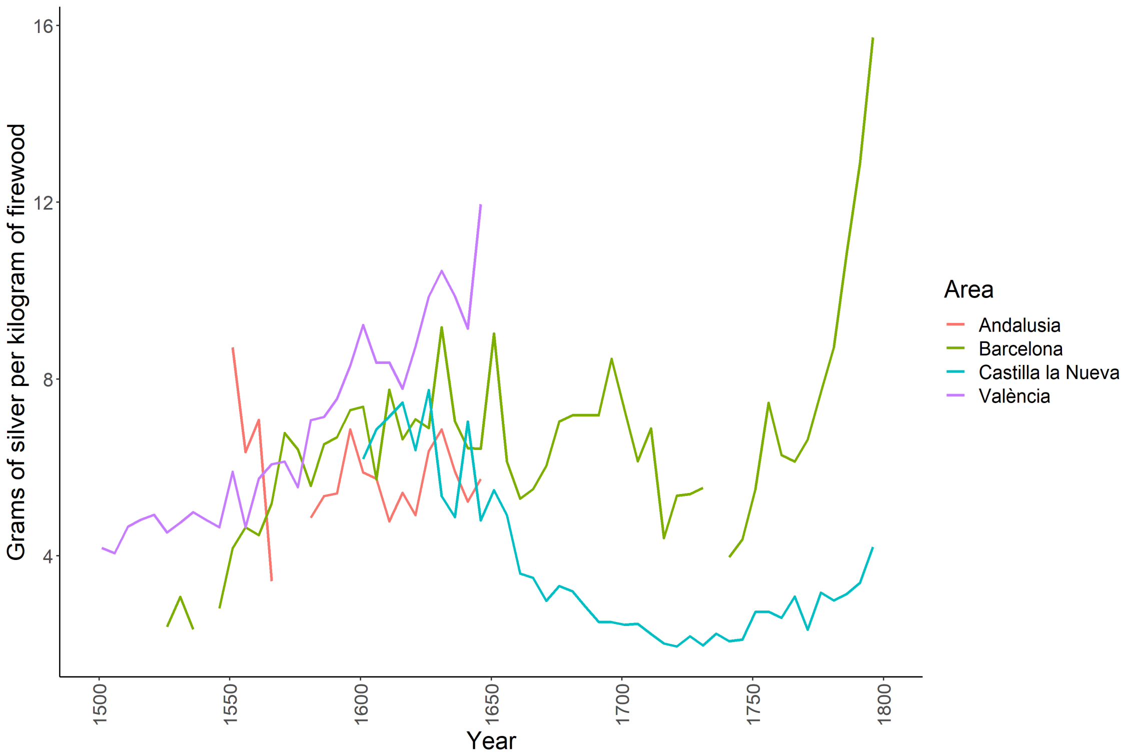
1.1 Presentation

In the hills and forests of the Montseny mountains in the country of Catalonia, the footprints of charcoal-making are well evident for those with a trained eye. However, the sights of both tranquil and laborious charcoal-makers, described by 19th century authors such as Prudenci Bertrana or Ramon Casellas, have vanished away with the arrival of industrial modernity. The environment researched by the naturalist Salvador Llobet during the 1950s in his dissertation *El medio y la vida en el Montseny*, in which charcoal-making was clearly an important economic activity of the region –if not the most important– is nowhere to be found. In the last thirty years, as the last generation of charcoal-makers arrives to the end of its days, various authors (Zamora, Gutiérrez, Panareda, Masnou) have published multiple books and essays on the topic, painstakingly describing every possible aspect of the process of charcoal-making, providing a very relevant ethnographic or sociological perspective. When asked on the demise of this industry, all of them agree: in the 1960s, the expansion of the butane cylinder and foreign competition from Extremadura, Portugal or Sardinia, among others.

In 2014, as I finished the Economic History Masters at the University of Barcelona (in collaboration with the Autonomous University of Barcelona and the University of Zaragoza), I was introduced to the discipline of Environmental History in general, and specifically on the subject of material and energy flows and social metabolism. The region of Catalonia I grew up in –the natural county of Baix-Montseny– has its fair share of currently overgrown hedges and *places carboneres*, abandoned clearings in the middle of the forest where charcoal used to be made. What could that contribution to Barcelona's energy metabolism have been? Most of the older (male) inhabitants of the Montseny massif and its surrounding environs have either worked or known someone that did in the forest at some point in their lives, with firewood harvesting and charcoal-making being two of the most common tasks. However, within two generations, woods have grown to an unprecedented point –at least in recent history– and are no longer being worked in at the scale they used to; charcoal-making has disappeared, and the forests are almost exclusively transited by locals or weekend-tourists from the city.

After talking about the demise of the charcoal industry with Dr. Enric Tello, we noticed that although it was a somewhat acknowledged phenomenon in the countryside, no studies existed on it with Catalonia as a case study in a scale further than the local, or simply from either a quantitative, historical, economic or environmental history perspective. Together with Dr. Iñaki Iriarte, expert in forest history and economics, we set as an objective to further shed light on the question by inserting the Catalan case study into ongoing international academic debates on levels firewood consumption. What the reader will find in the following pages is the result of the last six years of research, following the groundwork laid down in my Master's thesis (Maynou-Felker, 2014). In said work, part of the literature on firewood and charcoal consumption in Catalonia was analysed; although specific studies weren't found, an especially thought-evoking Figure was found among the vast work of Pierre Vilar (1964), compiled later by Feliu (1991) and displayed in Figure 1.1.

Figure 1.1: Prices of charcoal in various areas of Spain (1500-1800).



Sources: Feliu (1991).

It was apparent that something was happening in the latter half of the 17th century in Barcelona that was not happening –or at least at the same rate– in other areas of the Peninsula. What could this imply for the Energy Transition in Catalonia? Could this be related in some way to the relatively uncommon model of the Catalan industrialization? In parallel, the book *Power to the People* (Kander, Malanima, & Warde, 2013) had been recently released, conflating a plethora of European case studies –Spain among them– on the Energy Transition which included firewood in its calculations. Additionally, several studies had been published during that moment and the preceding decade on firewood consumption in various cities: Paris, Vienna, Madrid, Seville. Did Catalonia –and Barcelona as its capital– follow similar guidelines to those of its European and Spanish counterparts? What would become our main objective almost arose on its own: to research and analyse the case of Barcelona and compare it with its European counterparts so that it could be included in the general debates on the Energy Transition in historical perspective.

The main problem we have faced around this research question is that of scarce and conflicting historical sources. No wonder no one had attempted a reconstruction in the Catalan-Barcelonese case! We could have tried already-used methodologies, such as multiplying the population for a given rate of consumption, but we believed that these assumptions had to be actually grounded on some factual data, either qualitative or quantitative. Our first avenue of inquiry was that of fiscal sources, which turned to be entirely inadequate, as apparently tax evasion was rampant in the 18th century, and some of these taxes –the *impuestos de consumos*– were entirely not representative of the actual consumption, as they were calculated by assigning a linearly-increasing multiplier according to a person's economic standing. Our second main line of questioning was based on the bulk of freight: trying to calculate the actual quantities that entered the city of Barcelona though a given year. Although in the end turned to be a worthy endeavour, the disparity among scarce sources and the variability of its information made us initially *pause* on that particular issue. However, when we were looking for sources on quantities entering the city of Barcelona (specifically for the gate duties or *portatges*), our third source was *discovered*. There were monthly records on firewood and charcoal prices from 1848 to 1932 in the Provincial Bulletin! With this information, we set out reconstruct this historical price series, in which over a thousand of issues were painstakingly consulted. In the end, the whole ordeal ended up taking *way too much* time, as several topics had to be addressed: backwards-compatibility with sources of the modern period, convertibility to contemporary units, general literature on price behaviour, specific literature on biomass prices, commensurability with other sources...

In the end, both quantities and prices were to be "reconciled" through the use of methods of estimation based on the price-elasticity of demand. However, as research was progressing at a too slow pace while the 5-year PhD mark beckoned, the investigation had to be halted somewhere, and thus a dynamic estimation on consumption has presently been left out. Nonetheless, we believe that through the course of this PhD programme at least three contributions have been made: first, a "quantity-series" of firewood and charcoal entries to the province of Barcelona; second a "price-series" between 1848 and 1932 that to this point hasn't been yet published, and which can be connected to existing series in the past and potentially in the future, and; third, the critical examination of both under the light of a collection of European study cases, which results in a proposal of several rates of firewood and charcoal consumption for the city of Barcelona during the 18th and 19th centuries. Both three contributions have their faire share of assumptions and shortcomings: rather than obfuscating them, we he have tried to critically point to what we perceived to be limitations of our research. Finally, several of these "avenues of research" have been presented in the following section; some of them we couldn't attempt for various reasons, but nonetheless we consider worthy of pursuing, and may do so in the future. In any case, we hope that the research and materials hereby presented might be helpful to anyone in general, and specifically if trying to reconstruct Barcelona's or Catalonia's social metabolism.

1.2 Methodology and structure

In the most general terms possible, our perspective is versatile at an epistemological level. It seeks to reconcile the quantitative and qualitative aspects existing in a very dissimilar corpus of sources and literature, both in terms of type and spatial perspective. Biophysical laws and (some) principles of economic theory set the limits of what can be done in terms of transportation and trade. Where documents are lacking, interviews of the last charcoal-makers or nineteenth century literature help to clarify the rationality behind certain phenomena. The structure of this dissertation tries to follow the standard order of a scientific article, which reflects the standard deductive proceedings –perhaps starting from an inductive point– of the scientific method.

Thus, the first section seeks to provide an introduction on the general concerns behind the dissertation, such as the underlying hypotheses and objectives, the chronology, scale and space in which it takes place, the reasoning behind it and the relevance of the problem in a general scope. The second section presents the necessary knowledge and sources, so to say, to understand in which debates does this dissertation arise from and participate in. It is subdivided into four parts, which cover the topic from the most general perspective –"what is energy?"– to the most concrete –"what has been said about energy consumption in Barcelona?". The third section examines and discusses various historical sources, most of which have been scarcely –if ever– used to work on the question of energy. As it contains 13 specific categories in terms of sources, we have tried to adequately employ a classification prevalent in the historical sciences: that of primary, secondary and tertiary sources. The fourth section addresses the results from combining said sources, chiefly under three epigraphs corresponding on the nature of the data: prices, quantities and consumption. The fifth section discusses various interpretations on the phenomenon of the Energy Transition in Barcelona in light of new evidence hitherto provided. Finally, the sixth and last sections provides a set of conclusions on all aforementioned ideas and information.

1.3 Objectives and hypotheses

As we have identified an existing void in studies regarding the production and consumption of biofuels in Catalonia, we set out to fulfil three objectives:

- To provide a literature review of the most relevant bibliography regarding the production and consumption of biofuels in an international context, identifying the main debates and trends, while outlining the main processes behind the production of firewood and charcoal as a social, material and economical phenomenon in the Catalan case.

- To offer an account on the historical development and evolution of biofuel supply and supply networks in Catalonia, specifically centred in the city of Barcelona, outlining the main determinants behind supply and demand.

- To generate an estimation of biofuel consumption in the city of Barcelona based on more accurate accounts than those presently existing, as identified in first item of this list.

We have worked under four main assumptions in the form of hypotheses:

- Fossil fuels were not available in such a quantity that made them the *exclusive* energy source throughout the 19th and first half of the 20th centuries.

- Biofuel consumption in both Catalonia and Barcelona was significant at least until the diffusion of the butane cylinder in the 1950-1960s.

- Consumption of biofuels in both Catalonia and Barcelona during industrialization and the Energy Transition (ET) was not only maintained, but rose in absolute terms.

- Barcelona did not possess the necessary energy converters to undertake the Energy Transition *at least* during the chronological scope of our investigation.

1.4 Chronology, scale and space

In any historical study, the delineation of the chronological space is paramount; however, doing so while maintaining a critical perspective is also necessary. Therefore, a preliminary digression must be undertaken by recognizing that the fourfold division employed by social sciences to portray history –ancient, medieval, modern and contemporary– is a cultural and ideological construct originally *invented* during the Renaissance, adopted by the thinkers of the Enlightenment and adhered to by the historians of the late 2nd millennium. However, as environmental history stands at the crossroads between the aeon-spanning eras of those chronologies typical of the natural sciences, and the comparatively-ephemeral generations of the human species, such cultural-ideological conceptions become inoperative when analysing phenomena such as the Energy Transition.

The transition from a solar-based organic society towards a fossil-based industrial society happened –and in some cases is still ongoing –between the 17^{th} and the 21^{st} centuries. As in any observable phenomenon, it is relevant to question whether the causes of what manifested during the aforementioned time-frame were being put into motion before the particular moment when they were evident. As our analysis is substantially based on quantitative data, the chronological scale is determined by the existence of quantitative information; therefore, broadly speaking, our study takes place between the 15^{th} and 20^{th} centuries. However, the periods for which more data is available on this issue –which incidentally coincide with the advent of the Energy Transition– are chronologically situated between the second third of the 18^{th} century and the first third of the 19^{th} century; in other terms, between the starting point of the Industrial Revolution in the city of Barcelona until the Spanish Civil War (Nadal, Benaul, & Sudrià, 2012).

The question of scale and aggregation is especially relevant when dealing with biophysical issues, as nature does not always agree with the political and administrative demarcations and divisions that human societies force upon it. In our case, the available data corresponds to many scales: international, state-based, national, provincial, county-based, municipal or even from judicial subdivisions. In the case of (Spanish) provinces, it must be stated that unlike the traditional Catalan *vegueries*, they did not emerge out of an organic interaction between nature and people throughout history, but are an exogenous administrative system imposed by the Spanish, based on modern and rationalist ideas and modelled somewhat after the French revolutionary and Napoleonic *Départements* (Moreno, 1994; Oliveras, 2012; Sabaté, 1997). Therefore, when analysing the Catalan trade networks of the 18^{th} and 19^{th} centuries, it will be clear that their dynamics don't necessarily agree with Spanish and modern administrative boundaries, but in fact tend to follow the connections of the old Crown of Aragon: the Ebro river as a channel of distribution of Aragonese wheat and wood from the Pallars; the maritime connections between the Catalan and Valencian coastlines, the Balearic and Pityusic islands and Barcelona as their centre; the Pyrenees, acting not as a barrier, but as a connecting space with Europe through the lands of Occitania...

In any case, our analytical units must be restricted and limited to a relatively uniform administrative subdivision. Spanish provinces were implemented in 1833, coinciding with the period we intend to focus on. Although some of our data is referred to the province of Barcelona, our intention is to reconstruct part of the energy metabolism of the *city* of Barcelona. The city did not vary much in spatial terms during medieval and modern times, with the city walls acting as a constraint to outwards expansion (Batlle & Vinyoles, 2002; Busquets, 2004). After the siege of Barcelona in 1713-1714 –in the context of the Spanish Succession War– the *Ciutadella* was built as a means to enforce the Spanish dominion on the recently conquered city. However, the greatest transformations in space took place during the 18th century. In 1854 the city walls were torn down after a long dispute between civil and military authorities. During the last half of the 19th century, the towns of Gràcia, Sant Gervasi de Cassoles, les Corts, Santa Maria de Sants, Sant Andreu del Palomar i Sant Martí de Provençals were added as districts to the city proper, as well as Horta in 1904 and Sarrià in 1921 (Busquets, 2004). As it will be discussed extensively throughout the text, the city of Barcelona has a leading and directing behaviour over not only the province bearing its name, but over most of Catalonia's regions, with most of its trade or infrastructure projects being executed with Barcelona as either its starting point or its destination. On one hand, although our study is centred on the city of Barcelona, we understand that some notions valid for the city might be also valid for some of Catalonia's main cities; on the other hand, the city in historical perspective was well connected with its hinterland, leading us to posit some ideas regarding the mutually transformative relationship between both elements.

Summarized, this dissertation is centred in Barcelona and its hinterland between the 15th and the 20th centuries, with a special emphasis in the city of Barcelona and the province which bears its name during the 1760-1960 period.

1.5 Relevance

The Industrial Revolution inaugurated a paradigm of fossil fuel consumption which, several centuries after its inception, expanded and permeated the majority of human societies. What originated as a material transformation ended up changing the entire cosmovision of Agrarian organic societies –in which there is no sustained growth outside of natural cycles– onto a Fossil Fuel one, in which positive returns on investments –symbolized by an upwards or exponential curve– are naturalized and taken as granted, being ideologically extended and incorporated subreptitiously onto all areas of life (Haag, 2019a, 2019b). The notion of *getting more than originally invested*, especially in terms of energy, implies either ignoring externalities and their entropic consequences –as the depletion of stocks and funds, for instance– or is outright held in violation of the Laws of Thermodynamics and the zero sum dynamics of a closed system such as planet Earth (Ruppert, 2009).

Hundreds of authors have pointed the non-sustainable nature of the current modern industrial world-system from a plethora of approaches. However, those criticisms have been largely and consistently ignored by mainstream economic theory and, consequently, by key actors, institutions and policy-makers in general. At most, some neoclassical economists have admitted that there is indeed a problem, but that it will resolve itself naturally through the markets.[1] They argue that the same chrematistic dynamics, accounted for by their model, and in fact partially responsible for the current situation, will *eventually* generate the structure of incentives which will *eventually* lead in technological breakthroughs resulting in either clean or new energies being developed. Other approaches –including heterodox proposals– engage in similar diatribes, although presenting the problem in terms of societal problems and issues on the dynamics of (re)distribution, which they consequently solve by designing and inventing alternative, rational and "optimal" systems and placing the contingent but *necessary* event of change –the discovery of a new technology, a revolution or a *change in conscience*– in uncertain future horizons. However, both approaches are logically flawed, as they all rely and depend on a presupposed but yet undiscovered clean, sustainable and cheaply exploitable energy source.[2] Those whose solution to the energy problem relies aprioristically on the necessary existence of the *panacea* of energy sources are perhaps reminiscent of deluded gamblers expecting the certain and definitive strike of good luck. Furthermore, all proposals based on certain future events happening fail to consider the auto-destructing tendencies of self-propagating systems and especially the pace of these processes, as outlined by Kaczynski (2015, chapter II), especially when considering his second proposition:

> «*In the short term, natural selection favours self-propagating systems that pursue their own short-term advantage with little or no regard for long-term consequences*».

In any case, the question of a seemingly ever-growing energy demand in the wake of ecological catastrophe is a pressing issue. Many authors hedge their bets on the so called *green energies*. However, *green energies* are *renewable* insofar as considered in a strictly monetary perspective in the short term. If additional costs are factored in, such as the cost of transporting all the required materials and the product itself, or the energy expended in the management of their waste products, as well as other more complex and hard to quantify "externalities" such as biodiversity loss, landscape change or pollution, these *green energies* might not be

[1] As the theoretical links between economics, sustainability, development and economic growth are certainly beyond the scope of this dissertation, we refer the readers to outstanding reviews of literature such as Ayres, Van den Berrgh, and Gowdy (2001); Cabeza-Gutés (1996).

[2] Furthermore, those who hold these stances from Academia *have no skin in the game* (Taleb, 2020), as presumably no economist will be held personally responsible for espousing flawed or outright wrong models or predictions.

as clean or efficient as previously thought. Consequently, considering them as long-term viable sources is engaging in the same short-sightedness of mainstream economics. In both the cases of primary and secondary electricity, storage is one of its main problems as energy generation in wind turbines, hydroelectric dams and solar panels fluctuates according to wind, water reserves and flow, and the solar cycles in terms of position (day-night and stations). Furthermore, wind turbines kill thousands of birds during their useful life and, as their magnets require neodymium, generate nuclear waste (Kaczynski, 2015, p. 62). Hydroelectric dams offer a physical barrier for many aquatic species, and entrap the sediments which are the lifeblood of coastal, delta and estuary ecosystems. In the case of solar power, although some authors have identified negative impacts, such as "*site-dependency, loss of visual amenity, loss of cultivable land, impact on ecosystems, accidental release of chemicals and occupational hazards during construction and operation*" (Tsoutsos, Frantzeskaki, & Gekas, 2005), other authors have found them sustainable (Phillips, 2013), although admittedly the costs of setting up and maintaining urban distribution networks are unclear (Borenstein, 2012). Additionally, authors have identified that renewable energy sources offer "*power densities several orders of magnitude lower*" than fossil fuels (Capellán-Pérez, De Castro, & Arto, 2017), as well as an overall lower Energy Return on Investment (EROI) (Capellán-Pérez, de Castro, & González, 2019), hence establishing them as more land intensive (Smil, 2015), and anticipating a higher pressure on land in the wake of the Energy Transition from fossil to renewable energy sources (Capellán-Pérez et al., 2017). In fact, when analysing the land requirements for sustaining current consumption entirely by solar energy, authors have found that for many advanced capitalist states such as the EU-27, the land-cost would account for about 50% of their available land (Capellán-Pérez et al., 2017). Furthermore, the lower EROIs of renewable energy sources would mark an abrupt decline in the EROIs of the global energy system, from the current 12:1 ratio to that of between 3:1 and 5:1, thus increasing the necessary energy requirements by about 35% to maintain the current consumption rates (Capellán-Pérez et al., 2019). Moreover, an absolute transition to renewable energy sources would "*surpass the current level of reserves (...) for tellurium, indium, tin, silver and gallium*" (Capellán-Pérez et al., 2019).

Another option usually considered is that of nuclear energy –specifically fission in present times– which recently consisted of mostly pressurized water reactors (two thirds of all installed capacity), while boiling water reactors (21 % of total) and heavy-water reactors (14 % of total) held the latter third(Zinkle & Was, 2013). Although nuclear energy generates low carbon emissions and greenhouse gases, it presents several problems, such as the costs and impacts of nuclear waste management, the life-expectancy of power plants –5 years to build, 20-60 of useful life– and the dire consequences in case of a catastrophic failure (Stamford & Azapagic, 2011; Zinkle & Was, 2013). Furthermore, authors have sought to "escape the dynamics of competition between fossil and renewable fuels", positing nuclear power as a facilitator of extraction and refinement of both biomass and fossil fuels through the provision of waste heat from the nuclear process (Forsberg, 2009).

Furthermore, in all of these cases, the creation and maintenance of said infrastructure is dependent on a steady supply on rare earths and potentially non-domestically sourced materials and goods, therefore falling in the category of *organization-dependent technology* (Kaczynski, 2019, p. 87). This issue is somewhat problematic if we take into account that the Bretton-Woods paradigm of globalized and open markets with cheap transportation costs and shipping lanes protected by the US Navy is not an eternal, unmovable constant, and –incidentally– is both cause and consequence, generative and dependent, on low fossil fuel prices. In such a tightly-coupled and complex system, either one of the cyclical capitalist crises or a *Black Swan event* (Taleb, 2007) could lead to a catastrophic breakdown of the whole system (Kaczynski, 2015, p.49), entailing a failure along distribution networks and supply chains, rendering part of the industrial world without energy.

The only domestically available and unquestionably renewable energy carriers under the present climatic conditions of planet Earth are those which originate from the transformation of solar radiation –as well as other elements– into phytomass through photosynthesis. The resulting chains of carbon have been used by the human species for millennia in its many forms, which could be summed up as *food, feed and firewood* (Kander et al., 2013). The first two elements are consumed by organisms –humans and beasts– in order to feed themselves; they entail a metabolic transformation of energy through endothermic processes, which results in energy being available to be expended in the form of (what we consider) work. The latter element, defined as “firewood” due to its historical role, could perhaps better rephrased in the present into the category of “biofuels”, which stands for that biomass which is transformed into “useful” energy through exothermic processes with the possible intervention of technology in its many forms. As long as the Sun radiates energy, and as long as the Earth’s biophysical balance is maintained in a way that permits the existence of photosynthetic organisms, phytomass may be appropriated by human societies for consumption.

Nonetheless, renewable does not mean unrestricted or unlimited; as Reijnders (2006) points out: “*practices should be such that levels of soil organic matter and nutrients in soils can be maintained indefinitely (...) water usage and erosion should not exceed additions to water and soil stocks.* Therefore, a paradigm based on renewable fuels necessarily implies hard *limitations* and intensive *management* of ecosystems in order to sustain potentially much lower populations than the current. Needless to say, this is not an encouraging prospect for those generations raised on the ideology of unrestrained and unlimited progress, but from an evidence-based perspective and according to our present knowledge, it is the only properly *sustainable* paradigm. However, it isn’t entirely a fatal prospect: biofuels in their traditional forms –firewood and charcoal– can be readily harvested domestically and without the need of especially complicated technologies, thus bringing an end on the necessity of costly foreign imports. Furthermore, by relying on domestic production, this necessary *decoupling* from the global industrial system offers both a higher resilience against general crises and *antifragility*.

In any case, it is not our intention to offer a model for a transition to an alternative energy regime *per se*, but rather to elucidate some of the processes behind the "former" Energy Transition, more specifically from the South European and Mediterranean Catalan case. On one hand, by understanding the dynamics which shaped said Transition in terms of energy carrier consumption and interaction between carriers, we may challenge prevalent positions in the contemporary historiographic and economic debates and models. On the other hand, debates on the consumption of biofuels such as firewood and charcoal concentrate a relevant part of the recent literature and academic discussion, especially in regards to the so-called *developing* countries (Baland, Bardhan, Das, Mookherjee, & Sarkar, 2010; Bhatt & Sachan, 2004a, 2004b; Démurger & Fournier, 2011; Fox, 1984; Peeters, Soto-Pinto, Perales, Montoya, & Ishiki, 2003; Tabuti, Dhillion, & Lye, 2003).

A brief but important foreword

It must be acknowledged by those readers not familiar with the Catalan and Spanish languages that the word for charcoal and coal can be used indistinguishably: *carbó* in Catalan and *carbón* in Spanish can mean both charcoal and mineral coal. Although sometimes sources use certain adjectives to distinguish between the two –*carbón vegetal*, *carbón mineral*, *carbón común*, *carbó de rabassa*, etc.– this is not always the case. Additionally, the shops in which both coal and charcoal were sold are referred to with the generic *carboneries* or *carbonerías*. Throughout the text, we have tried to specify which fuel we believe is being referred to. In the cases in which this distinction was unclear, we have used the "(char)coal" variant instead to reflect the ambiguity.

In the same fashion, unless specified otherwise, biomass is herein used to express "biomass in the form of firewood, woody crop residues, charcoal or others", therefore not including other forms of biomass which are employed for purposes other than exosomatic energy consumption, belonging to the categories of food, feed or fertilizer. The term "woody crop residue" is used as a synonym of "crop residues as the result of pruning, which can be used as an exosomatic energy source when combusted"; this category refers mainly to the "residues" –again, an anthropocentric perspective– of extensive pruning of olive groves, vineyards and fruit trees. Furthermore, "biofuel" is used as an opposition to the term "fossil fuel" to avoid repetition of "fuels from a biotic origin".[3] On one hand, our use of the term "biofuel" deviates from the general contemporary

[3] Here, our use of "biotic origin" is entirely anthropocentric, as some fossil fuels are in fact the result of transformation of biomass under certain conditions over millennia. However, we also believe that said fossil fuels are recognized as such by the literature and the general public.

definition, which rather refers to liquid fuels based on the fermentation or distillation of crops – bioethanol, biodiesel, algal fuel, etc. Nonetheless, we believe that our distinct use of the term cannot lead to confusion, as said liquid sources of energy were entirely absent in our chronology due to their relatively innovative nature in our own time. On the other hand, it must also be noticed that straw, dung or reeds could be employed both as feed or fertilizer, however only acquiring the characteristic nature of "biofuels" when being used as such – when burned for exosomatic energy.

Finally, some acronyms are used prolifically throughout the text, which we present in the following list – in the language of their first issue. Notice that each of these sources is explained in its own section.

- **AECB**: Anuario Estadístico de la Ciudad de Barcelona. Includes "Gaceta de Barcelona".
- **AENC**: Anuario Estadístico de la Navegación de Cabotaje
- **BOE**: Boletín Oficial del Estado
- **BOPB**: Boletín Oficial de la Provincia de Barcelona
- **ECE**: Estadísticas de Comercio Exterior
- **IDESCAT**: Institut d'Estadística de Catalunya
- **INE**: Instituto Nacional de Estadística
- **MJCB**: Memorias de la Junta de Comercio de Barcelona

2. Literature review on the Energy Transition: An energy ladder or stacker?

2.1 Theoretical framework: Energy and Society

This dissertation, as well as Environmental History as a scientific discipline, stands at a crossroads between many fields of study. As it seeks to understand and explain the changes in Barcelona's energy metabolism over time, it is useful to explain the whole theoretical framework in which certain notions are used throughout this study, starting with the concept of *energy* itself.[1] Feynman (2010) put it as follows:

> *(Energy) is a most abstract idea, because it is a mathematical principle; it says that there is a numerical quantity which does not change when something happens. It is not a description of a mechanism, or anything concrete; it is just a strange fact that we can calculate some number and when we finish watching nature go through her tricks and calculate the number again, it is the same.*

In its broadest definition, energy is a determinate, abstract quantity which, according to the *law of conservation of energy*, may change in its forms but cannot be created or destroyed; therefore, energy is a quantifiable, quantitative aspect of things. If this notion is applied to a systems framework, a system's energy will remain constant unless it is performing work or transferring energy to other systems. However, in practice, the second law of thermodynamics states that all working systems lose some useful energy –exergy– as useless waste heat –entropy–, transferring the latter to their environment. Prigogine (1997), applying these concepts to human societies, concluded that they were *complex adaptive systems* that required a constant

[1]Some of the ideas, concepts and expressions used throughout this section were already presented and developed in my master's thesis (Maynou-Felker, 2014); some of them I have reproduced almost verbatim.

dissipation of energy and materials in order to function. Societies, as any thermodynamic system, have a natural tendency towards thermic death, which they counter through the use of *dissipative structures*, which reduce entropy in the system at the expense of their environment (González de Molina & Toledo, 2014). Slesser (1978) argued that if the Earth is assumed to be a closed system, an entropic reduction anywhere in the world has as a result an entropic increase everywhere else in the planet.

In fact, energetic dissipation has been thought of as *the driving force of evolution*, as it interconnected various physical, biological, social and economic processes (Georgescu-Roegen, 1975; Nicolis & Prigogine, 1977). Additionally, humans possess a differentiating characteristic from other species; aside from the internal endosomatic cycle necessary to keep our own bodies functioning, an external or exosomatic energy flow is required in order to sustain a society (Georgescu-Roegen, 1975; Lotka, 1956). To assure an ever-more efficient exosomatic energy flow, the ability to develop tools and technology is paramount for a society to thrive; therefore, culture has been categorized as a non-genetic evolutionary trait aimed at transmitting the ideas necessary to increase the odds at survival (Margalef, 1980; Sahlins & Service, 1960) or, in other terms, «the mechanisms to design and manage energy and material stocks and funds for the reproduction of a given society»(González de Molina & Toledo, 2014), including however a plethora of non-adaptive –perhaps rather *no-longer-adaptive*– behaviours (Sieferle, 2011, p.317).

The relationships that human groups establish with their environment in terms of materials and energy constitute a given *socio-metabolic regime*, from which a concrete *socio-ecological system* or *mode of subsistence* appears.[2] Haberl, Winiwarter, Fischer-Kowalski, Krausmann, and Weisz (2004) distinguish between three of this modes of subsistence, corresponding to hunter-gatherers, agrarian societies and industrial societies. Whether systems display emergent properties or not, the term metabolism comprises the sum of all processes happening inside a given system; the delineation of the scale of the system will, however, raise questions regarding its boundaries and interconnectivity with other systems, as well as the mutually existing relationships between funds and flows. Nonetheless, many case studies have set the city as the basic unit of analysis, starting with Abel Wolman's estimations on the metabolism of a theoretical city of the USA of a million inhabitants in 1955 (Fischer-Kowalski, 1998). Henceforth, historical changes in societal energy metabolism in the wake of the Industrial Revolution have been done either as reviews of sources and historical accounts(Sanz de la Higuera, 2014; Warde, 2019) or as case-study analyses. At the city scale, urban metabolism and changes in energy requirements have proliferated, such as in the cases of Madrid (Bravo, 1993; Hernando & Madrazo, 2017), Vienna (Gingrich, Haidvogl, & Krausmann, 2012) and Paris (Kim, 2013; Kim & Barles, 2012). At the country level, several studies have been published: on Sweden (Kander, 2002;

[2] Fischer-Kowalski (1998) provides an excellent review on the origin and usage of the term *metabolism* beyond the discipline of Biology.

Lindmark & Olsson-Spjut, 2019), Spain (Bartoletto & Rubio, 2008; Rubio, 2005), Italy (Malanima, 2006), England and Wales (Warde, 2007) and Portugal (Henriques, 2009), that have resulted on a broader study with similar methodology and a wider analysis for the Western European case (Kander et al., 2013), to which (Infante-Amate & Iriarte-Goñi, 2017; Infante-Amate et al., 2015; Iriarte-Goñi & Infante-Amate, 2019) have added new contributions for the case of Spain.

For Catalonia and Barcelona, many studies have analysed how the industrial development led to a growing consumption of new energy carriers like coal, coal gas and electricity, and the impact of technological changes in the energy and food provisioning supply areas (Alayo, 2007; Arroyo, 1996, 2003, 2006; Capel, 1994; Coll & Sudria, 1987; Fernández-Paradas & Sudrià, 2018; Nadal et al., 2012; Raveux, 2005; Renom, 2016a; Sudrià, 1987, 2017; Urteaga, 2003). The generally accepted historiographical view is that Catalonia –and Barcelona as its capital– stood in a relatively interesting position during the 18th: although it was the most developed region of the Spanish state with a dynamic capitalist class that sought to introduce every technological innovation from Europe, its domestic energy reserves were rather scant. The short rivers of a rugged geography –the Ebro river aside– could not support fluvial transportation of goods at a large scale, and domestic sources of coal were scarce, of low quality and situated amidst the Pre-Pyrenees. However, domestic resources were employed as best as it was possible, and European technologies were *adapted* –and even *improved*– to work in the Catalan conditions; such is the case of the Catalan forge, used in the Pyrenees and powered by water and charcoal, which entered its decadence in the 18th century due to foreign competition; or the *berguedana*, an improved spinning jenny invented during the late 18th century that enabled the local industrialists to compete internationally by importing cotton directly, instead of having to buy already-spun thread.

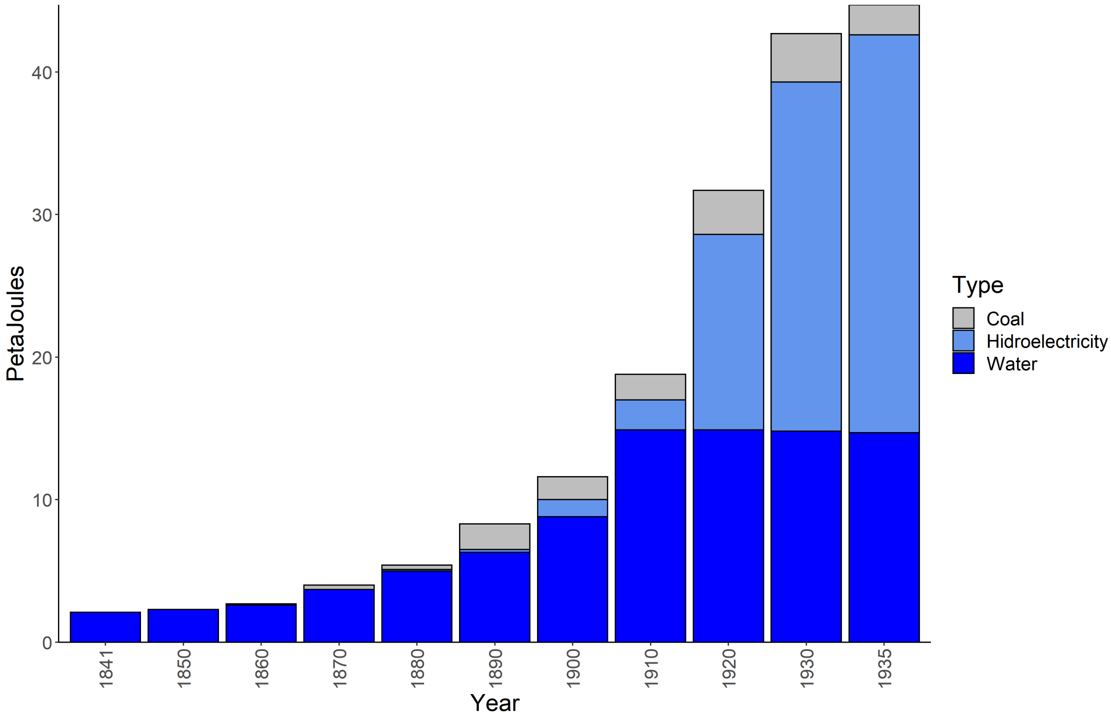
While many studies have analysed various aspects of industrial development in both Catalonia and Barcelona, to our best knowledge and to the present date no study has analysed the whole extent of either Catalan or Barcelonese social metabolism from a perspective analogous to the previously considered studies and including biomass in its analysis. However, a plethora of studies have analysed various concrete aspects of energy and materials consumption, especially in the case of fossil fuels. Nadal et al. (2012) is perhaps the most detailed compilation of graphics, data and studies on the matter, as it seeks to present and divulge the history of the Catalan industrialization. Among the vast trove of information it constitutes, some figures on the domestic production and consumption of energies at the scale of Catalonia are given: Figure 2.2 displays the production and the consumption of energies in Catalonia according to Nadal et al. (2012)[3].

Although this information is extremely interesting, as it is a valuable insight on the productive factors and sources of energy of Catalonia, it is insufficient for our goals, as on one hand the scale is Catalonia as a

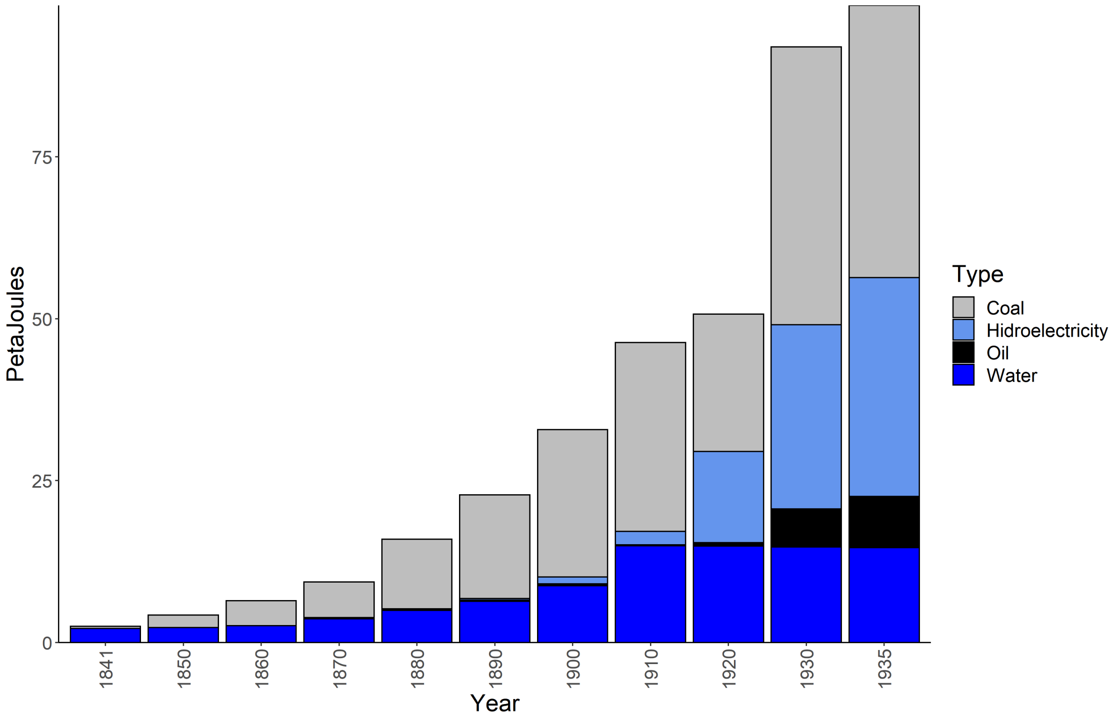
[3] The data has been converted from the original Tons of Coal Equivalent (TCE) to PetaJoules according to UN (1987)

Figure 2.1: Energy production and consumption in Catalonia (1841-1935).

(a) Production of (selected) energies:



(b) Consumption of (selected) energies:



Source: our own, from Nadal et al. (2012). Units have been converted from Tons of Coal Equivalent to PetaJoules according to UN (1987).

whole, and on the other hand, besides water, it doesn't include other "traditional energy sources", that is, –chiefly– biomass. At a first glance, however, several essential ideas are apparent: the domestic production of coal was nowhere near the levels it would have required to sustain consumption, and on the other hand the contribution of water was paramount, either in its strictly hydraulic fashion or in the relatively more modern form of hydroelectric power.

Table 2.1: Sectorial distribution of coal consumption (in tons) by industry in Barcelona and Catalonia (1935).

	Barcelona		**Catalonia**	
Industry	*quantity*	*% BCN*	*quantity*	*% CAT*
Textile industry	208,246	24.1%	219,023	23.1%
Construction materials (cement, glass and ceramics)	190,170	22.0%	191,692	20.2%
Energy (gas and electricity)	185,803	21.5%	199,296	21.0%
Retail (domestic consumption and small industry)	140,434	16.2%	169,137	17.8%
Mining	37,028	4.3%	37,753	4.0%
Other industries	36,562	4.2%	41,628	4.4%
Metallurgy (steel, mechanics and other metals)	33,136	3.8%	33,422	3.5%
Chemistry, explosives, oil and tras	30,135	3.5%	52,215	5.5%
Food industries (sugar and beer)	3,715	0.4%	4,850	0.5%
Total	**865,229**	**100%**	**949,016**	**100%**

Source: Nadal et al. (2012).

As Table 2.1 provides information on the total and specific consumption of coal by sector in Barcelona and Catalonia. It is interesting to notice how Barcelona concentrated more than 90 % of overall coal consumption, with energy production and domestic consumption making up about a third of overall consumption. The question beckons: could that quantity of energy and materials sustain a population of about a million inhabitants in the city, and almost two millions in its provincial environs? What was the role of "traditional energy carriers"?

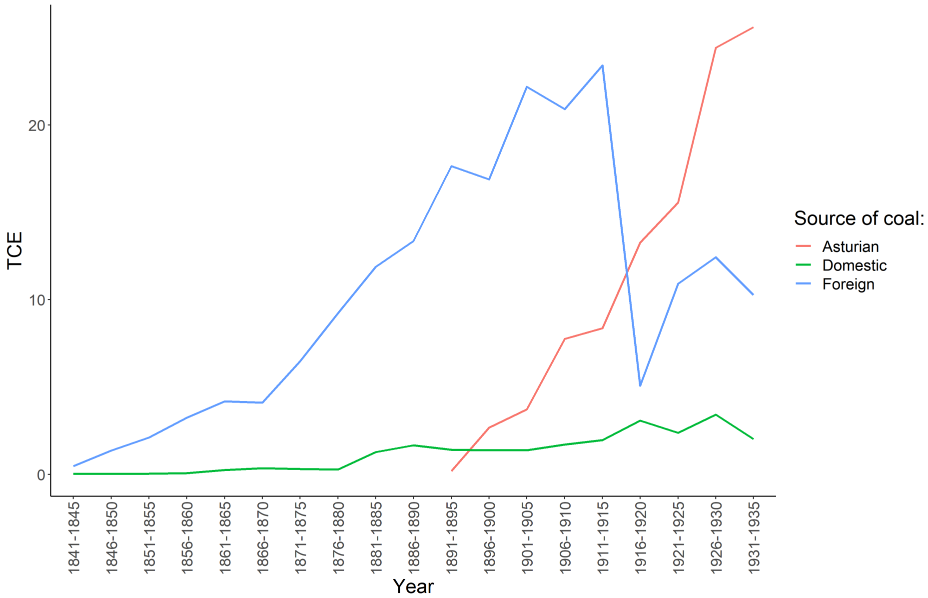
There is a gap in the historiographical literature in what concerns firewood and charcoal supply to the growing industrial cities, a subject only addressed so far from a few ethnographic studies regarding charcoal making in different mountain areas around Barcelona (Euba & Ribes, 2010; Gutiérrez Perarnau, 1996; Panareda & Masnou, 2010; Zamora, 1996). Hence, in broad terms, it is safe to assert that *modern* fossil fuels have received far more scholarly attention than *traditional* biofuels. The next section will address this particular question by analysing and interpreting existing narratives on the Energy Transition.

2.2 The Energy Transition: conflicting interpretations

In a historical perspective, before the Industrial Revolution and the first Energy Transition to coal, firewood and charcoal were the main sources of energy for heating, cooking and lighting at home, as well as for

Figure 2.2: Domestic reserves of coal and participation in the total.

(a) Origin of coal consumed in Catalonia (1841-1935).



(b) Main sites of domestic coal and subsidiary railways (1860-1935).

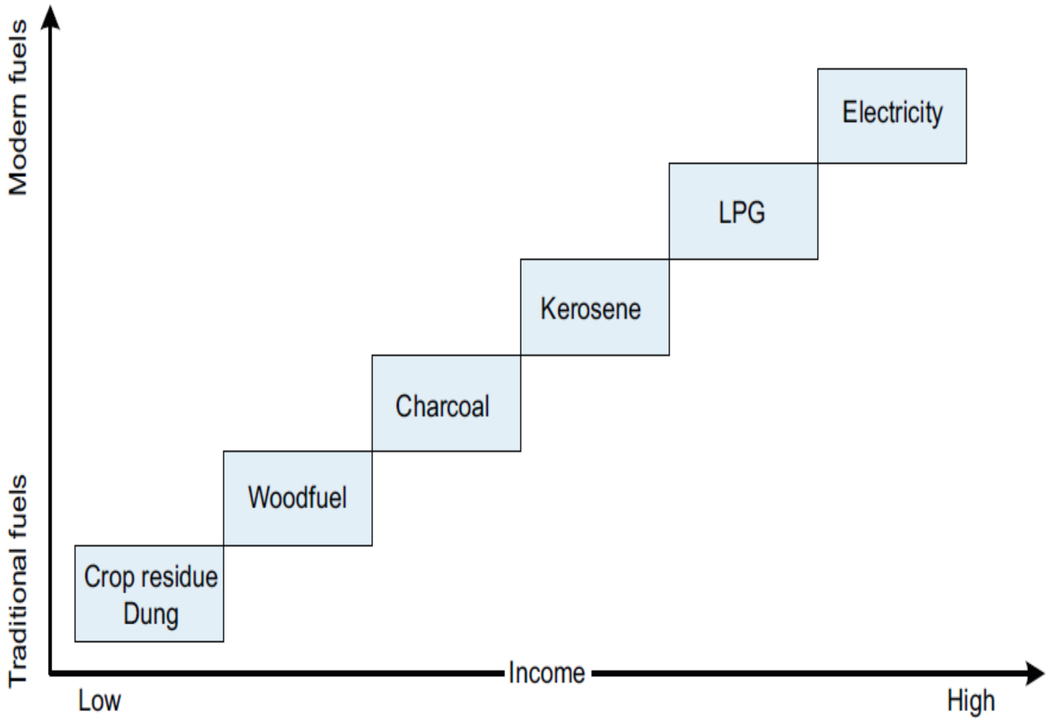
Source: Nadal et al. (2012), Figure a) is from Figure II.3.3. and b) from Figure II.2.7.

industrial purposes in most of human societies around the globe (Kander et al., 2013). In the absence of affordable access to other fuels such as coal or peat, biomass energy carriers were the only source available for domestic consumption, and cities had to develop, maintain, administer and secure increasingly big networks for their provision. As cities grew, biomass fuel had to be procured from increasingly distant areas. Cities such as Madrid, Paris or Vienna depended on supply areas in their periphery up to several hundreds of kilometres away. It could take up to two years from the moment a tree was felled until it was consumed in these cities (J. Bernardos, Ortego, Madrazo, & Nieto, 2011; J. U. Bernardos, 2004; Bravo, 1993; Kim & Barles, 2012). Indeed, urban expansion in preindustrial economies was constrained by the high levels of firewood consumption, since on average about one hectare of forest per inhabitant was required in Northern Europe during the Medieval and Modern Ages (Fischer-Kowalski, Krausmann, & Smetschka, 2013; Kander et al., 2013). The Industrial Revolution, and especially the spread of innovations that made fossil fuels available for an increasing number of uses, widened the set of different energy carriers consumed for human activities, from industry to household uses. In the long run, fossil fuels displaced biomass sources in relative terms, leading some historians to affirm that the Energy Transition eventually *liberated* forests, as societies were increasingly depending on the so called *Subterranean Forest* for energy provisioning (Sieferle, 2001). This substitution of firewood and charcoal for coal reduced the role of forests as energy providers, influencing the already ongoing phenomenon of the Forest Transition (Mather, 1992; Meyfroidt & Lambin, 2011). However, often societies' ecological footprint on forests was rather shifted geographically outside of Europe than diminished in general, while wood was sought as a raw material, rather than an energy source (Iriarte-Goñi & Ayuda, 2012).

The 1970s energy crises renewed scholars' interest in energy consumption in general, as well as the effects of oil prices on the economy (Kowsari & Zerriffi, 2011). In this context, the 'Energy Ladder Hypothesis' emerged as the main model explaining energy carrier change, especially in non-industrialized or industrializing countries. The model outlies a paradigm in which, as certain fuels are considered more efficient, users tend to switch to higher qualities as their economic situation improves, as pictured in Figure 2.3 (Kowsari & Zerriffi, 2011). This approach has been the go-to model to either support or disprove, both a general, theoretical level (Bisaga & Parikh, 2018; Van der Kroon, Brouwer, & Van Beukering, 2013), in relation to forest preservation (DeFries & Pandey, 2010; Zhao et al., 2017), climate (Burke, 2013; Smith, Apte, Yuqing, Wongsekiarttirat, & Kulkarni, 1994) or especially when considering present-day 'developing' countries' case studies (Grimm, Munyehirwe, Peters, & Sievert, 2016; Hanna & Oliva, 2015; Hiemstra-Van der Horst & Hovorka, 2008; Hosier & Dowd, 1987; Maconachie, Tanko, & Zakariya, 2009; Reddy & Reddy, 1994; Tukur, Kabir, Zaku, & Jimento, 2013).

Nonetheless, historical evidence challenges the 'Energy Ladder Theory', according to which societies in

Figure 2.3: The Energy Ladder Hypothesis.

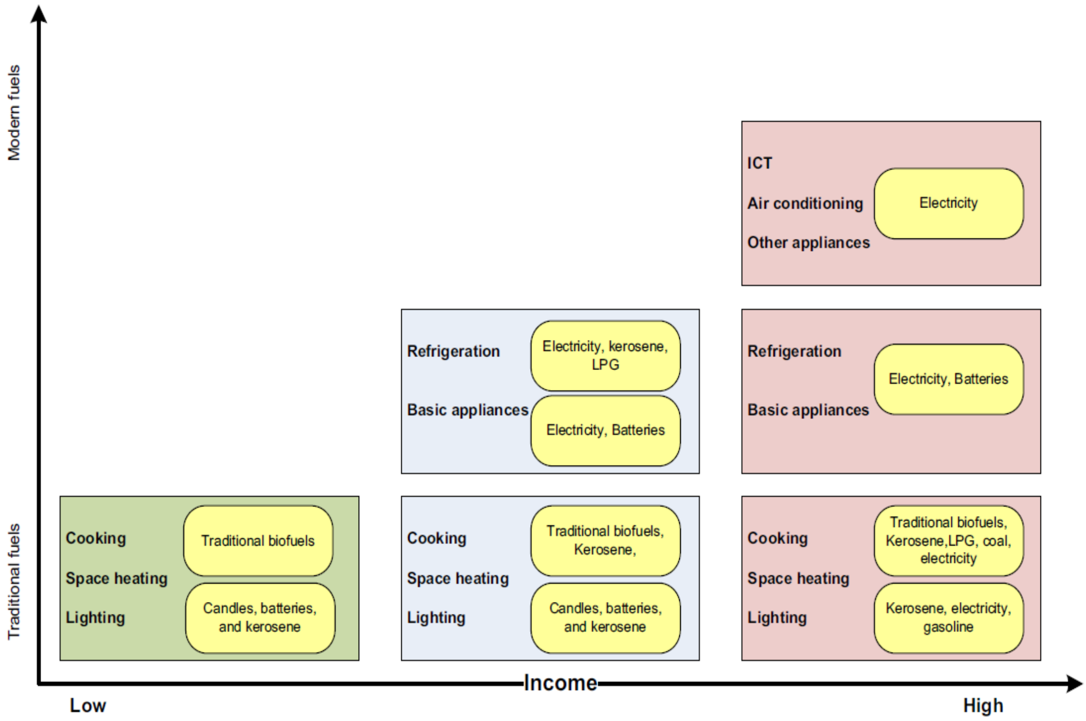


Source: Kowsari and Zerriffi (2011).

the wake of the Energy Transition would have moved along certain steps, each of them corresponding to a main energy carrier with their dependent subset of technologies in a linear, incremental manner. By placing this historical narrative within the traditional-modern dichotomy, each stage would have implied an improvement over the previous one. However, this approach has been criticised for its mechanical evolutionist view based on recent evidence in developing countries, in which social groups switch back and forth between 'traditional' and 'modern' fuels based on cultural norms, commodity prices and time allocation concerns, amongst other factors(Masera, Saatkamp, & Kammen, 2000; Serrano-Medrano, Ghilardi, & Masera, 2019). Furthermore, although the displacement of traditional energies did eventually happen, the first periods of industrialization increased the demand for forest-based energies and materials due to the development of new industrial activities, its dependent subsectors, the massive parallel population increase and urban growth (Iriarte-Goñi, 2013; Iriarte-Goñi & Ayuda, 2008).

The alternative approach is known as the 'Energy Stacker' view (see Figure 2.4), according to which different energy sources are combined and added depending on the different site-specific conditions, such as converter availability and relative costs, as well as the aims and strategies adopted by energy users(Iriarte-Goñi, 2013; Iriarte-Goñi & Ayuda, 2008; Iriarte-Goñi & Infante-Amate, 2019; Lindmark & Olsson-Spjut,

Figure 2.4: The Energy Stacker Hypothesis.



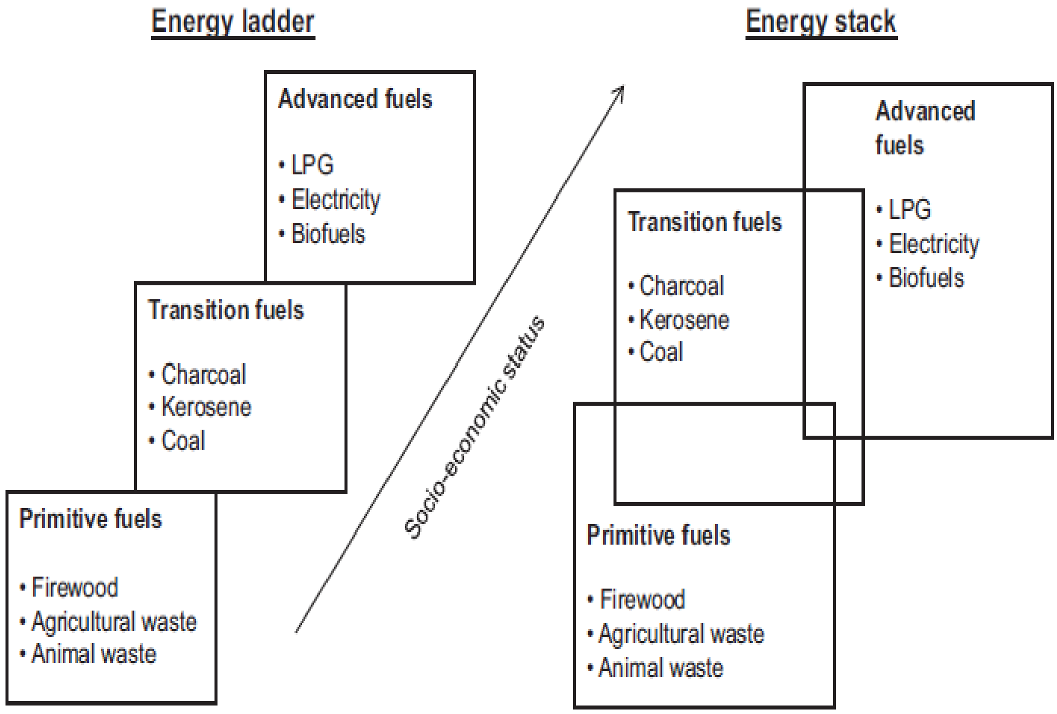
Source: Kowsari and Zerriffi (2011).

2019; Warde, 2019). Over a long period of time, the replacement of biomass fuels with fossil fuels only took place in relative terms, since the latter were added to the former in absolute terms—according to the energy stacker view. A real replacement –according to energy ladder view— only took place, if so, in a very long-term perspective. Figure 2.5 displays a comparison of both approaches.

2.3 Analogous case studies

As stated in section 2.1, several previous studies have addressed the question of energy consumption throughout various units of analysis. From an European perspective, several sources abound: however, those more relevant for our case due to methodology and geographical proximity are those of Kander et al. (2013) and Malanima (2006). While the former explains the general methodology and trends, Malanima (2006) does so concretely and from a Mediterranean perspective. On the Spanish level, several main reconstructions have been done: Bartoletto and Rubio (2008); Infante-Amate and Iriarte-Goñi (2017); Infante-Amate et al. (2014); Iriarte-Goñi and Infante-Amate (2019); Rubio (2005).

Figure 2.5: Models of the Energy Transition.



Source: Van der Kroon et al. (2013).

Kander et al. (2013) is the most complete work on the question of energy consumption in Europe in the present times. Among the many questions it touches, it presents several very relevant ideas as it seeks to explain three main questions: first, the relationship between energy and economic growth; second, the drivers of the energy transition and; third, the changes and the impact of the economic efficiency of energy use (p.6-13). In doing so, it follows the division model of "three industrial revolutions" (p.13), while employing the framework of *macro*, *meso* and *micro-innovations* (p.26-28), which in turn constitute *development blocks* (p.29). Therefore, the First Industrial Revolution was based on the development block of coal, with steam power and iron-smelting techniques as its associated innovations; the Second Industrial Revolution was based on the development blocks of oil and electricity, with their associated innovations (the Internal Combustion Engine, the development of new chemicals, machine tools, etc.), while the Third Industrial Revolution was based on transistors, and resulted into the development and diffusion of Informations and Communications Technology in general. As our case study is centred in the Energy Transition, we have focused especially in the first two development blocks, as well as on the previous period, and in broad terms we have sought to understand its drivers.

Regarding the premodern era, Kander et al. (2013) establish *seven long-run propositions* (p.70-79): reproducible sources of energy were predominant and their supply and demand was closely related to climate; the economy was constrained by high transport costs, low attainable power and low energy productivity and while energy was produced and consumed in a diffuse manner, European consumption was higher than the world's average. In this sense, the main constraint on expansion was that posited by the quantity and volume of energy carriers necessary to supply the demand of energy, as the authors better explained (p.57-58):

> « *The availability of firewood placed a constraint on urban growth, especially in northern Europe, where the need for firewood per head was higher than in the south. In a northern European region, where the daily demand of wood per inhabitant was 3-4 kg, one needed about a hectare of forest. Then a city of 10,000 inhabitants needed 10,000 hectares. This firewood had to be transported to the city. A city of 10,000 inhabitants needed to employ 30-50 carts daily to transport wood from the nearby forests, unless it was easily accessed by water. Since draft animals have to be fed, the area required to support the city's fuel need is greater still. Although this constraint worked in southern European cities as well, higher temperatures made the provision of wood easier, especially when woodland or woody offcuts from agriculture were available. This is certainly one of the reasons why, until about 1500, big cities were scarce in northern Europe. Thiey became numerous in this part of the continent where the main source of heating could be peat or coal. With these alternative fuels, the volume that had to be transported diminished because of the greater energy density of these fuels, and, with this, transport costs fell. Thanks to the widespread use of peat and coal, usually transported by water, big cities such as Amsterdam and London were able to expand rapidly fgrom the sixteenth century on.*»

The given premodern figures on firewood consumption throughout Europe in Kander et al. (2013, p.56-57), appearing also in Malanima (2006), are as follows: in early modern Italy, an average of 1.5 to 2 kg of firewood per capita per day was required, with a reportedly notorious geographical difference between the Piedmont –2.3 kg– and Sicily –1 kg–, and similar figures for Spain; in Central Europe, between 2 and 4 kg per capita per day; finally, in Scandinavia, between 8 and 10 kg per capita per day. The modern energy regime, however, was characterized by an historically unprecedentedly steep increase in energy consumption, chiefly heralded by coal and the exportation of the "British model" of energy consumption between 1820 and 1910 (Kander et al., 2013, p.132). Nonetheless, coal remained a relatively diffusely localized energy source, concentrated in small pockets throughout Europe. Countries with no domestic sources of coal still relied on firewood for thermal consumption: 50 % of overall energy consumption in Western Europe and up to 80 % in Scandinavia (Kander et al., 2013, p.151-152). The authors also note how coal consumption overtook that of firewood in France and Germany in 1854, while in Netherlands it did so in 1865; in the case of Spain, it was in 1894, while in Italy it was in 1904 (p.137-138). Conversely, energy sources based on biomass were rising in absolute numbers but decreasing in relative terms, thus supporting the Energy Stacker model: production and demand of traditional energies increased in food, draft power, firewood and water and wind energies (Kander et al., 2013, p.144).

Malanima (2006) provides an relevant account on the reconstruction of firewood consumption in a Mediterranean country. First, the author explains the main concerns in reconstructing series on "traditional fuels" (p.22):

> «*It is much harder to compile time series of traditional fuels. Since it is impossible to gather information on oil for lamps and wax for candles, and since, all considered, their contribution to the energy budget was negligible, the only fuel we should take into account is firewood, the most ancient source of heating and light. Charcoal being a secondary source, it must be converted into an equivalent quantity of firewood and added to the total estimate. As in the case of food, it would be preferable to approach the study of firewood consumption from the angle of supply. Studying demand only yields rough estimates. Multiplying a fixed figure, assumed as the average demand, by the population is an unsatisfactory solution, especially when dealing with the energy transition, when per capita consumption of traditional fuels diminished. On the other hand, reconstructing the supply is a difficult task, and sometimes a totally impossible one. As we shall see, in Italy as in most other European countries, it is far from easy to quantify firewood production. Hence, we must of a necessity combine a supply-oriented with a demand-oriented approach.*»

Afterwards, he presents several units and conversion factors (see Table 2.2), which are extremely relevant as they constitute the almost sole reference to an analogous climate to that of Catalonia, and which we have used throughout this dissertation unless specified otherwise.

Table 2.2: Units and conversion factors of firewood.

Unit	**Equivalent**
1 cubic meter	450 - 625 kg
1 kg of firewood	3,000 kcal
kgs of firewood to produce 1 kg of charcoal	5.5
1 kg of charcoal	7,300 kcal

Source: Malanima (2006, p.29).

Finally, the author presents a formula to calculate the total firewood consumption of Italy in energy (Malanima, 2006, p.29), as seen in Equation 2.1:

$$E = mF_a + mF_u + mA + mImp - mExp \tag{2.1}$$

where:

E = gross energy consumption in kcal;

m = unit of measurement to convert weight or volume units into kcal;

F_a = officially authorized cutting of firewood in the forests (in weight or volume);

F_u = unauthorized cutting of firewood in the forests (in weight or volume);

A = home consumption of self-procured firewood in rural areas (in weight or volume);

Imp = importation of firewood (in weight or volume);

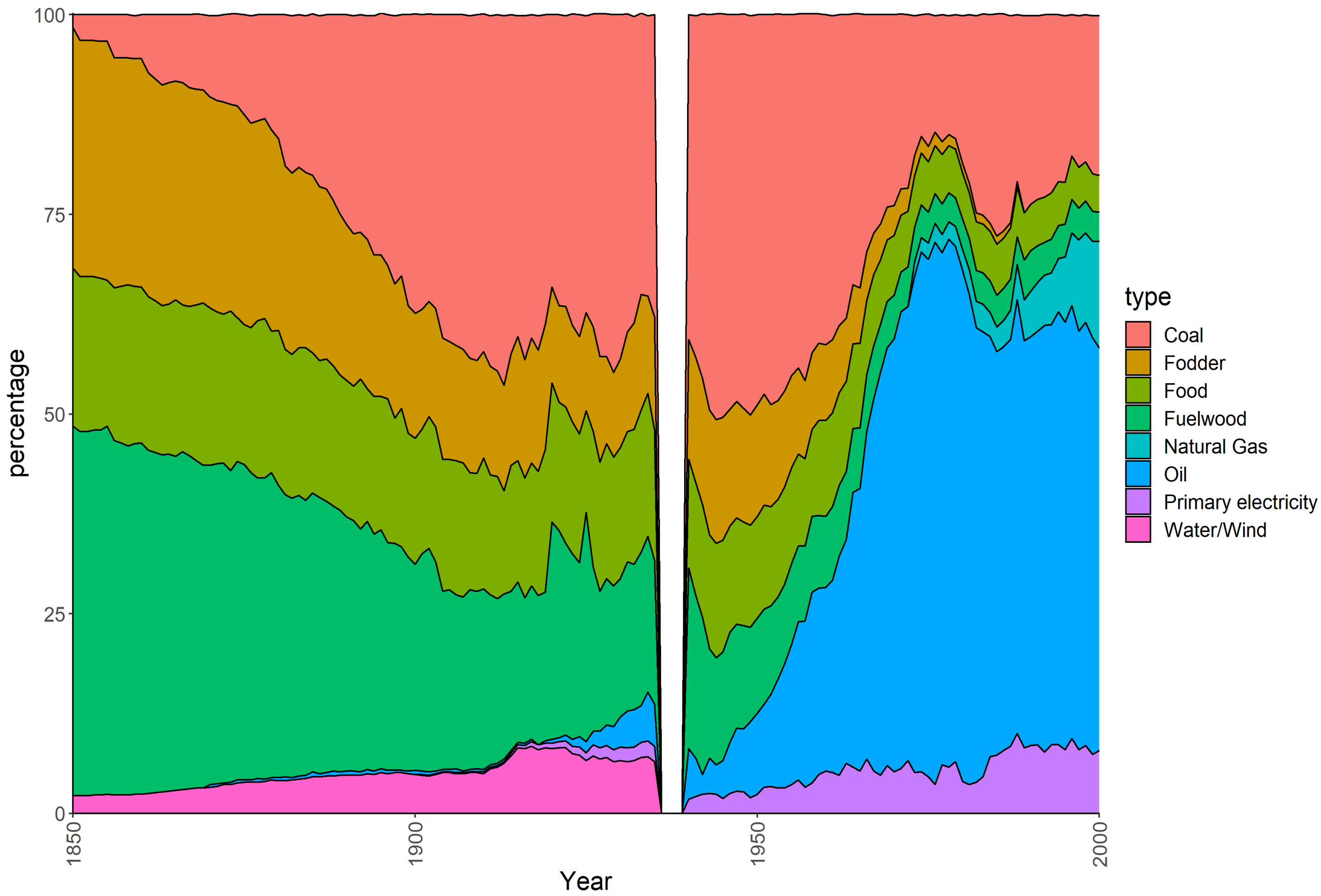
Exp = exportation of firewood (in weight or volume).

The first study that sought to analyse the contribution of firewood to overall energy consumption in the case of Spain was that of Rubio (2005). However, the methodology proposed by Malanima couldn't be exactly replicated, although his general understanding of the phenomenon was used, such as the rates of consumption per inhabitant per day. Regarding firewood, Rubio (2005) expresses the all-too-common problem of lack of sources:

> «*La leña es, de largo, el elemento más difícil de estimar. No sólo por su importancia cuantitativa en los siglos anteriores a la incorporación de los combustibles fósiles, sino por su importancia aún en los siglos XIX y XX y la escasez de estudios dedicados a ella, como se desprende de la Bibliografía económica del subsector forestal español, ss. XIX-XX, GEHR (en prensa). Estudios sobre el carbón vegetal y sobre la importante actividad económica desarrollada alrededor del carboneo no están del todo ausentes en de las investigaciones de los siglos XVI a XVIII, véanse por ejemplo los trabajos de Bravo Lozano (1993) y Bernardos (2002), pero desaparecen casi enteramente para los siglos XIX y XX. En realidad para los años anteriores a 1940 no existe información relativa al consumo de leña en España. Sólo se tienen los datos de producción de leña de los montes de utilidad pública de 1901 a 1933, recogidos en GEHR (1991), los cuales representaban una pequeñísima parte de todos los montes españoles, entre el 10 y el 15 por 100 probablemente. A partir de 1940 el GEHR recoge los datos de las estadísticas franquistas que tienen el problema de que no se incluían todas las leñas, y cuando incluyen el tojo a partir de 1956, la cantidad de leña se eleva a más del doble con respecto a los años anteriores. Todos los datos hasta el presente se encuentran en Barciela López et al. (2005). Para el siglo XIX no existe por tanto estimación alguna.*»

The lack of available sources on firewood for Spain makes it necessary for the author to base its calculations on estimations. As the only existing information for the contemporary period is that of the firewood harvested in public forests, the author uses that set of data for the 19th century and assumes it to be approximately representative of 10 % of overall Spanish supply. By using it as a representative portion, she reaches the conclusion that the consumption per capita per year of firewood between 1901 and 1933 would have been 352 kg per person per year, a number quite similar to Malanima's estimate of 350 kg per person per year. Despite the eventual cold years and a manifested downwards tendency –297 kg in 1933, according to the author– it apparently coincides quite well with the following series. In general terms, the structure of overall energy consumption of Spain in 1900 would be that of 35 % firewood and 65 % coal, which is, as the author notices, more similar to the USA during that period than to "countries more similar to Spain in terms of economy and technology". Her results were later published in another article (Bartoletto & Rubio, 2008), which compared the Spanish case to that of Italy. The data contained, which can be found at the Energy History project[4], is expressed in a graphical form in Figure 2.6.

Figure 2.6: Rubio's (2005) estimation of Spanish energy consumption (1850-2000).



Source: Rubio (2005), data retrieved from the Energy History project.

Rubio's estimate is extremely important, as it is the first of this kind for the Spanish case. If it were

[4]https://sites.fas.harvard.edu/ histecon/energyhistory/index.html

to be classified, it would fall in the category of "demand-based" estimations, as it is calculated by the multiplication of a given quotient –352 kg per capita per year– onto a demographic series. However, this methodology has its own problems, as it is entirely reliant on the constant used, beckoning the following question: is a consumption rate of 352 kg of firewood per capita per year representative for the whole period (1850-2000) and a valid average for the whole Spanish state? As the reader may know, the characteristics of Spain –both natural and cultural– are so widely divergent that it can barely be considered a valid unit of analysis in se. Could the firewood consumption of a Galician peasant –living in a temperate oceanic climate– be similar to that of one from Almería –living in a cold desert climate–, or that of a Catalan factory worker? Analysing at the level of the state can result in overlooking regional dynamics, which we know were clearly at play in the case of Spain, where the industry was almost entirely a Basque and Catalan endeavour during the entire 18th century. This effect is compounded even more in the case of firewood, as it is a product the supply of which depends heavily on climate and transportation costs, even more so in the premodern period, with land-based transportation being constrained by energy costs.

These concerns were addressed in a following working document (Infante-Amate et al., 2014), in which two very relevant factors were introduced: first, data on land-use per province was used to calculate the margins for the possible production, thus accounting for the variability between regions. Second, the contribution of "woody crop residues" was added to the overall consumption of firewood, thus accounting for the available biomass as a result of pruning fruit trees, olive groves and vines. As a result of this methodology, several important notions emerged: first, three models of woody biomass consumption were identified, coinciding broadly with three agroclimatic regions: the Mediterranean one, the Atlantic one and a "transition zone" labelled as Mediterranean-Continental (Infante-Amate et al., 2014, p.34). Woody crop residues were found to contribute more than half of all firewood consumption in the Mediterranean area, and a similar amount in the Mediterranean-Continental zone, while playing almost no role in the more septentrional Atlantic space. By adding the contribution of woody crop residues, and using this methodology, higher levels of consumption were recorded: from an average 3.52 kg/cap/day in 1860, to 3.20 kg/cap/day in 1900 and 2.41 kg/cap/day in 1930! If we were to classify this particular study, it would fall in the category of "supply-based estimations", as it calculates the "potentially available biomass" in the form of firewood for consumption. Nonetheless, the authors exposed an interesting idea: from the groundbreaking studies of Malanima (2006) and Rubio (2005), where the assumed rate of firewood consumption was assumed to be around 1 kg/cap/day in Mediterranean cases, new studies had been providing consistently higher yields (Infante-Amate et al., 2014, p.40-41): the works of various authors *using different methodologies* are quoted: J. Bernardos, Ortego, et al. (2011) for Madrid, which established a quantity of around 3 kg/cap/day in Madrid during the 18th and 19th centuries; Tello, Garrabou, Cussó, and Olarieta (2008) for Catalonia in 1860, with 1.8 kg/cap/day, which rose to 2.7

kg/cap/day if crop residues were added; and (Infante Amate, 2012; Infante-Amate, 2012) for Andalusia, with quantities ranging between 1 and 3 kg/cap/day between 1750 and 2000. Therefore, the authors conclude that Malanima's commonly used number for the Mediterranean of 1 kg/cap/day is not representative for Spain, in which these numbers moved between 2.4 and 3.5 kg/cap/day until the 1930s even when considering regional climate variations.

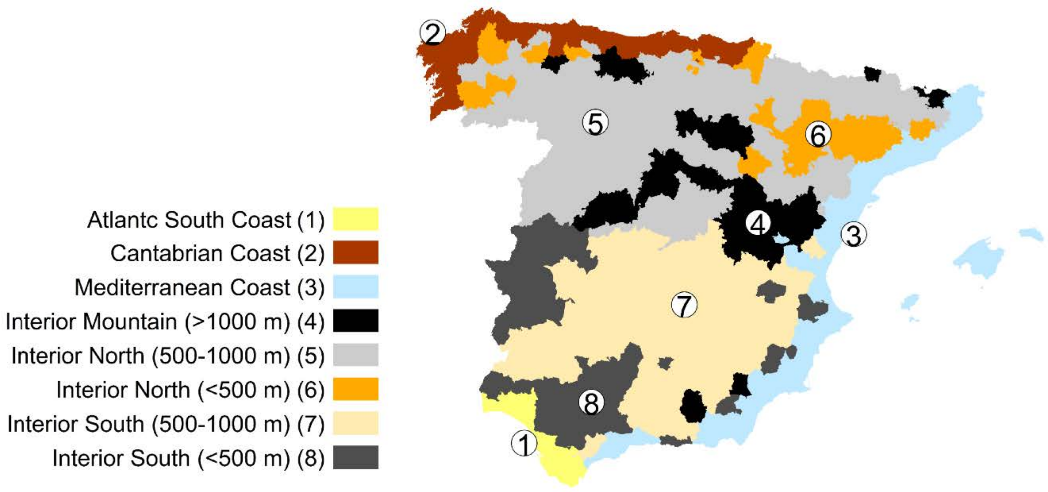
The model proposed in Infante-Amate et al. (2014) has been further iterated upon in Iriarte-Goñi and Infante-Amate (2019) and its complimentary methodological paper, Infante-Amate and Iriarte-Goñi (2017). The scale of the study has been further narrowed down: from province (50 in total) to judicial district (425 in total). First, the surface of forests –high forest, coppice, and open forest– and woody crops –olive groves, vineyards, fruit trees– is used to infer the total quantity of appropriated biomass, from which wood for non-energy purposes is removed. The remaining amount of biomass is that which could be consumed by the population of a particular judicial district. However, data on said districts is then aggregated into 8 bioregions based on geographic and climatic features as well as latitude, as shown in Figure 2.7.

The results based on their study show that in 1860, firewood consumption oscillated between 4.3 kg/cap/day –in inland mountain areas (4 and 5)– to a meager 1.4 kg/cap/day in the Mediterranean coastline – number 3. This is extremely interesting, as Catalonia possesses areas pertaining to bioregions 3 to 6, therefore comprising the entire range of possible metrics. If we were to classify the study to this point, it could be considered "supply-based", as perhaps a more refined iteration on Infante-Amate et al. (2014); however, the authors go beyond and try to infer the actual demand for modern energies –and therefore the *real* possibility of transitioning in terms of energy– by fulfilling two requirements: access to adequate infrastructure –ports or railways– as well as a «*a population size that would make supply profitable (...) 5,000 inhabitants as a minimum*»(Iriarte-Goñi & Infante-Amate, 2019, p.41). Using these two criteria, the study becomes both supply and demand based, and reaches interesting conclusions, such as the relatively poor access to new energies among most of Spain's inhabitants (43.7 % of total population in 1910, and 58.6% in 1950). However, aside from potential access, other factors might have played a role, such as relative prices of energy carriers, as shown in Figure 2.3.

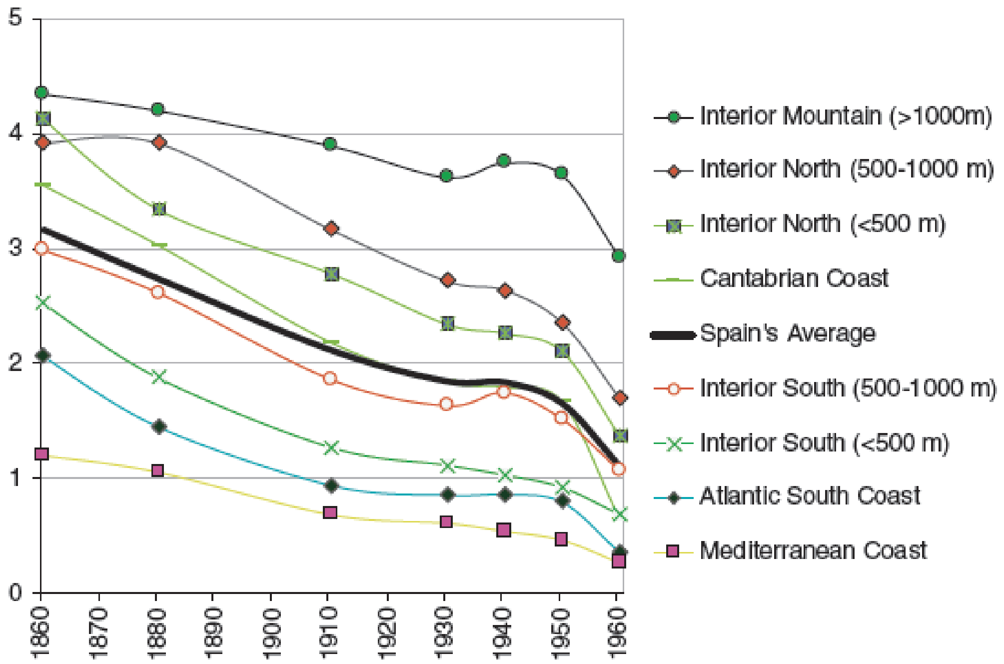
In any case, the conclusion of this study is twofold: on one hand, and despite regional disparities, firewood consumption was even higher than previously estimated. On the other hand, a very relevant part of the population, even in urban areas, didn't have access to fossil fuels. Thus, the authors distinguish between four phases, as seen in 2.7: first, up to WW1, the entry of coal to the market signalled a fall in firewood consumption and a timid advancement towards the Energy Transition. However, the second period –set between 1914 and the mid 1950s– was characterized by a halting of the process, probably as a consequence of the shocks produced by WW1, the Civil War and the autarchic period in access to energy stocks. The

Figure 2.7: Firewood bioregions and consumption per bioregion.

(a) Bioregions in Iriarte-Goñi and Infante-Amate (2019).



(b) Firewood consumption per inhabitant per day in respective bioregions.



Source: Iriarte-Goñi and Infante-Amate (2019).

Table 2.3: Price Index per GJ according to energy sources used.

Year	Firewood and charcoal	Coal	Coke	Oil	Electricity
1868	100	29	27		
1913	100	26	58	611	2,217
1922	100	56	67	350	1,296
1933	100	52	43	211	1,372
1948	100	14	12	112	113
1958	100	15	8	45	63

Source: Infante-Amate and Iriarte-Goñi (2017).

third period, set between the 1950s and the 1980s, was characterized by a fall in consumption of firewood in favour of other energy carriers. Finally, the fourth and final period –not shown in 2.7–, starting in the 1980s up to the present day, is characterized by an upwards trend in firewood consumption.

We can being the conclusion to this section by positing the following: over the last 15 years, several estimations on the quantity of firewood consumed have been presented either for Europe, Spain as a whole, provinces of Spain or individual judicial regions. In this process, several claims have been made on the nature and the speed of the transition, from the most general point of the scale to the more concrete one. Estimations have been provided both from the demand and the supply side. Therefore, one of our main objectives will be to assess whether the notions claimed in the previously existing literature either coincide or disprove with the information we have gathered, albeit at a different scale: that of Barcelona and the province of Barcelona. In our case, the choosing of a different scale is almost *dictated* by the existence of certain sources and the lack of others, that is, on the availability of documentation on firewood and charcoal during the 18th and 10th centuries. However, this approach makes the use of existing methodology either inviable or redundant. For instance, although detailed and useful for the Italian case, we cannot use Malanima's formula (Equation 2.1) in the case of Barcelona for various reasons. First, records of "authorized cuttings" are almost non-existent for the entire state of Spain until the 19th century, for which this sort of data only exists for public forests until the 1930s, as recognized by Rubio (2005). Therefore, data on both terms F_a and F_u of Equation 2.1 is either marginal or doesn't exist for much of the chronological period of our case study. Second, firewood provision from the increasingly scarcer forests of Barcelona and its immediate hinterlands became marginal in terms of contribution as the city grew throughout the 18th century, thus making the term A unusable.

In this chapter, we have seen some of the published on the topics of energy in various contexts. The next chapter will address how said literature corresponds to the Barcelonese case, specifically by gauging if and how various methodology can be fitted, adapted or discarded in terms of the available historical sources.

3. Historical Written Sources in Barcelona: A piecemeal puzzle

Throughout our research process, and in order to reconstruct the quantities and prices of firewood consumed in Barcelona, dozens of sources of various kind have been consulted; the only constant among them was heterogeneity. Nonetheless, this dissertation relies heavily on certain historical sources, some of which haven't been yet published in any format other than the original. In any case, as sources play a very important role in our research, the following system of classification has been put forward:

- First, we have included those sources that: i) we have used in more than a case or problem or, ii) that are generally considered to be well-known in the general literature. For instance, as the Mercantile Balances are used in both the reconstruction of quantities and the estimation of consumption, they have got their place in the following section. On the other hand, the well-known *Estadísticas Históricas de España* (Carreras & Tafunell, 2006) are only referred to in a case, and therefore haven't been included on the following section.

- Second, the sources have been classified according to the primary-secondary-tertiary system. Although minor disagreements on adequate categories may be valid, for the first category we have included materials published or created in the particular era of study; in the second category, which is presented in the results section, we have included documents which discussed the former or were written in scholarly fashion or *post hoc*; and finally, in the third category we have included what we have considered to be *databases* or repositories of other sources. While Figuerola's *Estadística de Barcelona* could be considered a secondary source –as it dealt with various sources of data– or Feliu's *Precios y salarios en la Cataluña Moderna* a secondary source –as he ponders on some of the information in the data series'–, the intention we have perceived (perhaps wrongfully) in both works, that of *exposition and commentary* in the first case and *compilation of sources* in the second, makes us consider this classification valid.

Therefore, all secondary and tertiary sources are discussed in the Results chapter 4.

- Third, inside every section –primary-secondary-tertiary– sources have been ordered *chronologically* in an ascending fashion, with shorter series taking precedence over longer ones. Thus, the Mercantile Balances of 1848 and 1849 are set before the BOPB series (1848-1932).

- Fourth, the last entry has been employed as a collection of miscellaneous sources, which either due to their importance or their lack of presence in the major literature, we've found deserving to be mentioned.

In every following subsection, a basic format of description, critique, exposition and analysis of every source has been followed. The following subsections, however, try to do so in a more general perspective: first, by reflecting on *why* these sources were generated and thus, on which problems and concerns may surround the information they contain (section 3.1), and second, on which is the nature of these sources in economic terms (section 3.2). Afterwards, sources are presented in the following order: the Manifesto of 1823 (3.3), Pascual Madoz's Dictionary (3.4), Laureano Figuerola's Statistics (3.5), the Mercantile Balances of 1848 and 1849 (3.6), the Official Gazette of the Province of Barcelona (3.7), Ildefons Cerdà's Statistical Monography (3.8), the Foreign Commerce Statistics (3.9), the Cabotage Yearbooks (3.10), the Statistical Yearbook of Barcelona (3.11) and the aforementioned Miscellanea section (3.12).

3.1 Written sources as a result of societal activity

Throughout history, the rural working classes have been the biggest producers and consumers of biofuels. If we discard contexts of scarcity and lack of access to resources, the cost of firewood is directly related to the time it takes to gather, cut, transport and store. No specialized tools are required; in fact, in some cases firewood only has to be picked up from the ground. Therefore, firewood gathering, done at a small scale such as to supply a family economy –which in historical perspective was likely to be illiterate– is not likely to generate any documentation whatsoever. In the traditional self-sustaining economies of the peasantry, the production and consumption of any commodity falls into a well-defined seasonally-based phase of the agrarian cycle; in the case of firewood, it is especially important to prepare the fuel adequately before the arrival of the wetter months to ensure that the wood is dry enough for consumption during the winter.

In Catalonia, charcoal-making was a relatively specialized seasonal activity, usually performed between the months of October and March, by professional charcoal-makers and the poorer classes of the local peasantry, which did so as a supplementary activity (Zamora, 1996). The fact that the production of charcoal took place in rural, remote areas between generally illiterate people, whom according to the traditional uses and customs relied on reputation, trust and honour to strike deals verbally with the proprietors of the forest or their representatives, explains why no documentation was generated in the place of production (Zamora, 1996). Therefore, throughout history, both charcoal and firewood began to be the object of quantization in a documentary fashion when they entered the commercial circuits towards the urban sphere. Before addressing the stages of transportation and urban consumption, however, we'll address another category which bore information on the place of production of biofuels in general, and later in time on the quantities to be gathered: the reports and investigations of various governments on forests and woodlands.

The main drivers behind the dynamics of the economic exploitation of wood-based biofuels are the access to the forests and the underlying structure of property. In a historical perspective, most sources of information emerge from legal proceedings on instances of legally-dubious grazing, hunting, appropriation of land or even theft and banditry taking place under the protective leafy covers of the forest. Although this type of documentation is indeed important to understand the role of the woods in general and its economic relevance for the rural populace, it is lacking on quantitative or statistical information. However, the deeper changes that occurred to the forest –which generated the bigger amount of this kind of sources– incidentally happened during the transition from common, mixed or indefinite property rights towards a system based on a juridically-defined private property with an underlying commercial profit-seeking perspective; what in the Marxist school(s) of thought is considered a transition from the feudal or tributary mode of production to the capitalist mode of production. Marx himself spoke of this process in one of his first articles on the rising number of legal cases on the theft of firewood by peasants of the Moselle basin, highlighting a phenomenon which was simultaneously happening to all Western European peasants (Linebaugh, 1976).

As the modern state developed, its interest on both public and private forests increased, as they were considered a military asset, which was necessary to provide timber of good quality so supply the navy. In Catalonia, however, the last Catalan Constitution of 1706[1] established that neither the inhabitants nor the municipalities of Catalonia could be compelled to provide firewood, straw or any other product without its due payment.

> «*Que los habitants en lo present Principat, no pugan esser compellits a haver de aportar pallas, llenyas, vitualles, ni altres cosas en los Presidis, y Plaças, sens que primer sels pague son just valor, y que la conexensa del que se haurà de pagar per lo transport de ditas cosas, toque als Jurats de les Universitats.*»

This agreement presumably was put in place due to the Spanish Armies excesses when quartered among

[1] Constitucions, capitols y actes de cort, fetas, y atorgats per la S.C.R. Magestat del Rey Nostre Senyor Don Carlos III, Rey de Castella, de Aragó, Comte de Barcelona, &c. en la Cort celebrà àls cathalans, en la Ciutat de Barcelona, en la Casa de la Deputaciò del General de Cathalunya, en lo any de 1706, p.81, cap. XXVI.

the population, as overstepping their welcome had been one of the main detonating issues of the Reapers Revolt in the 1640s. On the other hand, controls on felling by the Navy started in the beginning of the 18th century, first in the southern city of Tortosa and later «in the coastal provinces, and in extensive zones of the Pyrenees and the Ebro basin»(Cervera, 2017, p.29-30). However, the main preoccupation was on the supply of timber for naval and military purposes; therefore this kind of sources are no adequate for our perspective on energy consumption.

Although the existence of state-owned forests in the modern context predates the *privatization of the commons*, the latter process intensified during the 18th century, resulting in the proliferation of bureaucratic and courtly documentation by government officials of various ranks on the correct or more optimal economic exploitation of said forests. In this context, it must be noted than the references to the overexploitation and deforestation of woodlands are commonplace during the advent of modernity, making it hard to distinguish whether they were based in actual facts or were rather the Romantic notions of some authors on the «disappearance of idealized pristine Mediterranean forests»(Grove & Rackham, 2001, quoted in Cervera, 2017). As Cervera (2017, p.32) notes, this latter idea could be used as a justification for direct intervention in a context of struggle between absolute monarchy and traditional communal property rights, despite the fact that aside from local cases, there didn't seem to be a generalized situation of wood scarcity.

During the 19th century, several laws of liberal-oligarchic sign were put into motion, regulating various aspects of woodland exploitation[2]: in 1812, landowners had almost complete freedom over the economic exploitation of their woodlands, only restricted by local judges; in 1833, the General Forest Ordinances abolished the privileges of the Royal Navy while empowering proprietors to close the access to forests if they wished so; the confiscations of 1813 and especially 1855 made possible for the state to acquire those forests deemed of public utility. In 1863, the first Forestry Law began regulating the felling of trees and incentivized the replanting of forests, albeit only in the public ones; in 1894, the Law on Forestry Ordering was issued, inspired on German dasonomy. The regulation of private cuttings, with the corresponding administrative documentation that it generated, came quite late in 1925 during the Primo de Rivera Dictatorship, with its precepts being hardened in 1934, by the Generalitat de Catalunya during the Second Spanish Republic. As documenting the quantities extracted from the forests was made mandatory in the 1920s, the statistical data on forests is mainly from the 20th century, and was published by various state and regional gazettes; before that, the only information available is related to public forests.

In any case, the source it is based on, the *aprofitaments* or *aprovechamientos*, is useful at a quantitative level, because it displays the quantity and volume of timber, wood, firewood, etc. disaggregated by province

[2] A detailed evolution of public forests and legislation can be found in (Jiménez Blanco, 2002), while a detailed analysis of sources and a more specific analysis is present in several works of the GEHR – Grupo de Estudios en Historia Rural (GEHR, 1994, 1999, 2002).

and year, with occasional references to charcoal. However, it displays two main problems in terms of our research: on one hand, it only consigns the firewood legally extracted from forests of a certain magnitude. On the other hand, its data is generally restricted on public forests well until the Franco Dictatorship, therefore exceeding somewhat the chronology of our analysis, which is rather centered in the Energy Transition than in the Forest Transition.

While production sources seem lacking in our period, this situation changes when the commercialization of these products is examined. As firewood and charcoal were the dominant fuels in Europe well until the Industrial Revolution, they have left price records when being bought and sold in the city. A vast array of price data series exists for Europe for the period roughly between the 15th and the 18th centuries (Allen, 2001; Clark, 2004; Feliu, 1991; Hamilton, 1947; Reher & Ballesteros, 1993a, 1993b; Sala, 2003b; Vilar, 1964, to quote only a few). Although these sources have indeed their own problems –which will be examined in their corresponding sections– they are made of hundreds or thousands of notes throughout periods for which *almost no other information is available*, therefore providing us an entry vector onto a historiographical gap of information. In this sense, as prices reflect the meeting point between supply and demand, working with prices makes possible an approach on the underlying causes and transformations behind these two elements. Coincidentally, there are other case studies in which prices have been used to reconstruct series of consumption where other data was also lacking (Martínez-González, Jover, & Tello, 2019). For those periods in which so few quantitative information is available, this kind of inventive approaches are the only possible way to infer and deduct ideas from the past, despite the possible problems they might present.

Another type of extremely valuable sources on biofuels are the various annuaries and records of land and sea transportation through ports, customs and gates. Needless to say, a basic and common problem of all these sources is the contingency of certain types of data and their occasional unreliable nature due to concerns such as fraud or obfuscation. Figuerola (1993[1849]), for instance, provides several accounts on the quantities of coal and charcoal that entered the city, but nonetheless warns the reader that he "doesn't deem those quantities sufficient for even a fourth of overall population" and attributing that problem to fraud in registering and taxing. In case of the Spanish bureaus of statistics such as the INE, the level of aggregation of data –from state to city– varies on a yearly basis; a similar situation happens with the products chosen for display in given years. Fossil fuels, due to their importance and novelty, are ever-present, while biofuels tend to appear in periods of general energy scarcity. The archives of the Barcelonese *Junta de Comerç* provide disaggregated data on many products, coming through international commerce or cabotage. All these quantitative sources will be addressed in the following sections according to the general subdivision put forward between Primary and Secondary-Tertiary sources.

3.2 Biofuels as economic goods

Due to their intrinsic characteristics, both charcoal and firewood are, from the perspective of economic goods, hardly subject to a general standard. The species –in singular or plural– of tree from which they were harvested determine in great measure the resulting biophysical qualities, which are translated in lay terms in what is considered to be their *quality*. Depending on the technique or the type of firewood, different kinds of charcoal were produced. Table 3.1 outlines the main species of trees used in charcoal kilns according to Zamora (1996, p.25):

Table 3.1: Wood used in charcoal kilns in terms of their qualities.

Tree Species	**Flame duration**	**Embers duration**	**Quality of flame**	**Quality of embers**	**Charcoal quality**
Willow	40 min.	1 h. 40 min.	Bad	Bad	Very bad
Poplar	31 min.	2 h.	Medium	Bad	Very bad
Fir	32 min.	1 h. 10 min.	Regular	Regular	Feeble
Scots pine	10 min.	1 h. 50 min.	Regular	Medium	Forge
Beech	40 min.	3 h.	Good	Good	Good
Ash	50 min.	4 h. 15 min.	Very good	Good	Good
Oak	40 min.	2 h. 45 min.	Good	Good	Good
Birch	50 min.	3 h. 50 min.	Very good	Very good	Very good
Holm oak	45 min.	5 h.	Very good	Very good	Very good

Source: Zamora (1996, p.25).

However, yields and quality also depended on the type of charcoal kiln used. The *carbonera de boquet o de pila alta* was, according to Zamora (1996, p. 22), the most common charcoal kiln in Catalonia. Other types of charcoal kiln existed, as the *carbonera de manxa*, *carbonera en olla* or *carbonera de pila baixa*, used especially in the southern parts of Catalonia. The description of this latter type is given by Violant i Simorra (1990), as quoted in Zamora (1996, p.22):

> «*És plana i allargada, i arrodonida de sobre amb tendència a aixecar-se bastant més de la part més ampla, que no la del boquet o ull (xemeneia) de calar-hi foc. Ens digueren que pren el nom esmentat perquè té la forma de manxa, però, en realitat, deu ésser perquè els seus múltiples respiralls són disposats per a manxar el foc per mitjà del corrent de l'aire. La planta consta d'una figura trapezial, de paret o de pedres arrenglerades, en la part més estreta, la qual amida uns 5 metres per 1 metre, respectivament, d'amplada, amb els angles arrodonits en la part més ampla. A cada un d'aquests angles hi ha una espitllera arran de terra, les quals, junt amb altres tres que hi ha a la part del darrera, es converteixen en xemeneies, quan crema la llenya. La part més estreta l'ocupa el boquet per encendre-la, el qual tapen després de fer-ho. A més hi ha una ala o boquet o espitllera petita a cada costat que, a més de respiralls, a vegades també serveixen per a*

calar foc per aquells costats. La llenya la posen ajaguda damunt dels bancs o buscalls grossos que col·loquen a terra, formant els caminets o canals dels respiralls que xuclen i condueixen l'aire de les espitlleres i de les ales. Bo i apilant la llenya van pujant la paret esmentada del voltant arran de la pila. Després la cobreixen de feixos de rama de pi per tal de tapar la respiració, i a sobre posen una capa de terra, procurant que no es foradi. Si és una carbonera de 12 o 15 quintars (41'6 kg cada quintar), crema durant uns 8 o 10 dies, vigilant-la contínuament. Però se'n fan àdhuc de 50 a 60 quintars. Uns feixos de pi col·locats ajaguts a tall de paravent a les cinc espitlleres, mentre crema, decanten l'aire pel cantó que més convé al foc. Aquest tipus de carbonera, segons la veu d'un vell octogenari de Prades, on la veiérem cremar el 1946, fou importat al poble, des de Tortosa, feia llavorns uns 50 anys.»

Zamora (1996) also quotes how seasonal workers from Tortosa visited the mountains of Montseny, using this particular technique, which has left scarce documentation. Afterwards, he cites a text from the Commonwealth of Catalonia period (1914-1925) which highlights that despite the difference between various charcoal kilns is “practically negligible”, the charcoal produced by this latter type –*pila baixa*– had a blue tinge, a “much lower” potency as well as less overall production per kiln, but which apparently was appreciated by smiths. On the other hand, the *pila baixa* kiln hasn't to be re-fed with additional firewood –*bitllar* in Catalan– so it is more efficient when «*only three or four cargues can be made with low quality firewood*»(Zamora, 1996, p. 23).

In any case, many different qualities of charcoal could from this process; the *carbó de rabassa o rabassó* was made out of large branches or heather stumps, and was especially appreciated by smiths in the cases in which iron didn't have to get to a specially high temperature (Zamora, 1996, p. 24). The *carbó de fanals*, despite its name, it was not made from or for lanterns; it was made out of slim oak branches, which were later deposited in rectangular pits of 3 meters by 60-80 centimetres. They were then interred and let to burn for two or three days, after which it was put out with water. According to Zamora (1996, p. 24), its characteristic of zones with high population density, such as both Vallès counties. Finally, *Cisco*, defined as “small charcoal bits” by the RAE, its name originated from Latin *ciccum*, “insignificant thing”.

However, despite customs and traditional knowledge providing various methods to distinguish between its qualities, both charcoal and firewood were goods prone to deceit and fraud by dishonest sellers. Literature provides many case in which the quality of the product is falsified –trying to present less-calorifically potent varieties as higher ones– or in terms of quantity – selling sacks of lesser weight than the standard. Legislating to prevent the latter case of fraud was especially important for Barcelona's public administration, which already in 1785 published the following ban[3]:

«*Insiguiendo lo acordado por el Muy Ilustre Ayuntamiento en treynta y uno de Octubre proximo pasado en cumplimiento de la Orden, que se le ha comunicado de S. Exca. y real Acuerdo de quinze del mismo mes, ORDENO Y MANDO: I. Que no se venda, baxo pena de tres libras, la mas minima porcion de Carbón sin cribar. II. Que los Pesadores no exijan ningun estipendio por las Pesadas menores, baxo la misma pena. III. Que los tres Pesadores de la Marina asistan con puntualidad en las horas que se les están destinadas, y en ellas incesantemente despachen con preferencia à los Pobres, pues acrédite la experiencia su omisión, y retardo, baxo la pena de tres libras. IV. Que los Patrones de barcos no puedan, baxo la pena de veinte y cinco libras, y otras arbitrarias, conforme à la naturaleza de su exceso, dar Carbón de noche, ni de dia, sin que se les mande por los Almotacenes, para evitar con esto el extravío, que se hace de noche. V. Que nadie pueda, à no ser del numero de los sesenta Faquines señalados, traginar Carbón, baxo la pena prescrita en el último Pregón. VI. Que los sesenta Faquines estén a la Puerta del Mar, á la parte de la Ciudad, como se les tiene mandado, y no lo cumplen, en pena de tres libras. VII. Que los sesenta Faquines guarden su Turno, como lo observan los Carreteros de Mar, à cuyo fin se les nombrarán dos Sindicos para que quando el uno trabaje le substituya el otro, de modo que los Compradores no puedan elegir Faquin, sino que deban tomar el que esté de Turno, en pena de tres libras. VIII. Que igual Turno se guarde en el despacho del Carbón, sin distincion de clases, ni Personas. IX. Que ningun Faquin de los sesenta, pueda baxár a la Playa hasta que se empieze á distribuir el Carbón, en pena de tres libras. X. Que los Faquines no puedan exigir mas emolumentos, que los establecidos en la Tarifa, en pena de tres libras la primera vez, y privacion de oficio irremisiblemente la segunda. Y para que venga à noticia de todos, y nadie pueda alegar ignorancia, se publique en los lugares y parages públicos y acostumbrados de esta Ciudad, y su Marina, con las formalidades de estilo. Dado en Barcelona à siete de Noviembre de mil setecientos ochenta y cinco.*»

Supervising all matters related to charcoal was stayed as a role of the administration, which established the following in their *Bando General de Buen Gobierno de 1843*:[4]

«*Culaquiera que venda carbon deberá tenerlo separado segon las calidades y sin mezcla alguna,*

[3] This source is taken from Zamora (1996), Figure 6, page 36. It is entitled "Don Joseph Bernardino de Xarabeitia, Caballero del Orden de Santiago, Brigadier de los Exércitos de su Magestad, Teniente de Rey de esta Plaza, y como tal Corregidor Interino de esta Ciudad, y su Partido, from the Biblioteca Nacional de Catalunya.

[4] Bando General de Buen Gobierno, ó de Policía Urbana para esta ciudad de Barcelona; publicado por su Escmo. Ayuntamiento Constitucional en mayo de 1839 y revisado y adicionado por el de 1842, article 233. Available in digitized format at the Repositori Obert de Coneixement de l'Ajuntament de Barcelona: https://bcnroc.ajuntament.barcelona.cat/jspui/handle/11703/96431

con un letrero en cada monton bien intel·ligible y que esté á la vista, que especifique su calidad y precio, bajo la multa de 8 rs. Por la falta del letrero, y de 100 si hubiese carbon de inferior calidad mezclado con otro que se vendiese á mayor precio. Lo referido se entenderá sin perjuicio de las providència que el Escmo. Ayuntamiento tanga dictades ó dictare en cuanto al desembarco y permanència de carbon en la playa y su introduccion por las puertas de la Ciudad.»

The distinction of quality between fuels in the charcoal shops was especially important for the public administration: it appeared in the *Ordenances Municipals de 1857*[5], where it was noted that:

«*Todo carbonero tendrá el carbon ó leña separado, segon las calidades y sin mezcla alguna, colocando en cada monton un letrero bien intel·ligible y que esté á la vista, donde se esprese la calidad y el precio.*»

The Municipal Ordinances of Barcelona of 1891 established that charcoal and coal were to be sold at a specific shop –-the carboneria-— in dully labelled packages of 5, 10, 20 or 40 kilograms[6]. In these Ordinances, it was specified that:

«*Art. 668. Las carbonerías están sujetas á registro. Art. 669. Queda prohibida la venta de carbón de ambulancia por las calles y demás vías de la población. Art. 670. Todo carbonero tendrá el carbón ó leña separado, según las calidades y sin mezcla alguna, colocando en cada montón un letrero bien intel·ligible y que esté a la vista, donde se exprese la calidad y el precio. Art. 671. Los serones en que se conduzcan el carbón han de llevar una chapa en que conste el número del registro de la carboneria y el peso del carbón que puedan contener. Art. 672. Dicho peso corresponderá á 5, 10, 20 y 40 kilogramos, quedando, por tanto, vedada a la conducción de dicho combustible en cantidades que no corresponda á las expresadas ó sus múltiplos. Art. 673. La leña y los demás combustibles no podran venderse por medida, sino sólo al peso, ó por cantidades ó cuerpos ciertos sin referencia á unidades de peso determinadas.*»

In (neo)classic economics, goods are separated in various categories according to different criteria. However, Marshall (1890, xxii) himself commented on the preface to the first edition of his *Principles of Economics*:

«*There has always been a temptation to classify economic goods in clearly defined groups, about which a number of short and sharp propositions could be made, to gratify at once the student's*

[5] Ordenances Municipals de la ciutat de Barcelona de 1857, article 314. Disponibles en format digitalitzat al Repositori Obert de Coneixement de l'Ajuntament de Barcelona: https://bcnroc.ajuntament.barcelona.cat/jspui/handle/11703/96466

[6] Articles 668 to 673. The 1923 version of the Ordinances kept the same goods. For a digitalized version, see the Open Repository of the Municipality of Barcelona: https://bcnroc.ajuntament.barcelona.cat/jspui/handle/11703/96467.

desire for logical precision, and the popular liking for dogmas that have the air of being profound and are yet easily handled. But great mischief seems to have been done by yielding to this temptation, and drawing broad artificial lines of division where Nature has made none. The more simple and absolute an economic doctrine is, the greater will be the confusion which it brings into attempts to apply economic doctrines to practice, if the dividing lines to which it refers cannot be found in real life. There is not in real life a clear line of division between things that are and are not Capital, or that are and are not Necessaries, or again between labour that is an is not Productive.»

In a contemporary textbook of Neoclassical Economics, Mankiw (2016, p.212-213) provides a classification of goods according to their *excludability* and their *rivalry* in consumption. According to these categories, four categories emerge: private goods –exclusive and rival–, public goods –neither exclusive nor rival–, common resources –rival but not exclusive– and club goods – exclusive but not rival. In terms of this classification, charcoal is undoubtedly a private good, both exclusive and rival, as it was a secondary product, a processed good made by professional personnel, and which was generally produced specifically for urban consumption. However, the case of firewood is slightly more complicated, traversed by two axes: the regime of property laws and the environment in which the transaction took place. In a rural context of the *Ancien Régime*, common law defended the access to firewood, at least in its unharvested *fallen* form, in public forest or the commons', thus establishing it as a common good subject to the usual concerns of the *Tragedy of the Commons*. As the modern –and generally-speaking, oligarchic– property regimes closed the public access to forest or harvesting rights, firewood tended to acquire the condition of a private good. However, it must be stated that the difficulties in enforcing the new legislation generated a constant conflict during the 19th century (Jiménez Blanco, 2002). Nonetheless, in urban environments, access to forests was limited due to a *spatial* concern as cities grew and the surrounding forests disappeared. Thus, firewood acquired the category of a private good from the moment in which self-supply became impossible, either due to legal or geographical reasons.

Another important issue to consider is that of the complementary *versus* substitutive nature of fuels. In the case of fuels, both conditions depend on the nature of the *energy converter* employed by the consumer. For instance, in an hearth or in a brazier, the relationship between firewood and charcoal can be generally considered to be substitutive, as charcoal is the "high quality" and more expensive option, considered to be cleaner –producing less smoke– and with a higher calorific potential. Nonetheless, a small amount of firewood in the form of kindling is necessary to start the fire, thus rendering it as a necessary –complimentary– good. Here, it is important to highlight the work of authors such as (Masera et al., 2000;

Serrano-Medrano et al., 2019), which vindicate the mixed nature and interchangeability of energy sources under certain circumstances. Finally, it must be noted that while there's a degree of potential substitution between firewood, charcoal and coal, especially in the energy converters pertaining to the *development block* of coal, the degree of substitution is not perfect: on one hand, a steam engine may work at a lower intensity if fed by charcoal, as railway engineers found out early (Pascual, 2016). On the other hand, while technically dung or coal can be used to light fires for cooking, its toxic emanations may establish it as a last resort for many. However, during the late 18th and 19th centuries, many efforts were made to display coal as a cleaner option to firewood and charcoal. For instance, an advertisement in 1847[7] stated that:

> «*"Combustible para estufas y chimeneas". En Inglaterra y Francia se ha dejado de hacer uso del carbon vegetal, de la leña y hasta del carbon de piedra desde que el establecimiento de las fábricas de gas ha proporcionado al público el coke, combustible el mejor y más económico para usar en las chimeneas y estufas, pues á una gran duración é intesidad de calor, reúne la circunstancia de no producir humo ni olor alguno desagradable. Vendese en la fabrica del gas, Barceloneta."* »

The advertisement claimed that "charcoal, firewood and even coal weren't being consumed in England and France anymore", as coke was purportedly "burning at a longer duration and more intense in heat, not producing neither smoke nor bad smells". However, even though the advertisement claimed that it could be used at chimneys and stoves in general, this was in the case of coke, which had been partially drained of its toxic elements: adequate converters were necessary to avoid contamination of food or health problems. In conclusion, the degree of substitution depended on the availability of said converters, with the *cuina econòmica* or "economic stove" being the preferred innovation to enable cooking while sending the smoke through the chimney.

3.3 The Manifest of 1823

Its complete name is «*Manifiesto de las poderosas razones que tuvo el escmo. ayuntamiento constitucional de la ciudad de Barcelona, capital de la provincia de este nombre, para permitir la introducción e ganado, grano y otros artículos de consumo de procedencia estrangera*», in what could be translated roughly as *Manifesto regarding the powerful reasons the constitutional town council of the city of Barcelona, capital of the province of the same name, had to allow the introduction of livestock, grain and other foreign commodities.* This source has been used by authors such as Renom (2016a, p.25), and is available in a digitalized form. In the context of the Liberal Triennia (1820-1823), the officials of the Barcelonese town council published a book

[7] El Fomento, 18/11/1847, p.3.

detailing the “powerful reasons” that the local government faced during this period in order to obtain much needed basic goods. The book, after providing a lengthy allegation in defence of the constitutional liberties in face of a potentially imminent conflict with the Holy Alliance, exposes the measures proposed and taken in various town council meetings during the month of January by some civilian and military officers. In the first of this sessions, six demands are presented (18 January 1823, p.10):

> «*1.º Que se calcule por una comisión del seno de V.E. la cantidad de víveres de toda clase, que se necesiten para la subsistencia de Barcelona en un año con agregacion de la guarnicion que le competa. 2.º Que desde luego se autorize al comercio para que pueda introducir hasta tales cantidades y las que se necesiten para el consumo diario, de modo que la cantidad resultante del artículo primero quede siempre intacta y solo pueda echarse mano de ella en caso de sitio. 3.º Que se fijen al mismo tiempo los derecho, que deban pagar todos los artículos que se introduzcan, y que su producto sirva para que esta municipalidad pueda hacerse con víveres para sostener en el apurado caso que se menciona en el artículo precedente, á los que no tengan medios de procurarse su subsistencia. 4.º Qué a los introductores por mayor de dos mil quintales y cuarteras en sus respectivos artículos se les haga una rebaja en el derecho de entrada. 5.º Que no se olvide los artículos de carbón y leña y que por esto podria hacerse un córte en los bosques pertenecientes al Crédito público. 6.º Que se pidan al gobierno con urgència, ó se procuren del modo mas eficáz y ejecutivo hasta veinte mil fusiles.”* »

These points could be roughly summarized as follows:

1. That a commission should calculate the number of all sorts of goods which are required for the sustenance of Barcelona for a year, including the military garrison.
2. To permit all forms of commerce to acquire the necessary goods as calculated in the first point, and that those should be put aside and used only in case of siege.
3. To establish the tariffs on incoming goods, and for the resulting money to be reserved to care for the poor in the event of a siege.
4. To set lower tariffs for those suppliers that introduce quantities over 2,000 quintals and cuarteras in their respective products.
5. To not to forget about (char)coal and firewood, and that a cutting might be done in the town council’s forests.
6. To ask the government for –or to procure in any other way– 20,000 rifles.

The 5th point is especially relevant for our topic at hand, as it mentions biofuels specifically while proposing an extraction from public forests. As the commission asked for an estimation on the supplies necessary to resist a year of siege, the following answer was given (23 January 1823, p.12):

> «*La comision en el concepto pues de haber en Barcelona 120,000 personas propone que se acopien los artículos siguientes en las cantidad, que á continuacion se señalan:* »

Table 3.2: Quantities of basic goods to be stored in case of a siege according to the 1823 Manifesto.

English name	**Spanish name**	**Quantity**
Wheat	*Trigo*	365 mil cuarteras
Broad beans	*Habas y habones*	121 mil cuarteras
Kidney beans	*Avichuelas*	30 mil cuarteras
Rice	*Arroz*	100 mil quintales
Salted meat	*Carne salada*	140 mil quintales
Pork	*Tocino*	18 mil quintales
Cod	*Bacalao*	60 mil quintales
Oil	*Aceite*	15200 cargas
Salt	*Sal*	30 mil fanegas
Wine	*Vino*	176 mil cargas
Vinegar	*Vinagre*	250 pipas
Liquor	*Aguardiente*	2 mil cargas
Firewood	*Leña*	3000 mil quintales
(Char)coal	*Carbon*	500 mil quintales
Straw for a thousand horses, hospitals and other atentions	*Paja para mil caballerias, hospitales y demás atenciones*	100 mil quintales
Sardines	*Sardina*	3 mil cascos
Cheese	*Queso*	20 mil quintales

Source: Manifesto of 1823 (see 3.3).

Roughly translated, the commission, considering that Barcelona has a population of 120,000 people, proposes to gather the following articles in the described quantities in table 3.2. Despite it being an estimation, an therefore relatively speculative, the information that it contains is very relevant, as it is a *coetaneous* estimation, which shows the criteria behind what is probably a decision on the maximalist spectre of things. In a later session, the reserves of several other products were accounted for –wheat, rye, barley, beans, maize, flour, rice–, but unluckily fuels did not make it to the list. In any case, if we suppose the units to be Castilian *quintales*, firewood would account for about 138,024 tons, while char(coal) would amount to 23,004 tons. If we assume the data on population to be correct (about 120,000 inhabitants), the quantity of firewood per person per day would be around 3.15 kg, while the quantity of charcoal would be around 0.52 kg. However, if we assumed a ratio of 5:1 from firewood to charcoal, and we converted the quantity of charcoal to equivalent firewood, the result would be a staggering 5.77 kg/hab/day! In both cases, Barcelona would be situated to levels of consumption equal to those of North European cities, slightly higher than similar urban areas like

Milan and somewhat further from cities like Seville or Madrid. As this specific question will be addressed much further on the text, it is presently sufficient to state that such a coetaneous estimate is very valuable to understand contemporary expectations on consumption.

3.4 Pascual Madoz's Geographic-Statistical-Dictionary of Spain and its Overseas Possessions

The *Diccionario geográfico-estadístico-histórico de España y sus posesiones de Ultramar* is the *magnum opus* of Pascual Madoz. Published between the years 1845 and 1850, it is made out of a staggering sixteen volumes, and contains thorough descriptions on every municipality of the Spanish State. In our case, we are interested in his description of rights paid by various commodities in the city of Barcelona during the five years of 1835 to 1839, which we have partially reproduced.

Table 3.3: Duties and tolls of various products in the 1835-1839.

Product	**Unit**	**Duty**	**Quantity**	**Gate toll**	**Quantity**	**Quantity/year**
				Rs vn	*tons*	*tons/year*
Charcoal	Cargas	1.17	358,264	537,396	44,711	8,942
Firewood	Cargas	0.12	79,492	28,056	9,921	1,984
Coal	Quintales	0.03	35,125	3,099	1,616	323

Source: Madoz (vol.3, p.566).

When considering Table 3.3, at a first glance the reader may find that the product of the quantity by the gate toll does not add up; however, the Gate Toll is counted in Reales de Vellón, which followed a system of base 32 until financial reforms in the 1850s. We have calculated the equivalence between cargas, quintales and tonnes[8], obtaining a total of 44,711 registered tonnes of charcoal, 9,921 tonnes of firewood and 1,616 tonnes of coal, respectively. We have then divided the resulting number by 5 –as the information referred to a 5 year period–, obtaining a result of 8,942 tonnes of charcoal, 1,984 tonnes of firewood and 323 tonnes of coal coming in through the gate yearly. The original table also included per capita ratios of each product, according to the author: these were 0.61 cargas of charcoal per person per year, 0.14 cargas of firewood per person per year and 0.06 quintales of coal per person per year, which when converted gives us a number of 0.21 kg/cap/year of charcoal, 0.05 of firewood and 0.01 in the case of coal. If we then convert the charcoal to equivalent firewood and add it up to the original firewood, we get a rate of consumption of 1.08 kilograms of equivalent firewood per person per year. However, it must be stated that this figure corresponds to only those goods that entered the city through the gates –land-based– and paid their tolls.

[8] 1 carga = 124.8 kg ; 1 quintal = 46.008 kg

3.5 Laureano Figuerola's Statistics of Barcelona in 1849

This source is based on Laureano Figuerola's 1849 book *Estadística de Barcelona en 1849*, reprinted more than a hundred years later by Altafulla (Figuerola, 1993[1849]). It is a very thorough and complete work of statistical nature, which covers different topics such as demography, trade and industry in the mid-nineteenth century Barcelona. Among many other information, Figuerola details which commodities –and in which quantity– have paid their dues on entering the city through its various gates (table 3.4). Although the author doesn't specifically state it, these quantities refer to *legal, tax-paying* land-based trade, as if we check the data on oil and liquor in section 3.6 –a source the author knew and used, as we'll see later– the numbers shown –497,000 and 171,000 *roves* of oil and liquor respectively– are about an order of magnitude higher that those shown in table 3.4.

Table 3.4: Quantities of tax-paying goods introduced to Barcelona according to Figuerola (1844-1848).

Year	**Liquor** *(roves)*	**Snow** *(roves)*	**Soap** *(roves)*	**Oil** *(roves)*	**Charcoal** *(quintars)*	**Charcoal** *(tonnes)*
1844		18,160	6,565	327,171		
1845					50,200	2,310
1846	23,208	18,448		184,011	83,017	3,819
1847	13,133	15,272		101,516	83,856	3,858
1848	13,181	13,430	36,296	122,068		

Source: Figuerola (1993[1849]).

In any case, Figuerola (1993[1849], p.161-162) warns that:

«*Incompletas son las noticias que sobre tales artículos de consumo aqui estampamos, ni fiamos mucho en la exactitud de ellas por razones que mas especialmente darémos en el capítulo industrial de la defraudacion. Obsérvese sino el aceite en los actuales años y en el promedio que el Sr. Madoz ha puesto en su obra. Por mucha que sea la disminucion causada con el alumbrado de gas hidrógeno, no es posible suponer que en 1844 fuese mas del doble de los actuales dias, pues que ya en aquel año estaba muy propagada la indicada especie de iluminacion. El aguardiente y la nieve disminuyen en vez de ascender, cosa improbable atendido el mayor número de consumidores. El carbon vegetal es en una cantidad insuficiente para el consumo de una cuarta parte de la poblacion; y solo en un artículo cual el jabon vemos aumento, siendo asi que los adelantos de la química han hecho adoptar en nuestra ciudad la potasa y otros medios de limpieza que pueden con ventaja sustituirlo. Nuestros lectores admitirán en consecuencia tales datos con la reserva ó desconfianza que estamos obligados á inspirarles.* »

Translated as:

> "The news on the articles hereby presented is incomplete, and we don't trust its exactitude much for reasons that will be given in the chapter on industrial fraud. See the (data) on olive oil and compare it with that that Mr. Madoz has included in his work. Even if the fall (in consumption) caused by hidrogenous gas lightning, its not possible to assume that in 1844 (oil consumption) was double that of present days, as in that year said form of illumination was already widespread. Liquor and snow diminish instead of rising, an improbable thing considering a higher number of consumers. Charcoal is insufficient for the consumption of a fourth of the population; and only in an article such as soap we see an increase, as developments in chemistry have made our city adopt the use of potash and other means of cleaning which can advantageously substitute it. Consequently, our readers must admit such data with the reservations and mistrust which we are obliged to inspire (upon them)".

In this paragraph, two interesting notions appear: first, the author recognizes that charcoal is insufficient for the consumption of even a fourth of the total population. On the other hand, the author recognizes the fast implementation of lighting gas, although the validity of data in general is under suspicion. Afterwards, Figuerola shows data on charcoal entered through cabotage (table 3.5):

Table 3.5: Entries of charcoal through cabotage according to Figuerola (1845-1847).

Product	**1845**	**1846**	**1847**	**Yearly average**
Quantity (quintars)	33,170	28,872	42,830	33,959
Quantity (tonnes)	1,526	1,328	1,971	1,562
Value (rals de billó)	433,920	337,355	827,576	433,920

Source: Figuerola (1993[1849]).

The numbers on Table 3.5 disagree considerably with those in the section 3.6, both in quantity (from 94,000 tonnes in the *Balanza* from 1,500-2,000 in this calculation) and in value (from almost 33 million *rals de billó* in the *Balanza* to 430,000- 830,000 in this calculation). What does coincide, however, is the section of «*puertos de la península puestos por órden de preferencia, según la mayor cantidad de mercancías que desde ellos es traída al mercado de Barcelona*»(Figuerola, 1993[1849], p.229), which might be translated as "ports of the Iberian Peninsula ordered according to the quantities they deliver to the market of Barcelona". The author mentions charcoal coming from Alcúdia, Andratx, Arenys de Mar, Sóller, Sant Carles de la Ràpita, Tortosa and l'Escala, while firewood was delivered from Palma, Eivïssa, Andratx, Arenys de Mar, Sant Feliu de Guíxols, Tortosa and a very significant "etc.". In both cases, the superposition with the ports in the *Balanza* of 1848 are notorious (see section 3.6).

Figuerola (1993[1849], p.234) presents a table with a report on the main imported goods which have paid taxes, incoming from foreign lands and America in 1846, through every Spanish customs office and in

Barcelona in particular: in it, it is noticeable how for every element in which there is information on both Barcelona and the Iberian Peninsula, the former concentrates about a third of overall Spanish imports. In this case, the data for 1846 is similar to that of the *Balanza* of 1848 in terms of foreign imports: 3,258 tons of charcoal and 20,629 tons of coal. However, later on in the book, Figuerola recognizes a clear problem with official data, especially that of fiscal origin, as there seems to be a *general tendency towards fraud*, especially in the case of fuels (Figuerola, 1993[1849], p.284-285):

> « *"El carbon de piedra y el vegetal son ó han sido durante mucho tiempo objeto de una defraudacion constante si hemos de atenernos á los datos y cálculos que á ello conducen. Ya sobre el carbon vegetal hicimos notar tan vehemente sospecha (pág. 162), y por lo que respecta á la ulla ó carbon de piedra hallamos datos oficiales muy contradictorios en documentos que tenemos á la vista. En la balanza publicada por la Junta de Comercio en 1849 relativa al año anterior pág. 234 consigna aquella corporacion haber entrado procedentes del estrangero, quintales 388,394 y por cabotage (pág. 23) 6,920. Total en 1848 segun la Junta de Comercio: 395,314. (...) En una reseña publicada por la sociedad El Veterano para hacer conocer la riqueza minera que posee á fin de facilitar la construccion del ferro-carril desde Barcelona á S. Juan de las Abadesas, refiriéndose (página 27) á un dato librado á la compañía por la administración de la aduana, relativo al mismo año 1848, resulta que el carbon importado directamente del estrangero fue en la suma de 752,731 quintales, de modo que entre el dato de la Junta de Comercio y el de la administracion existe una diferencia de 364,337 quintales. Si paramos la atencion en el estado de la Junta de Comercio, parece más próximo á nuestros guarismos en los años inmediatamente anteriores. Pero aceptando como irrecusable el de la administracion que consigna la sociedad del Veterano, causa grande extrañeza que la Junta de Comercio pudiese haber cometido tan notable equivocacion. Sin embargo, si atendemos al número de máquinas de vapor existentes en la ciudad y en los alrededores de ella que deben surtirse de combustible en la misma, si consideramos el consumo de la iluminacion por el gas hidrógeno estraido de la ulla, el de los varios talleres que la han adoptado, el consumo de los buques del puerto y el de las locomotoras del camino de hierro resultará cierto el guarismo de la administracion en 1848; pero en tal caso es notoria la falsedad de las cantidades que oficialmente se suponen introducidas desde 1845 á 1847, pues que la diferencia de un año á otro puede ser únicamente de 45 á 50 mil quintales de aumento sucesivo, pero no de 300 mil repentinamente.* »

This quote is extremely important, as it highlights several relevant phenomenons. First of all, the author displays a constant criticism of the sources he himself employs, as well as those estimations existing in his own time. As he compares the data from Customs with that of the *Junta de Comerç*, he notes that it would be difficult to believe that any of both corporations would deliberately make a mistake on this issue. The conclusion that he reaches is that the *Junta de Comerç* would have somehow only reported *half* of all incoming coal, while leaving out of its data the other half, which was destined to industrial usages, huille gas factories, railways and the steamer ships themselves. What this would imply in practical effects is that half of the coal that reached Barcelona in that decade would not enter markets in general, but would be already vindicated by various corporations. In the latter cases –gas factory, railways, steamer ships– it must be stated that those infrastructures lay in the port of Barcelona or its immediate surroundings, thus manifesting the virtue of being close to the raw materials of its specific industries. On the other hand, if this notion was true, part of the discrepancies between the *Balanzas* of 1848 and 1849 might be explained by both fiscal fraud and oligarchic corporativism.

3.6 The Mercantile Balances of 1848 and 1849

Its complete name is *Balanza Mercantil de la Importacion y Esportacion Verificada por el Puerto y Aduana de Barcelona* –Mercantile Balance of Imports and Exports Verified by the Port and Customs of Barcelona– and was published by the *Junta de Comerç* of Catalonia in the years 1849 and 1850, corresponding to years 1848 and 1849 respectively. It is a *sui generis* source, as aside from those two years, no similar sources are available for the period. In the year 1848, the *Junta* collected directly the data from September to December of that year, while the rest of months were provided by the Customs authorities. In the case of 1849, however, the *Junta* itself took care of gathering the available information (Pujol, 1975, p.458).

Table 3.6: Imports of charcoal according to province or state (1848).

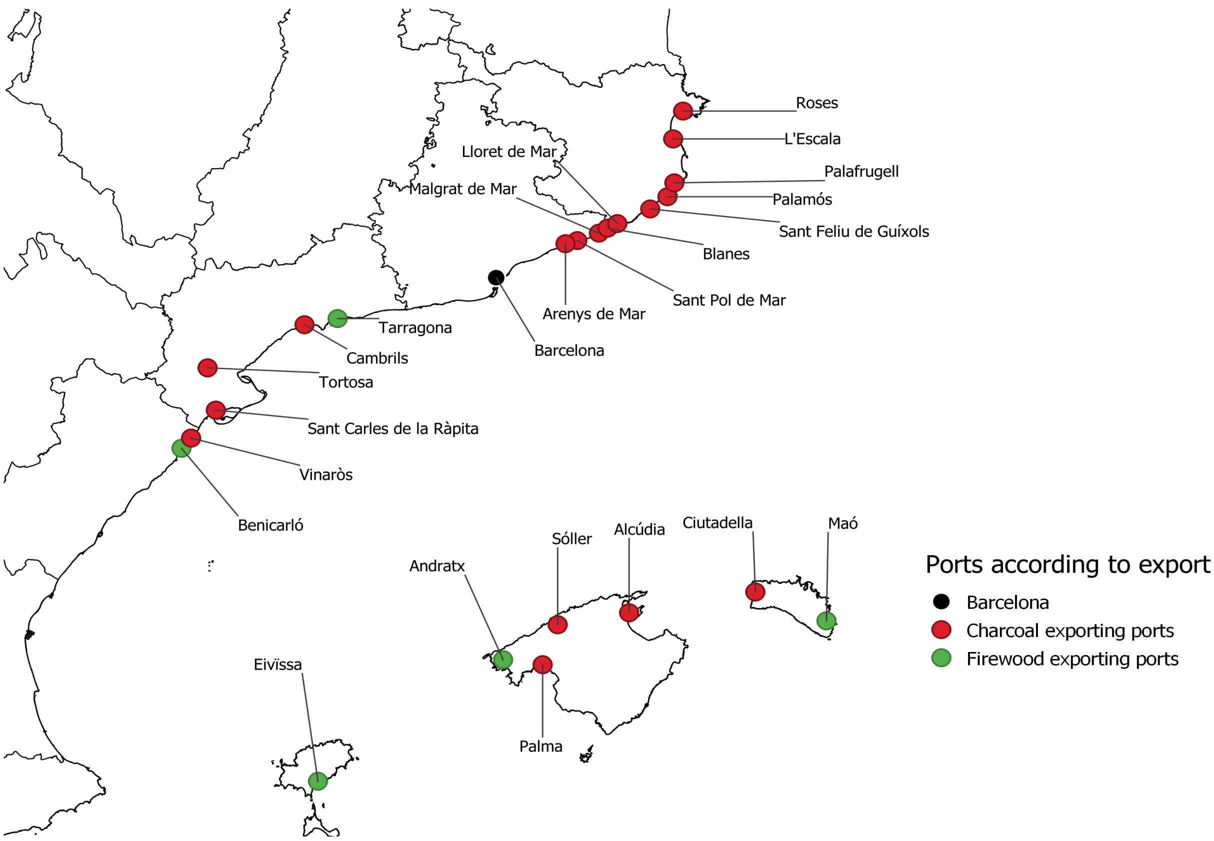
Origin	Quantity (tonnes)	Percentage (%)
Barcelona	47,687	48.17%
Girona	41,690	42.11%
Castelló	4,371	4.42%
Italy	3,938	3.98%
Balearic Islands	801	0.81%
Norway	358	0.36%
France	136	0.14%
Tarragona	15	0.02%
Total	**98,996**	**100%**

Source: *Balanza Mercantil de la Importacion y Esportacion Verificada por el Puerto y Aduana de Barcelona* of 1848 (see 3.6).

Table 3.6 displays the quantities of charcoal entering Barcelona through maritime means in 1848: 98,996 tonnes, of which 95.5 % came from cabotage and the remaining 4,5 % from international commerce. Figure

3.1 displays the main regional shipping ports: Malgrat de Mar, Sant Feliu de Guíxols, Palamós, Vinaròs and Palafrugell, which expended over 100,000 *roves*; in a smaller scale, from 40,000 to 1,000 *roves*, towns such as Sant Pol de Mar, Alcúdia, Sant Carles de la Ràpita, l'Escala, Palma, Arenys de Mar, Roses, Sóller o Tortosa; under 1,000 *roves* there's towns such as Blanes, Cambrils, Lloret and Ciutadella. In the case of firewood (Table 3.7), in the year 1848 the maritime imports account for 1,622 tonnes, of which 99.2 % came through cabotage and the remaining 0.8 % from international trade. The main ports of origin –over 10,000 *roves*– are Palma, Eivïssa, Alcúdia, Tortosa and Sóller; under 10,000 *roves*, towns such as Arenys de Mar, Andratx, Vinaròs, Ciutadella, Blanes, Sant Carles de la Ràpita or Maó; finally, under 1,000 *roves* there are Benicarló, L'Escala o Tarragona.

Figure 3.1: Main ports according to the *Balanza* of 1848.



Source: our own, from the *Balanza Mercantil de la Importacion y Esportacion Verificada por el Puerto y Aduana de Barcelona* of 1848 (see 3.6).

It must be noted that for this particular year we haven't found any sources on land-based trade, which were certainly relevant, especially in the case of firewood, which has more volume and is less dense than charcoal from an energy perspective. However, it is interesting to observe the scope of the Barcelonese

Table 3.7: Imports of firewood according to province or state (1848).

Origin	**Quantity (tonnes)**	**Percentage (%)**
Balearic Islands	1,210	74.64%
Tarragona	245	15.10%
Barcelona	85	5.25%
Castelló	44	2.70%
Girona	37	2.31%
Great Britain	14	0.85%
Total		**100%**

Source: *Balanza Mercantil de la Importacion y Esportacion Verificada por el Puerto y Aduana de Barcelona* of 1848 (see 3.6).

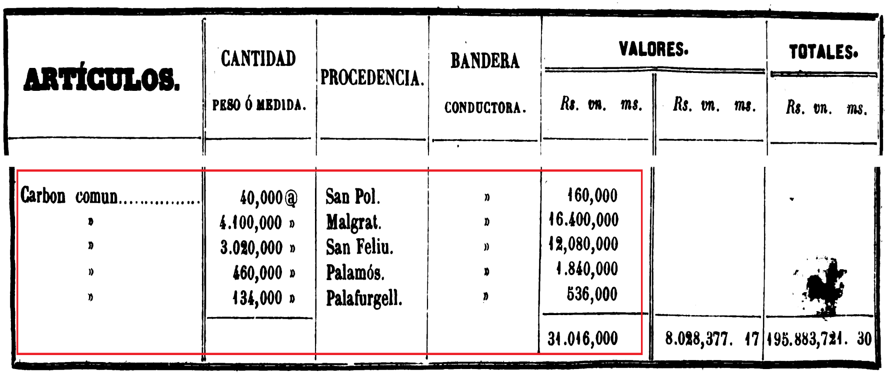
biofuel trading network, as it comprised almost exclusively by ports in the Catalan Countries. Tables 3.6 and 3.7 display the quantities of biofuels according to their origin in terms of the modern Spanish provinces: charcoal imports came mainly from ports in the provinces of Barcelona (48.2 %) and Girona (42.1 %). In the case of firewood, the Balearic Islands (74.6 %) and Tarragona (15.1 %) were the principal sources. Finally, it is relevant to note that there aren't any reports of exports of biofuels by maritime means, unlike fossil fuels such as coal or coke, for which dynamics of territorial redistribution of goods were present throughout the whole period.

Regarding fossil fuels, entries of coal via cabotage stood for a mere 1.75 % of total, while imports from foreign countries amounted to 98.25 %. Of the 18,187 tonnes of incoming coal, 97,11 % of them came from Great Britain. The overall movement of fossil fuels (the sum of cabotage and international trade) amounted to 20,138 tonnes of coal and 77 tonnes of coke, of which 1,951 and 33 of each were redistributed through cabotage, respectively. This process of maritime redistribution via cabotage is practically exclusive to the Catalan-speaking lands with the sole exception of Andalusia, which accounted for a 9,68 % and 43,04 % of outgoing coal and coke through cabotage, respectively.

In the case of the Balance of 1849, there are relevant variations in the data. First, the entries through *importación del Reino*, that is, imports within the Kingdom, don't appear disaggregated as in the previous year. Second, in the case of charcoal, they are notoriously lower than in the previous year, diminishing from 98,000 tonnes to 16,000. As it is such a relevant variation, this problem will be adequately addressed in the following lines and displayed in Figures 3.2 and 3.3. In the year 1848, the two topmost relevant entries in terms of charcoal are those of Malgrat de Mar and Sant Feliu de Guíxols, accounting for 47,000 and 34,000 tonnes, respectively (see Figure 3.2). Since the 1849 data is aggregated, we cannot check for changes at a municipal or port level.

In any case, if we ignored the data for those two towns in 1848, the total amount of charcoal for that year entering the city of Barcelona would be 16,999, an amount not too dissimilar from the 16,641 tonnes of 1849.

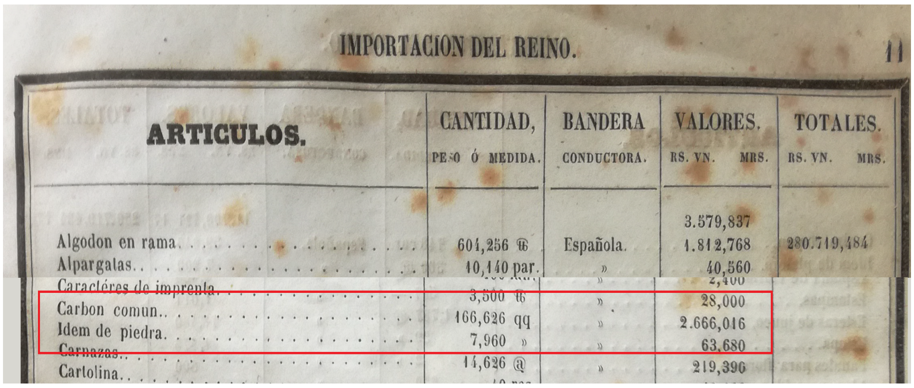
Figure 3.2: Balanza Mercantil of 1848, page 39.



ARTÍCULOS.	CANTIDAD PESO Ó MEDIDA.	PROCEDENCIA.	BANDERA CONDUCTORA.	VALORES. Rs. vn. ms.	Rs. vn. ms.	TOTALES. Rs. vn. ms.
Carbon comun	40,000 @	San Pol.	»	160,000		
»	4.100,000 »	Malgrat.	»	16.400,000		
»	3.020,000 »	San Feliu.	»	12,080,000		
»	460,000 »	Palamós.	»	1.840,000		
»	134,000 »	Palafurgell.	»	536,000		
				31.016,000	8.028,377. 17	195.883,721. 30

Source: *Balanza Mercantil de la Importacion y Esportacion Verificada por el Puerto y Aduana de Barcelona* of 1848, page 39 (see 3.6).

Figure 3.3: Balanza Mercantil of 1849, page 11.



IMPORTACION DEL REINO. 11

ARTICULOS.	CANTIDAD, PESO Ó MEDIDA.	BANDERA CONDUCTORA.	VALORES. RS. VN. MRS.	TOTALES. RS. VN. MRS.
			3.579,837	
Algodon en rama	601,256 ℔	Española.	1.812,768	280.719,484
Alpargatas	10,140 par.	»	40,560	
			2,400	
Caractéres de imprenta	3,500 ℔	»	28,000	
Carbon comun	166,626 qq	»	2.666,016	
Idem de piedra	7,960 »	»	63,680	
Carnazas	14,626 @	»	219,396	
Cartolina				

Source: *Balanza Mercantil de la Importacion y Esportacion Verificada por el Puerto y Aduana de Barcelona* of 1849, page 11 (see 3.6).

If we assumed that an accounting error had been made, and that the actual amounts of Malgrat and Sant Feliu were mistakenly annotated as three orders of magnitude higher, charcoal in 1848 would stand again at 17,081 tonnes, quite similar to the amount of 1849. However, this seems an unlikely case for various reasons, chiefly that neither the sums of quantities nor monetary values would add up correctly. In any case, the next quantitative information that we have found regarding exports of charcoal in Malgrat de Mar are from the year 1857 through the AENC (see 3.10), which account for the exportation of 27,574 *quintars*, equivalent to 1,268 tonnes. This number isn't close neither to the 47,000 tonnes of 1848 nor to the 47 tonnes if we assumed it was an accounting error. However, Pascual (2016, p.34) warns that:

> *"En les línies de Barcelona a França per «la costa»(Mataró) i per «l'interior»(Granollers), llavors en explotació fins a Girona, els productes forestals obtinguts dels boscos del Montseny, Montnegre i les Gavarres –fusta, llenya, carbó vegetal, escorces...– eren els principals productes*

> *transportats i significaven magnituds molt elevades del moviment. L'expansió del tràfic ferroviari d'aquests articles afectà, molt negativament, el moviment dels ports de Blanes i de Malgrat, que secularment havien estat els punts d'expedició dels esmentats productes forestals cap a Barcelona i altres poblacions del litoral català."*
>
> Roughly translated as:
>
> "In the (railroad) lines from Barcelona to France through the coast (Mataró) and the interior (Granollers), at that point connected until Girona, the forest products obtained from the forests of Montseny, Montnegre and les Gavarres –wood, firewood, charcoal, bark– were the main products being transported, and represented very high magnitudes of overall (railway) movement. The expansion of railway traffic of these articles affected very negatively the ports of Blanes and Malgrat, which historically had been the points of expedition of said forest products towards Barcelona and other towns of the Catalan coast."

The competition between railways and cabotage was the main underlying cause behind the diminishing of the latter between the years 1857 and 1889 (Pascual, 2016, p.32). The railway connection between Barcelona and Mataró was inaugurated in 1848; Barcelona and Granollers linked up in 1854; and finally, both lines were connected in 1857 in Maçanet-Massanes, to advance further onto Girona in 1862. Arenys de Mar joined the Barcelona-Mataró line in 1857, while Malgrat de Mar and Blanes opened their stations in 1859. It must be noted that the forest products expedited by the ports of Malgrat and Blanes were not produced locally, but rather collected and distributed from nearby valleys. In this way, forest products from the Montseny and Montnegre could be collected through the Tordera's basin towards Malgrat, Blanes and Arenys, as Sant Feliu did likewise with products from parts of La Selva county and certain counties of the province of Girona. However, it is likely that the expansion of railways redirected part of the Montseny-Montnegre produce either towards Granollers –in the northern side of Montnegre– or towards the coastal railways for the southern part of the Montnegre and the Selvan county.

In any case, the question remains. On one hand, a fall of almost a 85 % of overall charcoal imports seems unlikely. On the other hand, the possibility of an accounting error of *three orders of magnitude* seems also extremely unlikely, and in any case would put into question the entire validity of the source. However, another option is *plausible*: could it be the case that the opening of the Mataró railroad station resulted in at least a partial alleviation of overall traffic? This doesn't seem so unlikely, especially when considering that Arenys de Mar is at a distance of about 10 kilometers to Mataró. Additionally, the Montnegre mountain range covers the entire inland trek between those two points; as transporting goods in mountainous areas is costly, perhaps the displacement of the embarking point made it viable to transport these commodities to Mataró directly from the mountains. In any case, it must be noted that while the first volume of the *Balanza* of 1848 is over 300 hundred pages long, the latter one from 1849 is less than 80 pages long. All this evidence leads us to believe that the disaggregated data of the lengthier *Balanza* of 1848 is of better quality.

Table 3.8: Data summary of the Balances of 1848 and 1849 (in metric tonnes per year).

Year	**1848**			**1849**		
Product	*Coal*	*Charcoal*	*Firewood*	*Coal*	*Charcoal*	*Firewood*
Cabotage in	318	94,460	1,622	366	7,666	11,827
Cabotage out	1,955			1,698	5	
State-balance	-1,636	94,460	1,622	-1,332	7,661	11,827
Imports	17,869	4,433	14	23,161	8,980	
Exports						9
International balance	17,869	4,433	14	23,161	8,980	-9
Total balance	**16,233**	**98,893**	**1,635**	**21,829**	**16,641**	**11,818**

Source: *Balanza Mercantil de la Importacion y Esportacion Verificada por el Puerto y Aduana de Barcelona* of 1848 and 1849 (see 3.6).

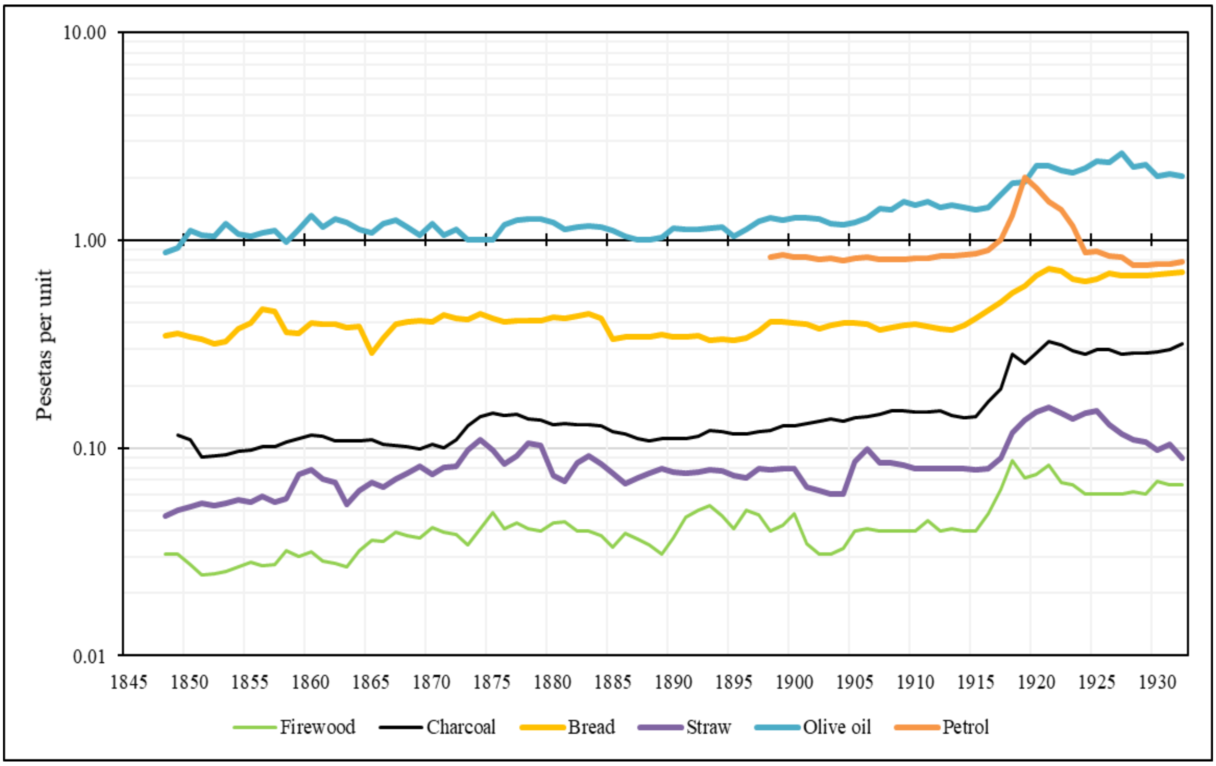
Table 3.8 provides a summary on all fuel imports, both organic and fossil, during the 1848-1849 period. If we were to analyse Barcelona's energy metabolism in terms of the energy carriers acquired through maritime traffic, we would get that in 1848 Barcelona consumed 3,530 TeraJoules of energy, of which 3,024 TJ came from charcoal (85.7 %), 471 TJ from coal (13.3 %), 35 TJ from firewood and a marginal quantity from coke. Despite its comparatively high industrial development, Barcelona stood in 1848 as a mainly organic economy. It must be noted, however, that land-based transport could change the aforementioned figure, although mostly in terms of organic energies such as charcoal and firewood, as coal wasn't available in significant amounts neither in the province of Barcelona nor in Catalonia in general, and at that point railways hadn't developed yet to the point that the city was linked to Europe nor to northern, coal-producing areas of the Iberian Peninsula.

As a comparison, the estimated consumption of biofuels in Madrid, a city of 235,000 inhabitants, during the period 1847-1848, has been estimated between 39,851 tonnes of charcoal and 15,939 tonnes of firewood (J. Bernardos, Hernando, Madrazo, & Nieto, 2011). In the case of Barcelona, there are no accurate population estimates for the year 1848; the Spanish INE notes that the legal population –lower than the actual one– was of 121,815 inhabitants in 1842, while Pedro Felipe Monlau in his work *Abajo las murallas!* considers it to be about 140,000 inhabitants (González, 2005). The most likely population estimate is that of 1857, comprising 235,000 inhabitants (López-Gay, 2014), although it is 9 years later than 1848. In any case, whether the population of Barcelona in 1848 was around 120,000, 140,000 or a higher number, its consumption of charcoal was between 2 and 4.5 times higher than that of Madrid according to the *Balanza* of 1848.

3.7 BOPB - The Official Gazette of the Province of Barcelona (1848-1932)

The *Butlletí Oficial de la Província de Barcelona* (BOPB) was –and still is– the official gazette of the province of Barcelona where regulations, judicial, royal and state decrees and orders were published. Amongst the vast quantities of information it contains, a series of monthly prices of various commodities can be obtained between 1848 and 1932. Despite the bread prices being partially published in the late sixties (Conard & Lovett, 1969), and the fact that the source was acknowledged as useful in the literature (Coll & Fortea, 1995), its quantitative potential has not yet fully been tapped.

Figure 3.4: Various goods' prices in the BOPB in a logarithmic scale (1848-1932).



Source: our own, from the BOPB (see 3.7).

In 1848, a Royal Order[9] established the mechanism and the forms by which War Commissars of every Spanish province were to set the prices at which the Army and the Guardia Civil –a Spanish police force under military rule— acquired their staple supplies. The Commissar's Office had to coordinate with their

[9]Real Orden of 16/09/1848, certified by the Intendencia Militar General on 23/09/1848 and published in the 17/10/1848 issue. The prices on the gazette changed from quarterly to monthly basis in 1850, as stated by Order 283, published in the nº46 BOPB issue in 17/05/1850. Recently, the digital archive has incorporated all issues pertaining to the time period we have analysed, which can be found at the Arxiu General de la Diputació de Barcelona (https://www.diba.cat/web/arxiu/boph). Data on barley is not included since the source uses an unclear unit of volume.

respective Provincial Council in order to obtain the prices of the following commodities: bread, barley, straw, firewood and olive oil, to which charcoal would be promptly added (1849) and later on, petrol (1892). The process through which the Commissar's Office obtained the prices was as follows: first, it addressed the mayors of the Partidos Judiciales –a Spanish administrative subdivision below the province level– under its jurisdiction to ask at which prices the aforementioned products were sold at their local markets. When the mayors replied with the information, the Office proceeded to convert the local units of currency, volume and weight to the Castilian standards. Finally, a simple arithmetic average was calculated for every product, and this was the price which was to be published in the next months' Provincial Gazette. For the Barcelona province, this information ended in 1932. The data series have been constructed by noting the monthly prices of the different products, either from the original or the digitalized issues of the BOPB: in total, over a thousand daily BOPB issues have been reviewed. Then, we have converted the respective units of currency, volume and weight before 1871 to International System units and current Spanish Pesetas according to the standards of the literature and calculated yearly averages (see Tables B.1 and B.2 of the Appendices).

From September of 1848 to August of 1932 we have been able to record 877 of 1,007 and 871 of 1,004 possible observations of firewood and charcoal prices respectively, which represent about 87% of all possible monthly entries in that timeframe. Recording rates are similar for other commodities included in the series with the exception of petrol, which started to be recorded at a much later period. The longest gap in the series is located in 1868, the year of the beginning of the "Spanish Glorious Revolution" for which we have no observations whatsoever. The rest of the gaps are mostly of only one or two months. Since the consistency of the series is quite solid in terms of total observations (see Table B.4 in the Appendices), we have covered the gaps by using linear interpolation. The results are displayed in Figure 3.4.

The most commonly used measure of of volatility is the coefficient of variation, also known as the relative standard deviation (RSD): it has been used by many authors throughout the literature (Sánchez-Albornoz, 1975; Segura i Mas, 1983; Vara, 1999), as Nogués-Marco (2001, p.18) notices. The relative standard variation is calculated by dividing the standard variation in a year by the simple arithmetic average of said year; the results for the BOPB series can be found in the Appendices (see Table B.5). Nogués-Marco (2001, p.19) notices that high RSD values can be attributed to four reasons: due to atypical values, a seasonal component, as a result of mixing different subtypes of a same product or due to general instability in the market price structure. In our case, there's relatively few atypical values in the series. There is also a clearly seasonal component in almost every product, as it is somewhat characteristic of goods from an agrarian origin, with firewood and straw displaying the highest rates, and petrol the lowest ones – albeit in a shorter period. Regarding the third issue, it can be assumed that variability within commodities was minimal, as the Gazette specified the specific qualities of each product. Finally, in relation to the fourth point, the years with the highest RSD are 1856 in the case of bread, 1858 in the case of firewood, 1863 for firewood and straw, 1865-1870 for almost every product –the gap in data for 1868 notwithstanding– and a mild disturbance during years 1916, 1917, 1919 and 1922, especially acute in the case of firewood.

The period of the 1860s and early 1870s was extremely unstable in both economic and political terms: the lack of cotton from the Southern USA in the context of their civil war and the losses of railway companies and their creditors inaugurated what has been considered as the first financial crisis of modern Spain (Martín-Aceña & Nogués-Marco, 2012). The last years of Isabel II's reign were beset by a succession of *pronunciamientos* and revolts, as well as subsistence crises which lead to the "Glorious Revolution of 1868". In Catalonia, a Federalist revolt took place during the year 1869, which was succeeded with the Third Carlist War (1872-1876). In Barcelona, the year 1870 was extremely fateful, as the recruitment for the First Cuban War led to a revolt, and an onset of yellow fever was experienced during the last months of the year. Additionally, the years of WW1 were set by a process of inflation which led to strikes and social revolt –with the special mention of the *La Canadenca* strike of 1919– as well as the failure of the Bank of Barcelona in 1920. Therefore, in general terms, volatility during those two aforementioned periods is to be expected, as circumstances were unstable in economical, political and social terms.

Table 3.9: Correlation coefficient of the goods in the BOPB.

	Firewood	*Charcoal*	*Bread*	*Straw*	*Olive oil*
Firewood	1				
Charcoal	0.88	1.00			
Bread	0.81	0.95	1.00		
Straw	0.83	0.84	0.80	1.00	
Olive oil	0.81	0.95	0.91	0.80	1.00

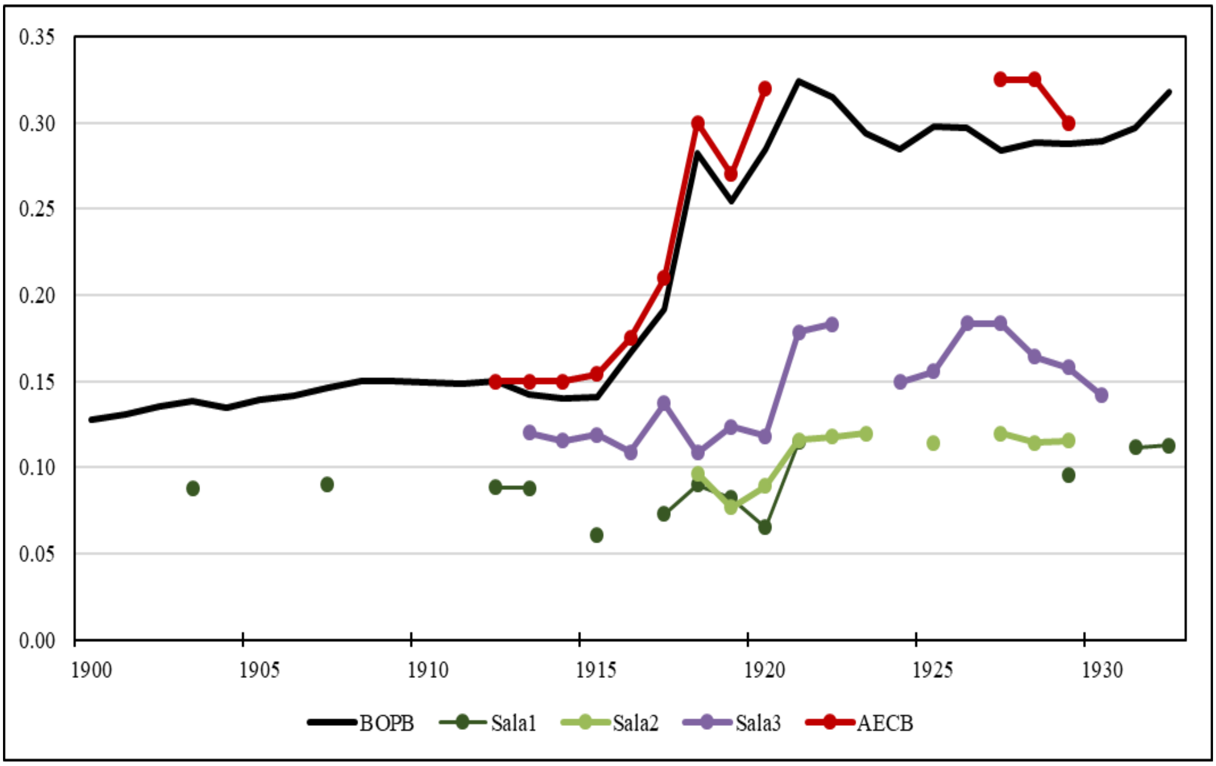
Source: our own, from the BOPB (see 3.7).

Another useful metric to test the "synchronicity in the evolution of prices" (Nogués-Marco, 2001) is that of the correlation coefficient of Pearson, which has been used by many authors (Blyn, 1973; Cartwright, Kamerschen, & Huang, 1989; Ferreira, Barroso, & Carvalho, 2012; Garbade & Silber, 1983; Werden & Froeb, 1993), as acknowledged by Nogués-Marco (2001, p.19). The values for our data series are shown in Table 3.9[10], displaying a very high positive correlation between products – of 90%. Nogués-Marco (2001, p.20) quotes Sánchez-Albornoz (1974) to argue that "the correlation matrix displays the market relationships between the goods that constitute said matrix (...) therefore, the higher the correlation coefficient is, the lesser weight random circumstances or self-consumption has in the prices". In our case, although the series is made from provincial prices, the correlation between prices is extremely high, hinting perhaps at the degree

[10] As charcoal is missing for the year 1848, the year range we have considered was that between 1849 and 1932. Petrol has not been included, as it first appears in the series during the year 1898.

of market integration existing in the province, highlighting Barcelona's role as a price setter.

Figure 3.5: BOPB charcoal prices compared to AECB and Sala's prices (1900-1930).



Source: our own, from the BOPB (see 3.7) and Sala (2003b).

However, because the data series is constituted of various intra-provincial prices, we have to test whether it reflects the *actual* prices paid in the city, or if it is a mere statistical abstraction. To test the BOPB series' coherence with other similar price series, we have scoured through literature and sources, with the former being especially hard to find in any other form than price indices. Figure 3.5 compares our BOPB series with prices from two sources: the first, charcoal from Girona from Sala (2003a) –the first two of which are from *masos* in the province of Girona, and the last from the city of Girona itself. The second source is the AECB, which we have registered on our own, although Gabriel (1988) published the same price series, albeit in an index form. The price from the AECB is almost identical to the BOPB, while the data from Girona displays a different price level but displays the same tendencies as the BOPB series. In Table 3.10 we have compared prices of commodities other than charcoal with other quantities of various products from both series. In general terms, the variation between prices is below 15 %, therefore confirming the validity of the BOPB as representative of Barcelonese prices.

Most of the data before the 1860s was recorded in either arrobas or quintales, with a few observations in quintales métricos, whereas after February 1866 observations started to recorded in kilograms. Furthermore,

Table 3.10: BOPB prices compared to AECB prices (1914-1929).

Year	**Bread**		**Petrol**		**Olive Oil**		**Coke**
	AECB	BOPB	AECB	BOPB	AECB	BOPB	AECB
1914	0.45	0.39	0.90	0.85	1.60	1.44	0.07
1915	0.50	0.42	0.90	0.86	1.60	1.41	0.07
1916	0.55	0.46	0.90	0.90	1.62	1.44	0.13
1917	0.56	0.50	1.03	1.01	2.03	1.67	0.19
1918	0.60	0.56	1.50	1.31	2.05	1.88	0.37
1919	0.62	0.60	1.90	2.01	1.90	1.90	0.27
1920	0.70	0.67	1.27	1.79	2.33	2.29	0.25
1921		0.73		1.54		2.27	
1922		0.71		1.40		2.16	
1923		0.65		1.18		2.12	
1924		0.63		0.87		2.23	
1925		0.65		0.88		2.41	
1926		0.69		0.84		2.37	
1927	0.70	0.68	0.70	0.83	2.80	2.63	0.22
1928	0.70	0.68	0.70	0.76	2.00	2.25	0.22
1929	0.70	0.68	0.70	0.76	2.20	2.30	0.22

Source: our own, from BOPB (see 3.7) and AECB (see 3.11).

different species and qualities of both firewood and charcoal were used for various tasks and purposes, often in a sequential or additive manner. In the BOPB there appear various references to charcoal being made of holm oak, thus establishing it in the mid-high tier in terms of quality, adequate for either heating through fireplaces and braziers or cooking in stoves. It is reasonable to assume that records capture various sub-products depending on availability and changes in supply, although a certain standard for quality was preserved. In this sense, the series probably does not reflect the prices of the worse product qualities –usually consumed by the lower classes– such as *cisco* (coaldust), but neither of charcoal used in industrial smelting and metalworking such as *carbó de rabassa*. Therefore, the BOPB series can be considered a representative average for the urban prices of mid-to-high product qualities of firewood and charcoal bought in the main marketplaces within the province of Barcelona.

3.8 Ildefons Cerdà's Statistical Monography of the Working Class in Barcelona (1856)

As part of his *General Theory of Urbanisation*, the engineer, city planner and social reformer Ildefons Cerdà published a specific booklet entitled *Statistical Monography of the working class in Barcelona*, which sought to understand the conditions of the Barcelonese working class in statistical, quantitative terms. In one of the subsections, the author makes an account on all household tools, among which a *capazo o espuerta para* *el carbón* –basket for (char)coal– is found, thus displaying what was the most common fuel (Cerdà, 1867, p.652). On another section, the author analyses the daily expenses for families in various categories, such as food, on which he proposes an average of 0.172 Reales per day in concept of "condiments and fuel" (Cerdà, 1867, p.661). If we assumed that the 15.69 Pesetas per year that that quantity represents were strictly spent on fuel, 400.72 kilograms of firewood or 152.29 kg of charcoal per year could be bought at current prices during that year (see Section 3.7). The former would result in about one kilogram per capita per day, although if we were to multiply the 0.4 kilograms of charcoal per capita per day by a factor of 5 or 5.5 –their equivalence in firewood, as is customary in the literature– the daily consumption rises to 2-2.3 kg/cap/day. On one hand, if we consider the previously recorded mention of the coal basket, as well as the references throughout the text of the *General Theory of urbanisation* to the space that coal bunkers took inside the household (p.232,246) and the 99 *carbonerías* –coal shops, which sold both coal and charcoal– operating during that year (p.260), it is sensible to consider that a very relevant part of overall fuel consumption was either charcoal or coal. On the other hand, when accounting for the food expenses for married men (p.657), the consumption of oil during dinner is recorded as being "0.025 L of oil, at 5.12 Reales per Litre", while the amounts during supper rise to "0.035 L of oil for the oil lamp, at 5.12 Reales per Litre". In any case, this is a clear reference to the prevalent source of domestic illumination on working class dwellings of the period. Finally, the 0.035 daily Litres of oil amounted to 12.775 L per year.

3.9 ECE - The Foreign Commerce Statistics

The *Estadísticas del Comercio Exterior* have been published by the Spanish Statistics Bureau –INE– from the year 1857 until the present. They have been used by many authors for many purposes, as the vast array of data they contain provides information on many issues.[11] However, unlike other European trade statistics, it must be noted that the Spanish ones are inconsistent in many aspects, such as following a specific, coherent approach. Thus, some authors have doubted their validity in some aspects or their validity in general (Valentín Andrés Álvarez (1943), quoted in Badenes, 2020, p.36-37):

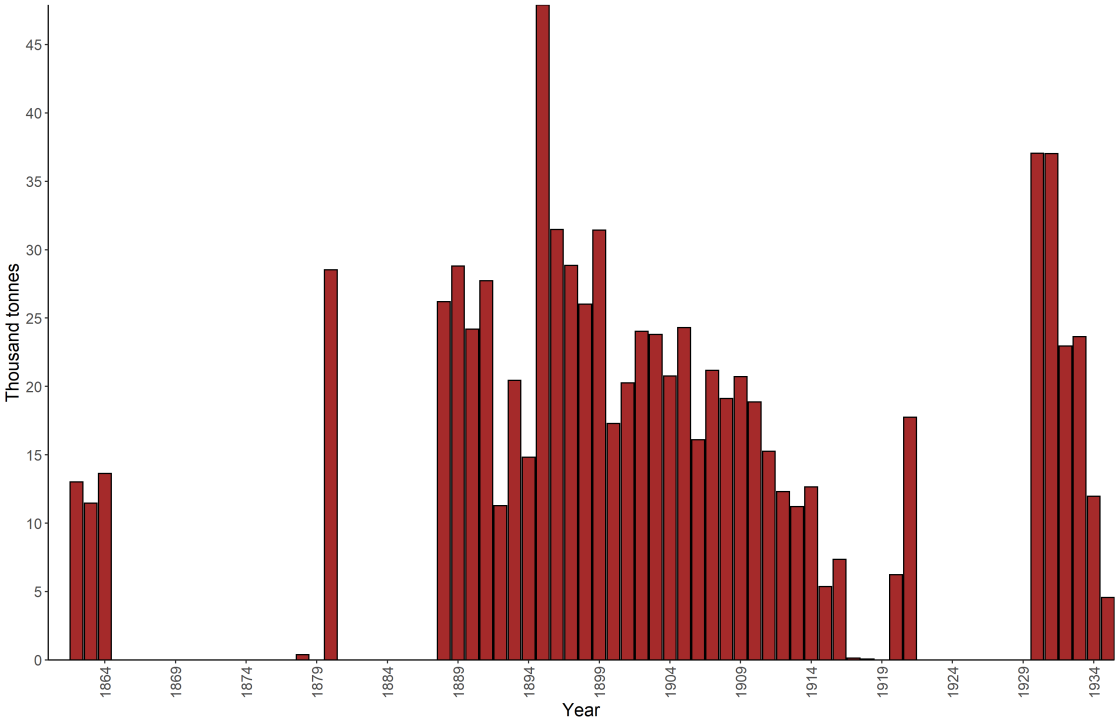
> «*Nuestras estadísticas del Comercio Exterior, al menos las anteriores a 1930, están falseadísimas por el número y magnitud de los errores cometidos al fijar los valores de las mercancías, pudiendo afirmarse, sin caer en la exageración, que no tenemos ningún conocimiento de la historia de nuestra Balanza de Comercio.* »

Which could be roughly translated as:

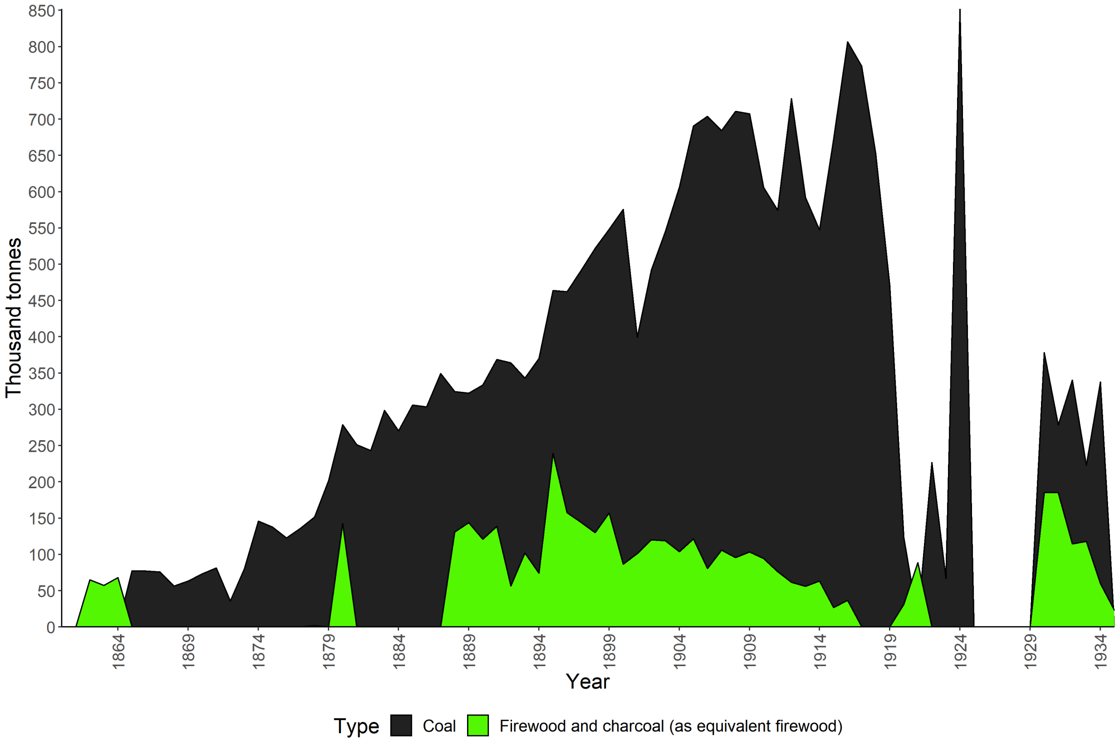
[11] I would like to thank Dr. Albert Carreras for providing me with the data for said period.

Figure 3.6: Energy carrier imports to the city of Barcelona according to the ECE (1860-1935).

(a) Charcoal



(b) Energy carriers



Source: our own, from the ECE (see 3.9).

> «Our Foreign Commerce statistics, at least those before 1930, are ripe with falsities due to the number and magnitude of the errors committed when reporting the values of goods, leading us to affirm, without exaggeration, that we don't have any knowledge of our trade balance.»

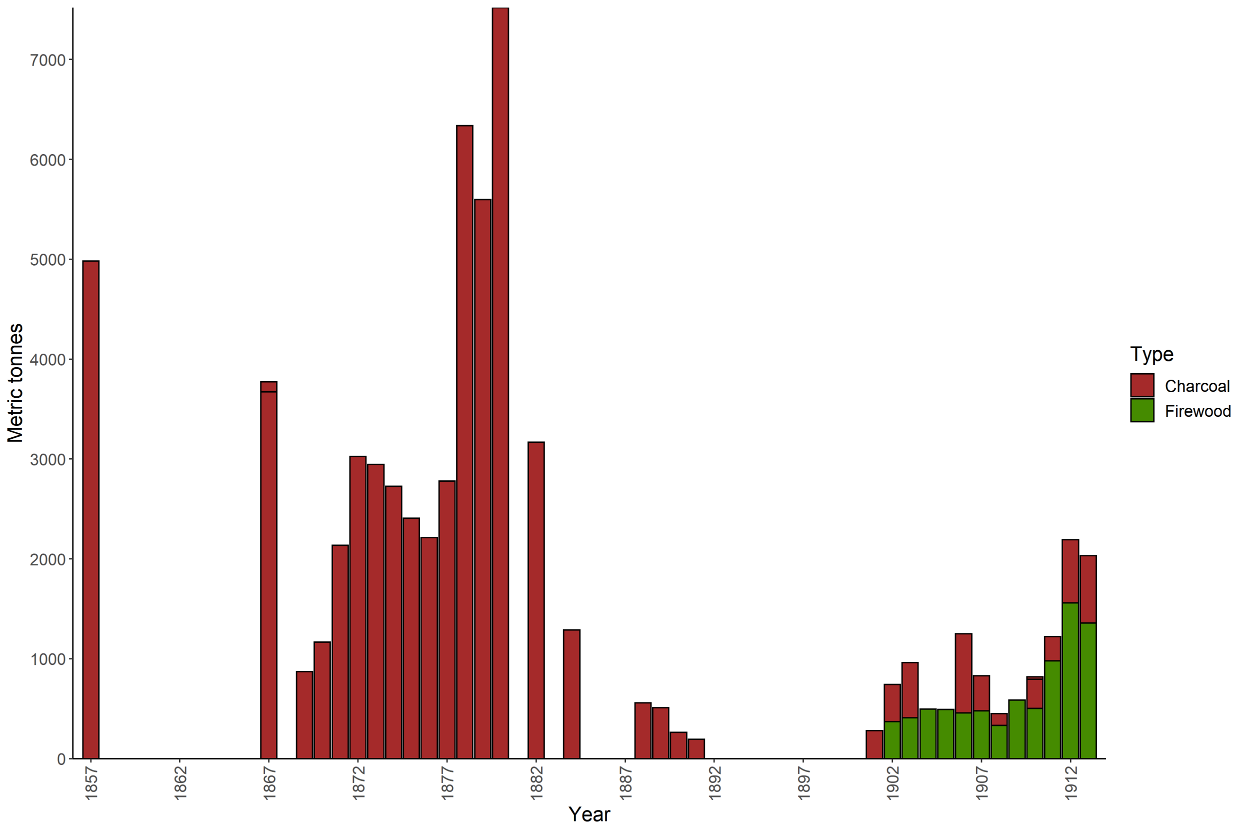
Among some of the causes behind these errors, the author highlighted three: delays in assigning values to the goods, the imposition of the same values to heterogeneous sets of goods, and meddling with protectionist intentions to increase tariff revenue, as explained by Badenes (2020, p.37). Nonetheless, several authors have attempted reconstructions and estimations on the trade balance (Carreras & Tafunell, 2006; Prados De La Escosura, 1982), as well as the debates surrounding foreign trade and trade policy (Tena Junguito, 1999, 2002, 2005). Coincidentally, Carreras (1983) has pointed out that there are less biases and imprecisions among physical quantities (quoted in Badenes, 2020, p.37). However, in our case, the main problem lies not in the *quality* of the data, but on the presence of the data itself. Disaggregated data, by ports and by products, is only available for certain periods; in the case of charcoal in the context of our chronological scope, that is between 1862 and 1935, with a brief gap between 1925 and 1929 where the ECE didn't disaggregate by toll. The main problem with this source is that charcoal appears intermittently, and for some years is completely absent (see Figure 3.6). Furthermore, in the aforementioned period, no imports nor exports of firewood were reported, and exports of charcoal were scarce and not very significant.

Figure 3.6 displays three different periods: the first one, roughly comprising the period 1860-1895, was characterized from an upwards tendency in terms of imports, albeit with some variation in the last years of the period. In the next period, from 1895 to 1920, international imports clearly fell. The last period, comprised between 1920 and 1936, saw yet again an increase in imports, although in the beginning of the 1930s the tendency was downwards again. On the other hand, Figure 3.6.b compares fossil fuel imports to those of charcoal and their equivalence in firewood. Unluckily, there aren't any records of imported charcoal for the period in which coal imports overtook those of charcoal and equivalent firewood, with the exception of some years in the 1880s.

3.10 AENC - The Statistical Yearbooks of Cabotage

The *Anuario Estadístico de la Navegación de Cabotaje* –Statistical Yearbook of Cabotage Navigation– was published between 1857 and 1920, and has been studied by authors such as Frax (1981, 1987). In the case of biofuels, data is non-continuous, varying, rather scarce, and localized between years 1857 and 1913. A significant problem noticed by Frax (1981), is that besides replicating some of the problems of the ECE seen in the previous section(3.9), its problems are compounded: during some years the prices-per-unit were taken

Figure 3.7: Firewood and charcoal imports in the city of Barcelona according to the AENC (1857-1913)



Source: our own, from the AENC (see 3.10).

from the ECE itself, leading to severe discrepancies in the case of values. Figure 4.9 displays biofuel entries through cabotage to the city of Barcelona.

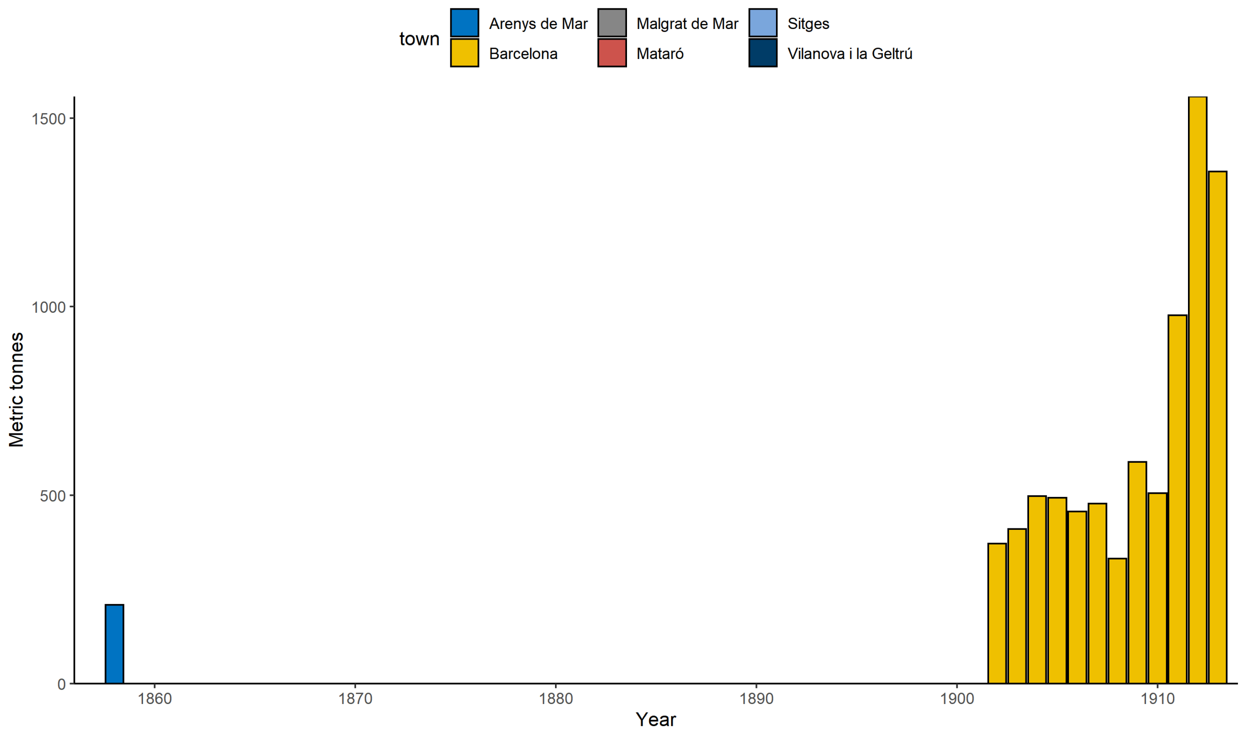
It is hard to believe that the gaps in Figure 4.9 – as well as in Figures 3.8 and 3.9– can be attributed to lack of entrance of goods. However, it is worth noticing that the period for which we posses data is, coincidentally, the one during which freight by cabotage suffered the steepest downturn in favour of railways (see section 4.2.2). In the case of firewood (Figure 3.8) throughout the province of Barcelona, data is concentrated at the chronological extremes of the series: from 1857 to 1861, several records were reported in the case of ports such as Arenys de Mar and Malgrat de Mar, which ten years before, in 1848, were reportedly expending over 40,000 tons (see Section 3.6), but opened their railway stations in 1857 in Arenys and 1859 in Malgrat.

3.11 AECB - The Statistical Yearbooks of the City of Barcelona

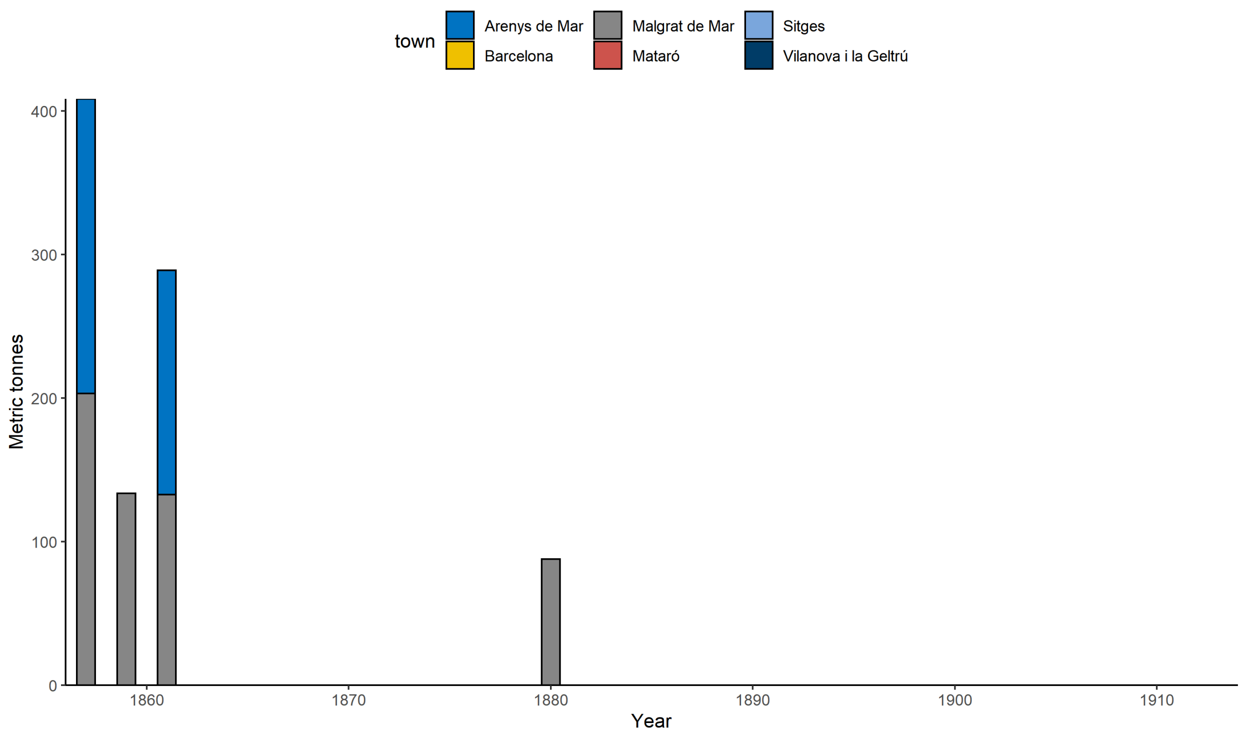
The Statistical Yearbook of the City of Barcelona has been published almost uninterruptedly from 1902 until the present, although from 1929 its name changed to *Estadística Municipal* – Municipal Statistics. It

Figure 3.8: Firewood cabotage freight in the province of Barcelona according to the AENC (1857-1913).

(a) Imports



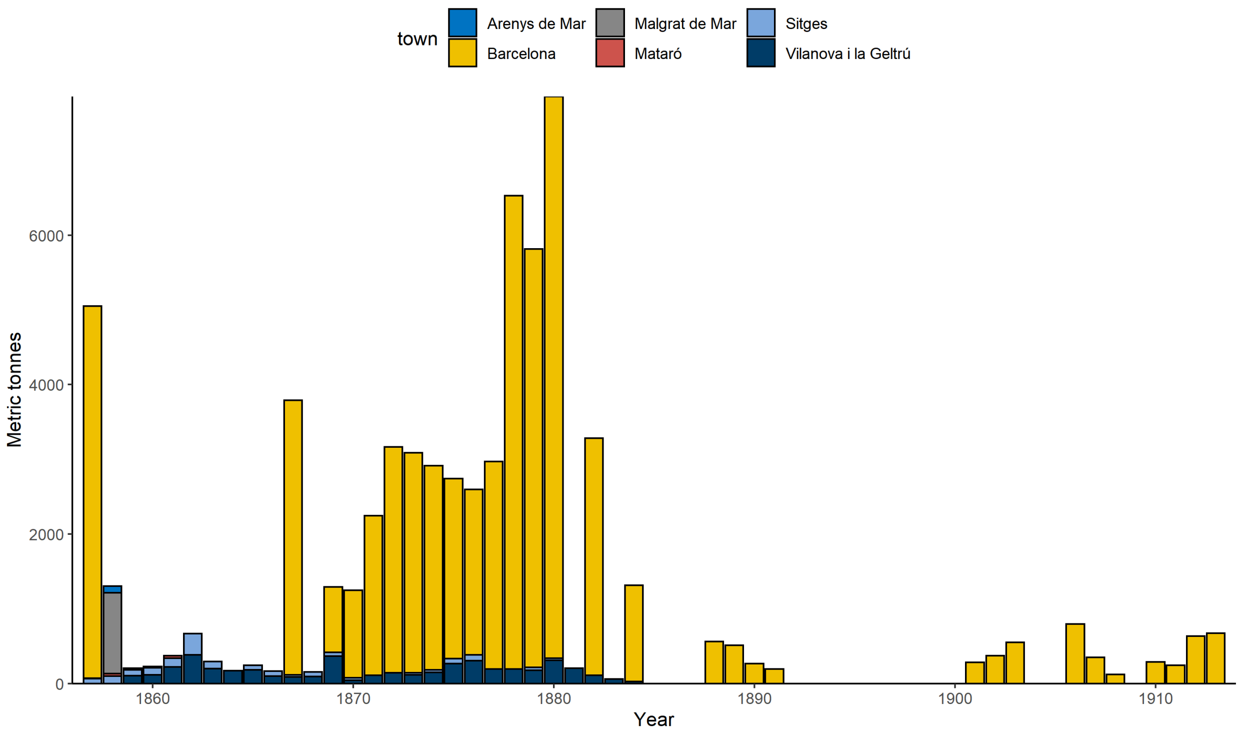
(b) Exports



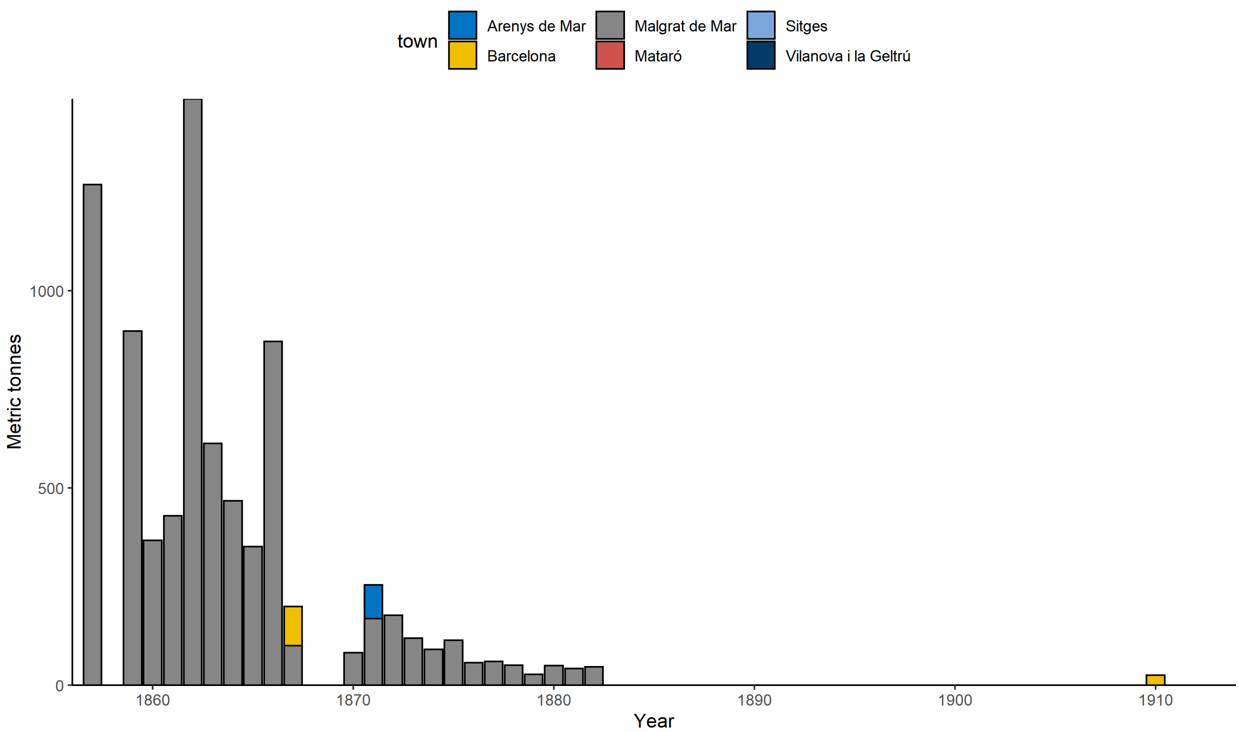
Source: our own, from the AENC (see 3.10).

Figure 3.9: Charcoal cabotage freight in the province of Barcelona according to the AENC (1857-1913).

(a) Imports



(b) Exports



Source: our own, from the AENC (see 3.10).

contains varied statistics, pertaining to demographics or the climate, including prices of supplies –although firewood and charcoal rarely appear; they have been covered in Section 3.7– or even data from cabotage freight. We have used the latter to either complement or compare data in sections 3.9 and 3.10. For instance, the Annuary of 1902[12] recorded the number of shops that sold fuels according to their characteristics and by district (Table 3.11). On another page, it recorded the number of "carbonerías" in Barcelona, which shows the slightly different number of 378 of these shops in the city in the years 1902 to 1906[13]. This is especially relevant if we consider that in 1852, there were 99 "carbonerías" according to Cerdà (see section 3.8).

Table 3.11: Establishments selling various types of fuel (1902).

District \ Type	**Coal* and firewood** *retail*	**Charcoal** *wholesale*	**Firewood** *wholesale*	**Mineral fuels** *wholesale*
Barcelona	275	4	3	18
Gràcia	54		1	
Sant Martí	41			
Sants	24		1	
Sant Andreu	10		1	
Les Corts	5		1	
Sant Gervasi	16			
Total	425	4	7	18

Source: AECB (see 3.11).

Additionally, for some years the Annuaries of 1909 to 1916[14] recorded the quantities consumed in the *Hospital de la Santa Creu* – the same institution on which Vilar and Nogués-Marco had performed their studies on prices, albeit at a different location (see Sections 4.1.1 and 4.1.2), which are displayed in Table 3.12. However, as the "new" building of the *Hospital de la Santa Creu* –near the Sagrada Familia– was built between 1902 and 1930 as a pinnacle of Modernist architecture –the Catalan variety of *Art Nouveau*–, it cannot be considered taken as a representative example.

After the Spanish Civil War, however, some truly *unique* information is provided: the energy carrier consumption estimates presented between 1941 and 1953 (see Figure 3.13, in which H&F refers to "Heat and Force"); although the series goes beyond 1953, it is the last year for which charcoal is displayed, probably due to the liberalization of the firewood and charcoal markets taking place in 1952.

As a result of converting Table 3.13 to energy units, Table 3.14 displays the total consumption of various energies in the city of Barcelona. Several things are relevant: first, energy consumption rose throughout the period, albeit from a certainly low starting point. Second, even through coal represented the most relevant

[12] Anuario Estadístico de la Ciudad de Barcelona, 1902, p.569 and 571.
[13] Anuario Estadístico de la Ciudad de Barcelona, 1902, p.505; 1903, p.456; 1904, p.478; 1905, p.529; 1906, p.517.
[14] Anuario Estadístico de la Ciudad de Barcelona, 1909, p.290; 1910, p.337; 1911, p.358; 1912, p.399; 1913, p.394; 1914, p.436; 1915, p.387.

Table 3.12: Fuel consumption per year of the *Hospital de la Santa Creu* (1909-1916).

Year \ Unit	**Candle coal**[15] T	**Coke** T	**Firewood** kg	**Gas** m³	**Electricity (light)** kWh	**Electricity (force)** kWh
1909	285	12	7050	23723	13242	3575
1910	328	12	5670	27393	23745	2827
1911	355	12	4530	28788	27417	4818
1912	296	9	4862	33522	23999	4074
1913	378	12	17010	39412	14970	5042
1914	402	15	17810	39207	16086.6	2890.34
1915	502	18	20375	45608	21008	2928.55
1916	356.6	12	35.83	47036	23118.6	2305.41

Source: AECB (see 3.11).

Table 3.13: Consumption of energy carriers in the city of Barcelona (1941-1953)

Year	**Coal**	**Charcoal**	**Lighting**	**H&F**	**Traction**	**Electricity (total)**	**Gas (total)**
	tonnes	*tonnes*	*MW*	*MW*	*MW*	*MW*	*thousand m3*
1941	274,562	8,350	74,741	158,134	55,873	288,748	20,613
1942	487,298	15,550	79,910	165,746	60,134	305,790	36,570
1943	486,733	29,450	85,654	179,736	62,318	327,708	47,118
1944	469,683	16,530	89,015	168,711	67,682	325,408	58,540
1945	650,392	51,400	61,277	130,370	57,793	249,440	55,807
1946	698,614	22,100	80,065	163,074	63,210	306,349	58,556
1947	810,833	59,029	96,304	171,054	67,198	334,556	63,974
1948	836,901	68,712	107,030	175,027	71,129	353,185	72,019
1949	993,422	68,848	74,440	122,894	65,947	263,281	75,669
1950	936,510	61,539	101,988	175,085	77,380	354,454	83,436
1951	886,123	59,784	124,624	212,322	86,924	423,870	95,192
1952	992,378	80,291	146,915	244,471	87,096	478,482	103,092
1953	887,241	112,448	155,456	263,100	91,695	510,251	106,108

Source: AECB (see 3.11).

Table 3.14: Energy carrier share over total annual consumption in Barcelona (1941-1953).

Year	**Total Energy**	**Coal**	**Charcoal**	**Gas**	**Electricity**	*Lightning*	*H&F*	*Traction*
	PJ	%	%	%	%	%	%	%
1941	8,25	67.5	2.9	4.4	12.6	*3.3*	*6.9*	*2.4*
1942	13,18	75.0	3.4	4.9	8.4	*2.2*	*4.5*	*1.6*
1943	13,91	71.0	6.1	6	8.5	*2.2*	*4.7*	*1.6*
1944	13,38	71.2	3.6	7.7	8.8	*2.4*	*4.5*	*1.8*
1945	17,46	75.6	8.5	5.6	5.1	*1.3*	*2.7*	*1.2*
1946	18,05	78.5	3.5	5.7	6.1	*1.6*	*3.3*	*1.3*
1947	21,69	75.8	7.9	5.2	5.6	*1.6*	*2.8*	*1.1*
1948	22,78	74.6	8.7	5.6	5.6	*1.7*	*2.8*	*1.1*
1949	25,37	79.4	7.8	5.2	3.7	*1.1*	*1.7*	*0.9*
1950	24,80	76.6	7.2	5.9	5.1	*1.5*	*2.5*	*1.1*
1951	24,43	73.6	7.1	6.9	6.2	*1.8*	*3.1*	*1.3*
1952	27,72	72.7	8.4	6.5	6.2	*1.9*	*3.2*	*1.1*
1953	26,79	67.2	12.1	7.0	6.9	*2.1*	*3.5*	*1.2*

Source: AECB (see 3.11).

Note: To convert data in Table 3.13 to IS energy units, we have used the factors 20.295 GJ/tonne in the case of coal –between the 29.31 GJ/tonne of anthracite and the 11.28 GJ/tonne of lignite, as Asturian coal was of a lesser quality than British–, 28.29 GJ/tonne in the case of charcoal and 17.59 GJ/thousand m^3 of gas (UN, 1987).

source of exosomatic energy, charcoal rose in parallel while electricity declined abruptly, it being especially steep between years 1945 and the early 1950s.

3.12 Miscellaneous historical sources

Despite Spanish neutrality during the Great War, rising prices and inflation of basic products ensued throughout the entire conflict. Authorities were gravely concerned and sought to understand this phenomenon, as it led to sustained revolts amongst the masses, highlighting the dependence on foreign imports of the Catalan industrial economy, especially notorious in the case of fossil fuels, but also present in other sectors, such as wood as a raw material (Iriarte-Goñi & Ayuda, 2006). This situation prompted both Barcelona's local statistical service and the Spanish *Instituto Nacional de Estadística* –among other publications– to include information on biofuels in its studies, noting the steep increases in price, as opposed to previous issues, which only contained information on fossil fuels. In parallel, several sources and authors reported that the extension of Catalan forests was at its historical minimum during the first third of the 20th century, perhaps as a result of decades of sustained pressure. The high prices of wood and other forest products, coupled with the lack of European exports due to the devastation caused by the war, had prompted many Catalan and Spanish forest owners to fell them down to keep supplying the local industries (Cervera, 2017, p.44-45). In

1916, the *Gaceta de Madrid* published the prohibition on charcoal exports.[16] In December, the prohibition was reaffirmed through another order[17]:

> «*Vista la propuesta dirigida a este Ministerio por la Junta Central de Subsistencias, en el sentido de que se disponga por el mismo la suspensión de la salida del carbón vegetal para el extranjero: Resultando que examinadas las estadísticas mensuales del Comercio exterior, se observa un aumento considerable en las exportaciones de dicho artículo, y que si bien los precios no se han elevado hasta ahora en proporción alarmante, la tendencia de los mismos presenta, sin embargo, cierta inclinación al alza, y: Considerando que es de interés primordial que el combustible de que se trata se venda á precio asequibles á las personas menos acomodadas, que son las que con más frecuencia lo utilizan en sus necesidades domésticas, y que para conseguir no sólo la consolidacion del precio actual, sino su futuro abaratamiento, si fuera posible, la prohibición de su salida para el extranjero es seguramente uno de los medios más eficaces, (...) se ha servido disponer: 1.º Que se prohiba la exportacion del carbón vegetal por las Aduanas de la Península é Islas Baleares, á partir de la fecha de la publicación (...).*»

An order[18] in 1918 established a set of restrictions regulating several aspects of coal and its commercialization, prompting the provincial *Juntas locales de Subsistencias* to count the quantities of firewood consumed between 1916 and 1917, as well as the usage of gas in lightning and cooking. As coal commercialization was becoming supervised and restricted, firewood and charcoal availability in a given city or province could entail a lesser assigned quantity of coal. In 1920, the *Gaceta de Madrid* noted a widespread scarcity of charcoal[19]:

> «*Dada la necesidad de facilitar el transporte del carbón vegetal, a fin de evitar la escasez que en muchos puntos se nota de tan indispensable artículo, esta Delegación Regia ha acordado que dicha clase de carbón sea considerado, a los efectos de su transporte por ferrocarril, como artículo de primera necesidad, debiendo, por lo tanto, disfrutar de las preferencias vigentes para dichos artículos y estimarse exceptuando de no ser admitida su facturación en los casos de suspensión de facturaciones. Deberían asimismo las Compañías de ferrocarriles procurar que se dote de material suficiente a las estaciones que sirven centros de producción de carbón vegetal y a las en que se venga facturando en gran cantidad y adoptar las medidas necesarias para la más rápida llegada a los destinos de dicha mercancía.*»

[16] Gaceta de Madrid, num 70, 10 March 1916, p. 565.
[17] Gaceta de Madrid num. 346, 11 December 1916, p. 595.
[18] Gaceta de Madrid num. 219, 7 August 1918, p. 399-400.
[19] Gaceta de Madrid, num. 105, 14 April 1920, p. 160. Ministerio de Abastecimientos: Delegación Regia de Transportes por Ferrocarril.

In 1900, the Institut Agrícola Català de Sant Isidre had addressed the Ministry of Economy by submitting the following note (Zamora, 1996, p.63):[20]

> «*El telegrama que ayer le envié bajo la presión alarmada de algunos agricultores, por haber leído en los diarios locales que una comisión había pasado para gestionar la igualdad de tributación arancelaria entre los carbones vegetales y minerales, no tuvo otra intención que acentuar su conocimiento sobre un asunto verdaderamente de importancia por muchos motivos.*
>
> *No se trata que los carbones vegetales extrangeros paguen los derechos arancelarios que satisfacen los minerales, sino de igualarlos en lo que pagan al Estado por su transporte marítimo, y esto perjudicaría a los carbones vegetales indígenas si no se hiciera la misma rebaja respecto al derecho sobre el transporte terrestre, ya que causando verdadera competencia a los nuestros, los italianos y en especial los de Cerdeña, la harían con más ventaja si todavía resultaran estos rebajados en las 5 pesetas que hoy en día vienen pagando por dicho concepto. Y esto sería de tanto lamentar, cuando el carboneo ya dificil en estos tiempos en nuestros bosques, acabaría por hacerse totalmente ruinoso, no solamente para los propietarios, sino también por el gran número de familias que, en nuestras montañas, se dedican al carboneo.*»

According to (Zamora, 1996, p.64), however, there's records from charcoal commerce with Sardinia in 1856 already. However, competition with foreign goods had increased, and in 1928, the main platform of Catalan landowners published the document *La crisis del carbón vegetal* –the crisis of charcoal– where several problems on the state of forests and the economics behind charcoal-making were highlighted; the authors adduced that chiefly, international competition rendered the enterprise economically inviable (IACSI, 1928, p. 5):

> «*La competencia extranjera es la causa determinante de la crisis de los carbones vegetales de España y especialmente de los de Cataluña. Por los puertos de Barcelona, Valencia y otros; u por via Irún y Port-Bou, con la particularidad de que por Francia vienen grandes cantidades en camión, se importa anualmente un mínimum de 85.000 toneladas de carbones de leña, procedentes principalmente de Francia, Argelia, Córcega y Cerdeña. Últimamente Portugal se presenta también a competir con nuestros carbones. Esta importación equivale a 17.000.000 de pesetas que todos los años se van al extranjero, sin que tal tributo redunde en beneficio de nadie como no sea del comerciante importador.*»

[20]The IACSI or *Institut Agrícola Català de Sant Isidre* roughly translated as the Catalan Agrarian Institute of Saint Isidre, was founded in 1851 and is one of the oldest agrarian associations in Europe.

Furthermore, this source (IACSI, 1928, p.8) provides additional information on the cost structure of charcoal-making, which is summarized in Table 3.15:

> «*En la comarca de Olot el coste de obtención del carbón por tonelada se distribuye así: Cortar las plantas. (1) = 12 ptas. Convertirlas en trozos = 24 ptas. Carbonear = 40 ptas. Transporte del carbón a la carretera pública o estación de ferrocarril = 40 ptas. Total: 116 ptas.(1) Es de advertir que para producir una tonelada de carbón necesita el propietario 5 toneladas de leña por término medio. El precio corriente es de 200 pesetas tonelada sobre vagón origen, quedando al propietario un margen de 84 pesetas por tonelada.*»
>
> *En el Vallés los gastos son: Cortar las plantas = 15 ptas. Convertirlas en trozos = 30 ptas. Carbonear = 55 ptas. Transporte de carbón a la carretera pública o estación de ferrocarril = 40 ptas. Total: 140 ptas. El precio del carbón es de 235 a 240 pesetas tonelada, de modo que a pesar del aumento de gastos en relación a los que se porudcen en Olot, hay un beneficio por tonelada de cerca 100 pesetas, debido a la proximidad de grandes centros de consumo como Tarrasa, Sabadell y Barcelona. Sea el beneficio de 84 pesetas, sea de 100 pesetas por tonelada, prácticamente la operación es ruinosa, puesto que tal beneficio viene sobradamente absorbido por el importe de los tributos que pesan sobre el monte y por los que exige la conservación del mismo, especialmente los de limpia de la vegetación baja que ha perdido el valor que tenía en otros tiempos y que no obstante todo propietario cuidadoso tiene que extirpar para favorecer el crecimiento del arbolado y evitar al propio tiempo el peligro de los incendios.*»

Table 3.15: Cost-benefit structure of charcoal making according to the IACSI.

Item	**Olot**	**Vallès**
Cutting the plants	12 Pesetas	15 Pesetas
Chopping them up	24 Pesetas	30 Pesetas
Making charcoal	40 Pesetas	55 Pesetas
Transporting the charcoal to the public road or train station	40 Pesetas	40 Pesetas
Total costs	116 Pesetas	140 Pesetas
Price (per tonne)	200 Pesetas	235-240 Pesetas
Profit margin	84 Pesetas	100 Pesetas

Source: IACSI (1928).

During the 1930s, the Generalitat de Catalunya put into motion several initiatives aimed at protecting and expanding Catalonia's forested areas, including reforestation programs and legal limitations to felling in both public and private forests; in 1938, during the war, oaks and alders became forbidden to be cut down (Cervera, 2017, 46). It was clear that both forests and their byproducts were to be supervised in a more intense fashion.

In 1929 a "Charcoal section" was created in the corporativist organ of the Port of Barcelona[21], a testament to the importance of this commodity. In 1934, it published its internal regulations, regarding working conditions[22]. Additionally, Zamora (1996, p.65) records how the *Associació de Magatzemistes de carbó vegetal de Barcelona* addressed the Chamber of Commerce, Industry and Navigation with the following lines, in which the author fears smuggling and contraband if charcoal imports from Morocco are permitted:

> «*En referència al carbó vegetal procedent del Marroc Espanyol, diu que la importació està prohibida segons la Direcció General de Comerç. Si s'autoritzés seria obrir una porta al contraban, per la manca de control que existeix en aquell territori i així com ha succeït en altres mercaderies, vindrien procedències estrangeres, com si fossin de la Zona Espanyola.*»

Just before the start point of the Civil War, the Catalan government[23] published the directives necessary for importing charcoal – under the epigraph number 132 in the 1936 tariffs. Besides the intricacies of the bureaucratic process necessary to obtain a license to import, an interesting piece of information appears: section d) refers to those cooperatives or unions which import charcoal wholesale to distribute it among their peers' establishments. During the early stages of the Spanish Civil War, an early preoccupation with forest resources was noticed by the DOGC:[24]

> «*Atès que s'elaboren actualment a Catalunya grans quantiats de carbó de pi, de faig i d'alzina, les escorces dels quals vegetals serveixen, entre altres aplicacions, per a la fabricació d'extractes tànics, que podrien arribar a mancar en el nostre mercat consumidor, He resolt: Sempre que per a l'elaboració del carbó vegetal siguin emprats troncs i branques de faig, de pi i d'alzina proveïts d'escorça pelable, se sotmetran aquells a un previ pelat abans de la carbonització.*»

During the summer of 1937, the maximum prices of many products were fixed in an order by the Spanish Government[25], including charcoal, which was set at a price of 0.65 Pesetas per two kilograms, that is, 0.325 Pesetas per kilogram. In September, prices were set again by an order [26] at 0.22 Pesetas/kg in the case of charcoal *sobre vagón, a granel* –in the loading station near the production area, at a wholesale– while it was to be sold at 0.35 Pesetas per kilogram at urban markets. Later in 1937, the Generalitat of Catalonia published 3 important orders in the same issue in the DOGC[27]: the takeover of the gas industries (p.542), a takeover in charcoal-making (p.543) and the rationing of charcoal (p.543-544). The second order began:

[21] Gaceta de Madrid num. 152, 1 June 1929, p. 1303.
[22] BOGC num. 235, 23 August 1934, p. 1103-1105.
[23] BOGC num. 193, 11 July 1936, p. 339.
[24] DOGC num. 80, 21 Març 1937, p. 1203-1204
[25] Gaceta de la República num. 243, 31 August 1937, p. 870.
[26] Gaceta de la República num. 271, 28 September 1937, p. 1252-1255.
[27] DOGC num. 309, 5 November 1937, p. 542-544.

«*Les circumstàncies difícils que travessa el país fa que el Govern de la Generalitat es vegi obligat a intervenir d'una manera directa en la regulació dels preus i distribució dels articles de consum més necessaris. Un d'aquests articles és el carbó vegetal. Cal, doncs, evitar que aquest combustible sofreixi les càrregues d'una especulació poc escrupulosa, portant una carestia i un transtorn a la vida domèstica, perjudicada ja per altres necessitats que la present situació fa menys remeiables. És de tota necessitat procurar que el preu del carbó quedi reduït als seus justos límits i el seu repartiment s'efectuï en un sentit d'equitat, atenent sempre que els dos interessos en joc, el del productor i el del consumidor, es vegin atesos per un igual.*»

The third order set prices:

«*Primer – El racionament màxim del carbó vegetal queda fixat per a tot Catalunya a raó de 5 quilos per setmana per a les famílies fins a cinc individus, i de 10 quilos per setmana quan la família consti de sis individus o més.*

Segon – Els preus globals màxims de venda a l'engròs per 100 quilos nets queden fixats per a cada comarca d'acord amb les tarifes següents:

a) En 36 ptes sobre camió o estació d'origen per a les comarques de l'Alt Empordà, la Garrotxa, el Ripollès, la Cerdanya, l'Alt Urgell, el Pallars Sobirà, el Pallars Jussà, la Vall d'Aran, el Berguedà, el Solsonès, la Noguera, la Segarra, la Conca de Barberà, el Priorat, la Ribera, el Baix Ebre, el Montaià i Terra Alta.

b) En 39 ptes per a les comarques del Baix Empordà, del Gironès, la Selva, l'Osona, el Bages, l'urgell, el Segrià, les Garrigues, l'Anoia, l'Alt Penedès, Garraf, el Baix Penedès, l'Alt Camp, el Tarragonès i el Baix Camp.

c) En 41 ptes per a les comarques del Vallès Oriental, el Maresme, el Vallès Occidental, el Baix Llobregat i el Barcelonès.

Si el cost del transport a bast en qualsevol dels pobles de les comarques a que fan referència els apartats a i b fos superior a 4 ptes el quintar mètric, el preu de taxa per a la venda a l'engròs vindria augmentat en 1'50 ptes per quintar.

Tercer – Els preus màxims de venda al detall resten fixats d'acord amb les xifres següents: Barcelona ciutat, en 6'50 ptes els 10 quilos. Comarques del Baix Empordà, el Maresme, el Baix Llobregat, Garraf, el Tarragonès, el Barcelonès i ciutats de Girona, Sabadell, Terrassa, el Vendrell, Reus i Granollers, en 6 ptes els 10 quilos.

Resta de Catalunya, en 5'50 ptes els 10 quilos.»

However, prices kept rising, and in 1938, the DOGC set them again, distinguishing again between different areas in Catalonia and specifying prices for various qualities of biofuels:[28]

> «*A instàncies de la Secció d'Aprofitaments Forestals d'aquest Departament, i davant la necessitat de fixar els preus que han de regir per a la venda de llenya en les seves diverses varietats (...) he resolt: Primer – Els preus globals màxims per a la venda a l'engròs de llenya a la Vegueria de Barcelona i a les Comarques de l'Osona (Vegueria de Vic), de la Selva (Vegueria de Girona), de l'Alt Penedès i Garraf (Vegueria de Tarragona) i d'Anoia (Vegueria de Manresa), seran els següents: Per a la llenya de pi estellada, d'uns 60 cm. de llargària, a 85 ptes la tona. Per a la llenya de pi i alzina, en tronc, igual llargària, a 75 ptes la tona. Per a la llenya d'alzina estellada, d'uns 60 cm de llarg, a 95 ptes la tona. Aquests preus s'entenen situada la llenya a peu de carretera.*
>
> *Segona – Els preus de la llenya a l'engròs que regiran per a la resta de Catalunya seran els mateixos que es consignen a l'apartat anterior, rebaixats en 5 ptes per tona.*
>
> *Tercer – Són fixats com a preus màxims de venda de la llenya posada al domicili del consumidor, els següents: A la ciutat de Barcelona, per a la llenya de pi estellada, d'uns 60 cm de llargària, a 15 ptes els 100 quilos; per a la llenya de pi d'alzina en tronc, igual llargària, a 12'50 ptes els 100 quilos i per a la llenua d'alzina estellada, d'uns 60 cm de llargària, a 16 ptes els 100 quilos. A la Comarca del Barcelonès (Vegueria de Barcelona), per a la llenya de pi estellada, d'uns 60 cm de llargària, a 13'50 ptes els 100 quilos; per a la llenya de pi i alzina, en tronc, igual llargària, a 10'50 ptes els 100 quilos i per a la llenya d'alzina estellada, d'uns 60 cm de llargària, a 15 ptes els 100 quilos. A la resta de Catalunya, per a la llenya de pi estellada, d'uns 60 cm de llargària a 13 ptes els 100 quilos i per a la llenya de pi i alzina, en tronc, igual llargària, a 10 ptes els 100 quilos, i per a la llenya d'alzina estellada, d'uns 60 cm de llargària, a 13'50 ptes els 100 quilos. A Barcelona per la llenya en tacs al major i servida a domicili el de 185 ptes la tona i al detall a 2'50 ptes els 10 quilos, posats al domicili del consumidor. A la resta de Catalunya, per a la llenya en tacs, al major i servida a domicili, el preu serà de 165 ptes tona i al detall, a 2 ptes els 10 quilos.*»

In April of 1938, another order[29] modified the prices of various commodities. Charcoal was set at 0.80 Pesetas/kg *sobre vagón, a granel* while firewood was set at 7 Pesetas per 100 kilograms in the same conditions, that is, 0.07 Pesetas/kg. In urban markets, charcoal was being sold at 0.45 Pesetas/kg and firewood at 20

[28] DOGC num. 27, 27 January 1938, p. 356.

[29] Gaceta de la República num. 119, 29 April 1938, p. 582-585 – biofuels in page 583.

Pesetas the 100 kgs, that is, 0.2 Pesetas per kilogram. In October 1939, the prices were set again[30], with charcoal being set at 50 Pesetas the 100 kilograms «*puestos a pie de camión, a granel*»–that is, out of the truck at a wholesale– or 0.5 Pesetas per kilogram, while firewood was being sold at 80 Pesetas per tonne or 0.08 Pesetas/kg in the forest. In public markets, prices were set at 0.8 Pesetas/kg in the case of charcoal and firewood at 0.25 or 0.30 Pesetas/kg whether it was splintered or in blocks. Over several months, prices had almost doubled in the case of charcoal, and tripled in the case of firewood, as it is characteristic during periods of strife and warfare.

After the Spanish Civil War, the initial stages of the Franco dictatorship were characterized by commercial isolation and an autarchic economical system. Controlling measures over public and private resources were increasingly implemented by the authorities, who put forward a policy of both massive replanting and the establishment of a strict system of cuttings dictated by the state on both public and private grounds, directed at the forest district or provincial level (Cervera, 2017, 49). The lack of fossil fuels prompted the isolationist state to incentivize the usage of *gasógenos*, that is, cars and other vehicles run on gas resulting from charcoal combustion. Zamora (1996, p.66) quotes how these engines had been perfected in Italy due to international sanctions on energy sources imposed to them by the Society of Nations as a response to the Abyssinian War of 1935. In any case, a system was implemented in which every Spanish province was categorized in terms of whether it was in a surplus, in a deficit or it could autonomously supply itself with firewood and charcoal. Publications such as the Statistical Annuary of the City of Barcelona started recording the theoretical values of charcoal consumed by its population (see section 3.11). The situation of commercial isolation made the supply of energy from domestic sources a paramount issue for the regime, which had to do with sources that were being *phased out* in many other European countries.

In 1940, the dire effects of fossil fuel scarcity were already becoming widespread. As we'll see throughout several sources throughout this subsection, the State was extremely interested in circumventing the lack of fossil fuels for vehicles –especially oil in this case– through the use of *gasógenos*, engines based on wood gas. A BOE[31] order in November of 1940 stated:

> «*La organización y desarrollo del empleo de los gasógenos y de las substancias de origen nacional que han de utilizarse en la posible sustitución de los derivados del petróleo, exige como base esencial la rápida obtención de estas últimas, y en cuanto al carbón vegetal se refiere, es indispensable para ello la construcción de hornos metálicos que permitan obtener con mayor celeridad que lo hacen los métodos actuales de carbonización, aquel volumen de carbón que ha de utilizarse en*

[30] Gaceta de la República num. 289, 16 October 1938, p. 191-197 – Biofuel prices in p. 193.

[31] BOE num. 318, 13 November 1940, p. 7812-7813. Orden de 12 de noviembre de 1940 por la que se declaran aplicables los beneficios del Decreto de 17 de septiembre sobre gasógenos, a la fabricación de hornos metálicos para carbonización de leña.

el porvenir. Por tanto, y con el fin de impulsar su construcción y empleo, esta Presidencia ha dispuesto:

Que la fabricación de hornos metálicos y aparatos de carbonización y destilación de carbón vegetal con el fin de emplearlo en gasógenos, se considerará incluída en el párrafo segundo del artículo 1.º del Decreto de 17 de septiembre de 1940 para los efectos que del mismo se derivan. Asimismo, les serán aplicables las normas establecidas en dicho Decreto para la fabricación de gasógenos.»

In May of 1942, several decrees were published on the issue. The first of them[32] established CAMPSA –the state-owned company holding the monopoly on oil– as responsible for the distribution of this new product –charcoal for *gasógenos*– at a benefit rate of 4 % (second article), while prices were to be fixed by the corresponding commissions (third article).

«*El Decreto de diecisiete de septiembre de mil novecientos cuarenta, dictado con la finalidad de impulsar la fabricación de gasógenos, encargó a la Compañía Arrendataria del Monopolio de Petróleos el suministro, en sus estaciones de aprovisionamiento, de los productos de índole vegetal o mineral que los gasógenos hayan de destilar, correspondiendo a la mencionada entidad la preparación de los mismos, con sus envases. Encomendada a la CAMPSA la realización de estas nuevas activitdades, (...) dispongo:*

Artículo primero – Los gastos de primer establecimiento y los de explotación necesarios para el servicio de suministro de carbón, encomendado a la CAMPSA por el artículo séptimo del Decreto de diecisiete de septiembre de mil novecientos cuarenta, se realizarán con cargo a la Renta de Petróleos. Artículo segundo – La Compañía percibirá, en concepto de premio de administración un cuatro por ciento de los beneficios líquidos que se obtengan anualmente. Artículo tercero – Los precios del carbón para gasógenos que sea vendido por la CAMPSA se fijarán trimestralmente por los Ministerios de Hacienda e Industria, decidiéndolos en defecto de acuerdo, la Presidencia del Gobierno. (...)»

The second decree[33] expanded the scope of those materials fit for wood gas elaboration, including in it the lower qualities of –non-wood– coal, such as lignites.

«*Se considera como interés nacional a los efectos de lo dispuesto en la Ley de veinticuatre de octubre de mil novecientos treinta y nueve, de protección a las nuevas industrias de interés*

[32] BOE, 15 May 1942, p. 3416. Decreto de 7 de mayo de 1942 por el que se regulan las condiciones en la que la CAMPSA ha de atender el aprovisionamiento de carbones para gasógenos.

[33] BOE, 15 May 1942, p. 3416. Decreto de 9 de mayo de 1942 por el que se dispone sea considerada como industria de interés nacional la de fabricación de aglomerados especiales para los gasógenos de los vehículos automóviles, a base del aprovechamiento de nuestros carbones minerales inferior (lignitos) o de difícil aprovechamiento (menudos), proyectada por la Sociedad en constitución «Aprovechamientos Carboníferos, S.A.»

nacional, y con derecho a las preferencias que establece el artículo tercero del Decreto de la Presidencia del Gobierno de fecha diecisiete de septiembre de mil novecientos cuarenta, la de fabricación de aglomerados especiales para los gasógenos de vehículos automóviles, a base del aprovechamiento de nuestros carbones minerales inferior (lignitos) o de difícil aprovechamiento (menudos), proyectada por la Sociedad en constitución ACSA.»

The last decree of that issue[34] established the fabrication of the «Llodra» *gasógeno* engine for automobiles as a national interest. As the situation became more dire, the authorities set up a system of fixed prices of firewood and charcoal in October of 1942. The BOE published the following[35]:

«*El aumento del consumo del carbón vegetal producido, en primer lugar, por la escasez de otros combustibles, pero principalmente por el aumento de sus aplicaciones, ha determinado una elevación excesiva en su precio, que es preciso evitar. La diversidad de los lugares de producción del mencionado producto y la variablidad del lugar de consumo hará, quizá, difícil la adquisición por CAMPSA de dicho combustible para su empleo en los gasógenos, por lo que es preciso determinar la preferencia para su adquisición en forma que impida, de un modo real, todo procedimiento de falsear el precio de tasa. En virtud de lo expuesto, y a propuesta de la Junta Superior de Precios, esta Presidencia del Gobierno ha tenido a bien disponer:*

Primero – A partir de la fecha de publicación de esta Orden en el Boletín Oficial del Estado, el precio máximo del carbón vegetal para todas sus aplicaciones será de trescientas cincuenta pesetas tonelada métrica sobre vagón origen o f. o b., incluídos toda clase de productos.

Segundo – El precio máximo de la leña será el de cien pesetas tonelada métrica sobre vagón origen o f. o b., incluídos todos los impuestos.

Tercero – Todos los contratos públicos o privados de aprovechamiento de montes para la obtención de leñas y carbones vegetales, sean o no resultado de subastas, serán revisables en virtud del cumplimiento de los apartados anteriores. Todos los contratos de suministro de leña y carbón vegetal, cuyos precios sean inferiores a los marcados como máximos en los apartados primero y segundo, deberán continuar a los precios anteriores, siempre que el comprador utilice el combustible para su uso propio.

Cuarto – Queda prohibido el transporte del carbón vegetal sobre camiones, fuera del recorrido necesario desde el punto de origen a la estación de embarque y en el interior de las poblaciones,

[34] BOE, 9 May 1942, p. 3416. Decreto de 9 de mayo de 1942 por el que se declara de interés nacional la fabricación del gasógeno marca «Llodra», de carbón vegetal.

[35] BOE num. 290, 14 October 1942, p. 8251. Orden de 15 de octubre de 1942 por la que se fijan los precios de los carbones vegetales y leñas.

para su distribución.

Quinto – De acuerdo con la Ley de 4 de junio de 1940 y Orden de 5 de mayo de 1942 (Boletín Oficial del Estado del 7 de mayo) del Ministrio de Agricultura, sobre regulación de precios y abastecimientos de maderas, la administración forestal podrá adjudicar directamente el carbón producido en determinadas zonas para su entrega a la CAMPSA o a aquellas industria que por su interés primordial determine el Ministerio de Industria y Comercio.

Sexto – Todo el carbón vegetal que circule fuera de la provincia de origen deberá ir acompañado de una guía expedida por la Comisaría de Recursos correspondiente.

Séptimo – El carbón vegetal y leñas que circulen fuera de su provincia de origen sin guía será intervenido y puesto a disposición de la CAMPSA o de la Comisaría General de Abastecimientos y Transportes a los precios señalados en los apartados primero y segundo.

Octavo – Los precios del carbón vegetal y leña para el consumidor (sic.) se fijarán por las Juntas Provinciales de Precios, partiendo de los indicados en los apartados primero y segundo de esta Orden. Los almacenistas sólo podrán percibir en concepto de beneficio comercial el 10 por 100 sobre el costo del carbón c. i f. o vagón destino, de modo análogo a lo que se especifica en el apartado 10.º de la Orden de esta Presidencia de 27 de abril último (Boletín Oficial del Estado) sobre precios de carbones minerales.

Noveno – El precio del carbón vegetal vendido por la CAMPSA para el uso de gasógenos no será tomado en ningún caso como valor de referencia, siendo sancionados por la Fiscalía de Tasas todos los precios que no cumplan las condiciones requeridas. El precio de venta por la CAMPSA del carbón para su empleo en aparatos gasógenos será determinado partiendo del precio sobre vagón origen, ya indicado en el apartado primero de esta Orden, aumentando en todos aquellos gastos, mermas y beneficions que fueran señalados en virtud del acuerdo trimestral a que hace referencia el artículo 3.º del Decreto de 7 de mayo de 1942 que regula las condiciones en que CAMPSA ha de atender el aprovisionamiento de carbones para gasógenos.

Décimo – Los habituales proveedores de carbón vegetal para la producción de lingote y de sulfuro de carbono no podrán, en ningún caso, vender a otro cliente mientras tengan pendientes pedidos de sus consumidores habituales, quedando esta obligación subsistente para el caso de que la explotación de los montes cambie de titular. El precio de este carbón será también el indicado en el apartado primero, salvo en el caso de no ser suministrado por ferrocarril, en cuyo caso ese precio se considerará sobre fábrica receptora.

Undécimo – Quedan derogadas cuantas disposiciones se opongan al espíritu y letra de esta Orden.»

The effects of this Order were quite relevant for several reasons: first, a widespread lack of fuels was noted, paralleled by an increase of charcoal, as well as an increase on its spread towards other uses, from which a steep increase of prices was taking place (first paragraph). In this context, the maximum price of charcoal was set at 350 Pesetas per tonne after taxes (first disposition), while firewood was set at 100 Pesetas per tonne (second disposition). The fourth point prohibited the transportation of charcoal out of their respective provinces, it only being permitted if accompanied by a guide from the corresponding Resource Commission (sixth disposition), otherwise the freight being liable to intervention by the state (seventh disposition). The profit margin for distributors was set at a maximum of 10 % (eight disposition). The ninth point established a difference between the normal charcoal, meant for general consumption, and the special, higher quality charcoal for use in *gasógenos*. All qualities and characteristics of the latter, as well as its price, were specified in an order during December of the same year[36].

«*El aumento contínuo del número de vehículos que emplean combustible sólido mediante aparatos gasógenos impone el señalamiento de normas con el fin de asegurar una más eficaz distribución del carbón vegetal para uso de aparatos gasógenos. En su virtud, previo informe de la Junta de Gasógenos y a propuesta de la Junta Superior de Precios, esta Presidencia del Gobierno ha tenido a bien disponer lo siguiente:*

Primero – La composición del carbón vegetal apto para gasógenos será la que siguie: Humedad máxima, 10 por 100. Tamaño, 15 a 30 mm. Potencia calorífica, 6.500 a 7.000 calorías por kg. Cenizas máximas, 5 por 100. Deberá proceder de las llamadas maderas duras.

Segundo – El carbón especial para gasógenos tendrá el precio de 700 pesetas tonelada en almacén de origen o centro productor de carbón especial para gasógenos.

Tercero – El precio del carbón para gasógenos suministrado por las estaciones de servicio de CAMPSA y los agentes revendedores de productos petrolíferos monopolizados, será señalado trimestralmente por la Comisión designada al efecto en virtud de la Orden de la Presidencia de 7 de mayo de 1942, tomando como precio base el señalado en el punto anterior.»

Therefore, dispositions stated that charcoal for wood gas was to be made out of high-quality wood, of a maximum of 10 % humidity, generating pieces between 15 and 30 mm, with a calorific value of 6,500 to 7,000 calories per kg and a maximum ash content of 5 % (first); the price was set at 700 pesetas per tonne (second),

[36] BOE núm 357, NUM December 1942, p. 10447. Orden de 18 de diciembre de 1942 por la que se regula el precio del carbón vegetal especial para gasógenos.

although liable to be set on a trimester basis by the designed Commission (third). Apparently, these prices were maintained until 1945[37]. In parallel, several places in Mallorca were being authorized as embarking points for charcoal –among other forest products– such as the beach of Punta de l'Àguila in Banyalbúfar (in 1943[38]) or Magaluf (in 1946[39]) through cabotage, with Barcelona as the most likely destination. In 1946, the previous decrees on prices were modified by the following order[40]:

> «*La Orden de esta Presidencia de 15 de octubre de 1942 por la que se fijaron los precios de los carbones vegetales y leñas, estableció una diferenciación entre el precio base o en origen de los carbones vegetales y el precio de venta de los suministrados por la CAMPSA para su empleo en gasógenos, disponiendo que este último se determinaría partiendo del precio sobre vagón origen con los correspondientes aumentos, es decir, que el precio base del carbón vegetal quedó señalado en una misma cuantía para todas sus aplicaciones, incluyendo, por tanto, la de su consumo en gasógenos. Iguales criterios de diferenciación y formación de precios fueron mantenidos en la Orden posterior de esta Presidencia de 18 de diciembre de 1942, referente al precio y condiciones de composición del carbón vegetal para gasógenos, si bien, para estimular la producción con tal destino y en atención a las condiciones de composición establecidas como mínimas, el precio base o en origen de este carbón se fijó en un cuantía superior en el doble a la que había sido señalada por la Orden de 15 de octubre del mismo año.*
>
> *Esa tan considerable diferencia en el precio del carbón vegetal, según su destino, ha sido causa de que, con el consiguiente desabastecimiento de otros sectores de consumo, se origine una desviación de la mayor parte de la producción hacia el consumo a precio más alto, a pesar de no observarse el cumplimiento de las condiciones diferenciales de calidad entre uno y otro tipo de combustible en los suministros que aunque no eran realizados por la CAMPSA se destinaban a su empleo en gasógenos. Por otra parte, las circunstancias que hicieron preciso el señalamiento de un precio alto para conseguir un aumento en la producción de carbón vegetal con destino a gasógenos pueden considerarse virtualmente desaparecidas al haber mejorado el suministro de carburantes líquidos. En virtud de lo expuesto, esta Presidencia del Gobierno, a propuesta de la Junta Superior de Precios, ha tenido a bien disponer lo siguiente:*
>
> *1.º El precio del carbón vegetal, cualquiera que sea su destino y aplicación, será, como máxima,*

[37] BOE num. 148, p. 4373. Ministerio de Industria y Comercio, Secretaría General Técnica: Revisando el precio del carbón vegetal.

[38] BOE núm. 170, p. 5939. Orden de 31 de mayo de 1943 por la que se acuerda habilitar la playa de «Punta del Aguila», del término municipal de Bañalbufar (Mallorca) para el embarque en régimen de cabotaje de maderas en rama, rollo y tronco, corteza raspada de madera y carbón vegetal, procedentes del bosque de «Son Buñola»

[39] BOE num. 169, 18 June 1946, p. 4958-4959. Orden de 7 de junio de 1946 por la que se habilita el puerto de Magalluf (Mallorca) para el embarque, en régimen de cabotaje, de maderas, cortezas, carbón vegetal y piedras.

[40] BOE num. 12, 12 January 1946, p. 357. Orden de 9 de enero de 1946 sobre unificación de precios de carbón vegetal.

> *el señalado en la Orden de esta Presidencia de 15 de octubre de 1942, debiéndose tomar éste, por tanto, como base para determinación del precio de venta por la CAMPSA del carbón para su empleo en aparatos gasógenos.*
>
> *2.º En todos aquellos combustibles para gasógenos preparados a base de mezclas de carbón vegetal y carbón mineral o cualquier otro componente, el precio de dicha mezcla no podrá ser superior, en ningún caso, al valor de la media ponderada de sus componentes, considerados a su precio oficial de tasa, no pudiendo tampoco, sea cualquiera la calidad y el número de sus componentes, exceder el precio resultante para aquella del señalado, como máximo, para el carbón vegetal en el apartado primero de esta disposición.*
>
> *3.º Quedan anuladas cuantas disposiciones sobre precios de combustible para uso en gasógenos se opongan al contenido de lo preceptuado en la presente Orden, debiendo dietar los Ministerios de Hacienda y de Industria y Comercio las instrucciones precisas para el más exacto cumplimiento de lo establecido en la presente disposición.*»

This source is extremely interesting, as in the second paragraph it states that since the price of fuel for wood gas was set at double the price of standard charcoal, production had massively shifted from the latter to the former, resulting in scarcity for "general-purpose charcoal" and a decrease and outright falsification of the qualities of wood gas charcoal. Additionally, as the conditions which required such harsh measures had disappeared as the supply of liquid fossil fuels had been ameliorated –or so they reported–, the prices of charcoal were set back to the values considered in the order of October 15th, 1942 (first disposition), while the price of fuel for wood gas was to be no higher than the average price of its components according to the officially set prices. However, this system was again subsided by a more thoroughly dictated one in December of 1946[41]:

> «*La Orden de esta Presidencia de 15 de octubre de 1942 estableció como precio uniforme para los carbones vegetales de cualquier clase y procedencia el de 350 pesetas por tonelada sobre vagón origen. La necesidad de crear un estímulo para la producción de carbones vegetales de calidad apropiada para su consumo en gasógenos, con arreglo a las condiciones de composición mínima necesarias a tal finalidad, aconsejó publicar la Orden de esta Presidencia de 18 de diciembre del mismo año estableciendo el precio de 700 pesetas por Tm en origen para los carbones aptos para dicho consumo.*
>
> *Acogiéndose a esta disposición, todos los carbones vegetales de buena calidad, con raras excep-*

[41] BOE num. 364, 30 December 1946, p. 9101. Orden de 27 de diciembre de 1946 por la que se señalan precios de carbones vegetales y leñas, en producción y para la venta al público.

ciones, se han venido vendiendo desde dentonces al precio de 700 pesetas por tonelada sobre vagón origen, pues aunque al disminuir la demanda para gasógenos se dictó la Orden de 9 de enero de 1946, derogando el precio especial para éstos, se vió pronto que subsistía una fuerte demanda de los carbones de buena calidad, lo que obligó a dejar en suspenso la aplicación de dicha Orden. La experiencia ha demostrado la conveniencia de fijar precio diferente a los carbones vegetales de distinta calidad, adoptando una clasificación clara y sencilla como medio de lograr una disminución efectiva de su precio medio de venta en el mercado nacional.

Al propio tiempo es indispensable acomodar los precios de las leñas a los del carbón vegetal, pues si aquéllos son demasiado altos se paraliza la carbonización, y si son demasiado bajos quedarían sin cortar gran parte de las leñas nacionales, con el consiguiente perjuicio para el abastecimiento de este combustible. En virtud de lo expuesto, esta Presidencia del Gobierno, a propuesta de la Junta Superior de Precios, ha tenido a bien disponer:

Primero. Las clases de combustibles vegetales y sus precios correspondientes, sobre vagón origen, serán las siguientes: a) carbones vegetales de buena calidad, procedentes de leñas de encina, alcornoque, roble, haya y pino en trozos de tamaño superior a 15mm de diámetro: 600 Pesetas/Tm. b) Carbón de brezo y de raíces de otras plantas, zaragallas y carbones no especificados en el apartado a): 450 Pesetas/Tm. c) Ciscos procedentes de carbones menudos del apartado a): 350 Pesetas/Tm. d) Picón vegetal de residuos carbonizados en rama y ciscos no especificados en el apartado c): 300 Pesetas/Tm. e) Leñas de encina, roble, haya y pino: 160 Pesetas/Tm. f) Las demás leñas no especificadas en el apartado e): 140 Pesetas/Tm.

Segundo. Los precios de venta al público de carbones vegetales, ciscos y picón, en las provincias que tengan un exceso de producción o se abastezcan plenamente a sí mismas, se determinan por la suma del precio sobre vagón origen; seraje; los gastos de transporte hasta la población consumidora; los portes urbanos; las mermas del 3 por 100 sufridas en el transporte; el margen comercial de 15 por 100 al venedor al detall, más los gravámenes locales legalmente autorizados.

Tercero. Los precios de venta al público de las leñas en las provincias con exceso de producción o producción suficiente para abastecerse a sí mismas, serán la suma del precio en origen; los portes a serrería; los gastos de troceado; las mermas del 3 por 100 en el transporte y 3 por 100 en el asserrado; los portes de serrería a carbonería; el 15 por 100 de margen comercial detallista, más los gravámenes locales legalmente establecidos.

Cuarto. Los precios de venta al público de carbones vegetales en las provincias de producción deficitaria, serán la suma del precio sobre vagón origen; seraje; el 10 por 100 sobre el precio en *origen para margen comercial del almacenista; los gastos de transporte; el 3 por 100 de mermas de transporte; el 1,5 por 100 de mermas de almacenaje; los portes urbanos; el 15 por 100 para margen comercial al detallista, más los gravámenes locales legalmente autorizados.*

Quinto. Los precios de venta al público de las leñas en las provincias deficitarias serán la suma de los precios sobre vagón origen; el 10 por 100 de dichos precios como margen comercial de los almacenistas; el transporte ferroviario; el 3 por 100 de mermas en dicho transporte; los portes de estación a serrería en destino; los gastos de troceado; el 3 por 100 de mermas en sierra; los portes de serrería a carbonería; el 15 por 100 de margen comercial al detallista, más los gravámenes locales legalmente establecidos.

Sexto. Como resultado de la aplicación de todos estos conceptos, los precios de venta al público de los distintos combustibles vegetales en las diversas provincias españolas, serán los que se detallan en el cuadro anexo[42]*, y se entenderán como precios máximos. (...) »*

Table 3.16: *Cuadro anexo: precios de venta al público en provincias consumidoras.*

Provincias	**Carbón 1º**	**Carbón 2º**	**Cisco**	**Picón**	**Leña 1º**	**Leña 2º**
Albacete	0.95	0.75	0.60	0.54	0.37	0.35
Alicante	0.97	0.77	0.62	0.55	0.37	0.35
Almería	0.91	0.71	0.56	0.50	0.37	0.35
Barcelona	1.02	0.82	0.66	0.59	0.37	0.35
Cádiz	0.93	0.73	0.58	0.52	0.37	0.35
Castellón de la Plana	0.98	0.78	0.63	0.56	0.37	0.35
Coruña (La)	0.96	0.76	0.62	0.55	0.37	0.35
Granada	0.94	0.74	0.59	0.53	0.37	0.35
Guipúzcoa	0.88	0.68	0.53	0.47	0.37	0.35
Lérida	0.91	0.71	0.56	0.50	0.37	0.35
Lugo	0.95	0.75	0.60	0.54	0.37	0.35
Madrid	0.92	0.72	0.58	0.51	0.39	0.37
Málaga	0.94	0.74	0.59	0.53	0.37	0.35
Murcia	0.97	0.77	0.62	0.55	0.37	0.35
Ourense	0.95	0.75	0.60	0.54	0.37	0.35
Pontevedra	0.96	0.76	0.62	0.55	0.37	0.35
Sevilla	0.91	0.72	0.57	0.50	0.37	0.35
Tarragona	1.00	0.81	0.65	0.58	0.37	0.35
Valencia	0.97	0.77	0.62	0.55	0.37	0.35
Vizcaya	0.90	0.70	0.55	0.40	0.37	0.35
Zamora	0.89	0.69	0.54	0.48	0.37	0.35
Zaragoza	0.97	0.77	0.62	0.55	0.37	0.35

Source: BOE num. 308, 3 November 1948, p.5066-5067. See note 42.

Table 3.16 is an adaptation of the table quoted on BOE 364 of 1946. The missing data from the *provincias*

[42] See Table 3.16. I have adapted the original table from the source to coincide with the format. Therefore, the table displays only the quantities on the consuming provinces; information on producing provinces is reproduced below the table.

productoras y autoabastecidas refers to the provinces of Alava, Asturias, Avila, Badajoz, Baleares, Burgos, Cáceres, Ciudad Real, Córdoba, Cuenca, Gerona, Guadalajara, Huelva, Huesca, Jaén, Las Palmas, León, Logroño, Navarra, Palencia, Salamanca, Santa Cruz de Tenerife, Santander, Segovia, Soria, Teruel, Toledo y Valladolid, and was set at 0.79 Pesetas/tonne for 1^{st} class charcoal (a), 0.61 Pesetas/tonne for 2^{nd} class charcoal (b), 0.49 Pesetas/tonne in the case of *cisco* (c), 0.43 Pesetas/tonne for *picón* (d), 0.35 Pesetas/tonne for 1^{st} class firewood and 0.33 Pesetas/tonne for 2^{nd} class firewood.

Table 3.17: Corrientes comerciales: leña

Provincias productoras	**Provincias deficitarias**	**%**
Alava	Guipuzcoa	60
	Logroño	20
	Discreción	20
Avila	Madrid	100
Badajoz	Sevilla	100
Burgos	Madrid	100
Ciudad Real	Alicante	30
	Albacete	30
	Murcia	20
	Discreción	20
Cuenca	Madrid	40
	Valencia	40
	Discreción	20
Gerona	Barcelona	100
Granada	Almeria	100
Guadalajara	Solamente Alcalá de Henares	100
Huelva	Sevilla	100
Huesca	Barcelona	40
	Zaragoza	40
	Discreción	20
Jaén	Almería	30
	Sevilla	60
	Discreción	10
Lérida	Barcelona	100
Navarra	Guipuzcoa	25
	Logroño	20
	Zaragoza	35
	Discreción	20
Salamanca	Madrid	100
Segovia	Madrid	100
Soria	Madrid	40
	Zaragoza	40
	Discreción	20
Teruel	Valencia	100
Toledo	Madrid	100
Valladolid	Madrid	100

Source: BOE num. 308, 3 November 1948, p.5066-5067. See note 42.

The establishment of this system, based on a tripartite system of provinces in either a surplus, a deficit or self-sustaining in terms of firewood or charcoal production was to become enshrined in the following years: in 1948, another order[43] defined certain "commercial currents" (see Tables 3.17, 3.18, 3.19)which were to determine the flows of each energy carrier between provinces.

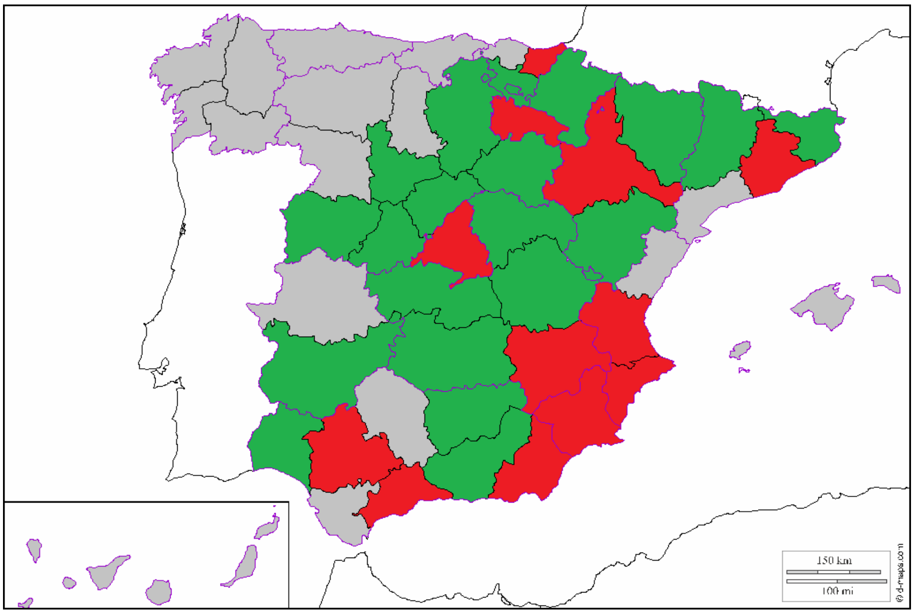
> «*La situación en que actualmente se encuentra el comercio de leñas y carbones vegetales aconseja el establecimiento de corrientes comerciales de suministros, que a la vez faciliten la distribución en las zonas de consumo, determinen una mayor economía y facilidad en su transporte. Por lo expuesto, el Servicio de la Madera y la Comisaría General de Abastecimientos y Transportes, conjuntamente, disponen:*
>
> *Primero: A partir de la publicación de la presente disposición, queda intervenida la circulación de la leña y del carbón vegetal. Estos combustibles necesitaran ir acompañados de la guia única de circulación, cuando su transporte sea interprovincial y cualquiera el medio empleado, como asimismo en el caso de desplazamiento dentro de la provincia, si éste se realiza por ferrocarril.*
>
> *Segundo: (...) Igualmente enviará a la Comisaría General de Abastecimientos y Transportes antes del día 10 de cada mes un parte mensual en el que se expresen las toneladas suministradas a cada una de las provincias deficitarias.*[44]
>
> *Tercero: en relación con su propia producción y consumo, las provincias se clasificarán en: a) Productoras; b) Alibles o autoabastecidas; c) Deficitarias. Se incluen respectivamente en dichas categorías.*»

> «*A. En relación con las leñas* (see Figure 3.10).
>
> *Como productoras: Alava, Avila, Badajoz, Burgos, Ciudad Real, Cuenca, Gerona, Granada, Guadalajara, Huelva, Huesca, Jaén, Lérida, Navarra, Salamanca, Segovia, Soria, Teruel, Toledo y Valladolid.*
>
> *Como alibles o autoabastecidas: Baleares, Cáceres, Cádiz, Castellón, Córdoba, La Coruña, Las Palmas, León, Lugo, Orense, Oviedo, Palencia, Pontevedra, Santa Cruz de Tenerife, Santander, Tarragona, Vizcaya y Zamora.*
>
> *Como deficitarias: Alicante, Albacete, Almería, Barcelona, Guipúzcoa, Logroño, Madrid, Málaga, Murcia, Sevilla, Valencia y Zaragoza.*»

[43] BOE num. 308, 3 November 1948, p. 5066-5067. Circular conjunta números 698 y 5, respectivamente, interviniendo la circulación de leñas y carbones vegetales y señalando corrientes comerciales para su distribución.

[44] I have not had the opportunity to consult the archives on this particular source, but it could be extremely interesting to analyse the dynamics of inter-provincial energy and material flows during the Franco dictatorship.

Figure 3.10: Provinces of Spain according to their firewood provision in 1948: surplus in green, deficit in red, self-sustaining in grey.



Source: BOE num. 308, 3 November 1948, p.5066-5067. See note 42.

«*B. En relación con el carbón vegetal* (see Figure 3.11).

Como productoras: Ávila, Badajoz, Burgos, Cáceres, Ciudad Real, Córdoba, Cuenca, Gerona, Guadalajara, Huelva, Huesca, Navarra, Salamanca, Segovia, Soria, Teruel y Toledo.

Como alibles o autoabastecidas: Alava, Baleares, Jaén, La Coruña, Las Palmas, León, Lérida, Logroño, Lugo, Orense, Oviedo, Palencia, Pontevedra, Santander, Santa Cruz de Tenerife, Valladolid y Zamora.

Como deficitarias: Albacete, Alicante, Almería, Barcelona, Cádiz, Castellón, Granada, Guipúzcoa, Madrid, Málaga, Murcia, Sevilla, Tarragona, Valencia, Vizcaya y Zaragoza.

Cuatro: Las corrientes comerciales y porcentajes de exportación quedan establecidas en la siguiente forma: (see Tables 3.17, 3.18 and 3.19).»

Therefore, Barcelona, which was set as a province in a deficit in both firewood and charcoal, concentrated a 100 % of movement from Girona and Lleida, and 40 % from Huesca in the case of firewood. In the case of charcoal, it received a 100 % of Girona's output, a 60 % from the provinces of Cáceres, Guadalajara, Soria and Toledo, 50 % from Burgos and 30 % from Ciudad Real and Navarra. The order followed:

«*Quinto: Las provincias clasificadas como alibles o autoabastecidas y las consideradas como deficitarias consumiran ellas mismas la leña o carbon vegetal que produzcan.*

Table 3.18: Corrientes comerciales: carbón vegetal (I)

Provincias productoras	**Provincias deficitarias**	**%**
Avila	Madrid	100
Badajoz (parte Norte)	Valencia	40
	Alicante	25
	Murcia	15
	Cartagena	10
	Discreción	10
Badajoz (de Zafra hasta el Sur)	Sevilla	30
	Málaga	30
	Cádiz	30
	Discreción	10
Burgos	Vizcaya	30
	Zaragoza	10
	Barcelona	50
	Discreción	10
Cáceres	Madrid	30
	Barcelona	60
	Discreción	10
Cáceres (capital y Aldea Cano)	Valencia	40
	Murcia	15
	Alicante	25
	Cartagena	10
	Discreción	10
Ciudad Real (parte Norte)	Barcelona	30
	Madrid	60
	Discreción	10
Ciudad Real (parte Sur)	Albacete	50
	Alicante	40
	Discreción	10
Córdoba	Sevilla	20
	Málaga	30
	Granada	20
	Almería	20
	Discreción	10
Cuenca	Valencia	50
	Alicante	40
	Discreción	10
Delegación especial de Algeciras	Málaga	100
Gerona	Barcelona	100
Guadalajara	Madrid	30
	Barcelona	60
	Discreción	10

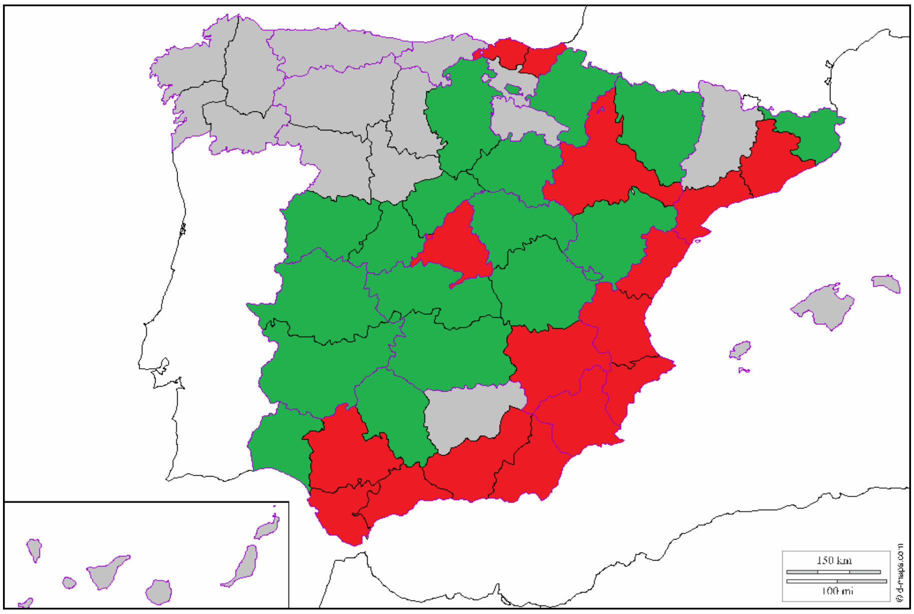
Source: BOE num. 308, 3 November 1948, p.5066-5067. See note 42.

Table 3.19: Corrientes comerciales: carbón vegetal (II)

Provincias productoras	Provincias deficitarias	%
Huelva	Sevilla	50
	Málaga	30
	Granada	10
	Discreción	10
Huesca	Zaragoza	50
	Tarragona	40
	Discreción	10
Navarra	Gupiuzcoa	30
	Barcelona	30
	Zaragoza	30
	Discreción	10
Salamanca	Madrid	100
Segovia	Madrid	100
Soria	Valencia	20
	Zaragoza	10
	Barcelona	60
	Discreción	10
Teruel	Castellón	40
	Tarragona	30
	Valencia	20
	Discreción	10
Toledo	Madrid	30
	Barcelona	60
	Discreción	10

Source: BOE num. 308, 3 November 1948, p.5066-5067. See note 42.

Figure 3.11: Provinces of Spain according to their charcoal provision in 1948: surplus in green, deficit in red, self-sustaining in grey.



Source: BOE num. 308, 3 November 1948, p.5066-5067. See note 42.

Sexto: Las Delegaciones provinciales de Abastecimientos y Transportes comunicarán a la Comisaría General, en el plazo de un mes, a partir de la publicación de la presente Circular, y en relación con su provincia, las necesidades de leña y carbón vegetal que se presuponga ha de corresponder a los distintos meses del año para la capital, pueblos mayores de 10.000 habitantes y núcleos industriales no comprendidos en los dos conceptos anteriores. La Comisaría y el Servicio de la Madera a la vista de los datos anteriores señalarán los cupos que correspondan.

Séptimo: Reconocidas las necesidades a que se refiere el apartado anterior la expidición de guías para el destino del sobrante a las provincias deficitarias se realizará de acuerdo con las siguientes normas:

a) Cuando las producciones de leña y carbón de una provincia cubran con exceso las necesidades reconocidas para la misma, la expedición de guías correspondientes al excedente se efectuará de conformidad con las corrientes comerciales y los porcentajes que se señalan para cada combustible en el apartado cuarto de esta Circular, sin que, en ningún caso, ni bajo pretexto alguno, sea permitido alterar dicha distribución. A estos efectos, se garantizará la satisfacción de las referidas necesidades en las provincias productoras, estableciéndose para las mismas un «Cupo de Consumo Provincial», expresado por un porcentaje de su producción total.

b) Las provincias alibles o con autoconsumo que en determinada época tengan una producción que *supere a sus necesidades podrán igualmente remitir dicho excedente, previa autorización del Servicio de la Madera. El referido Servicio, de acuerdo con la Comisaria General de Abastecimientos y Transportes, consignará en la autorización que con tal fin realice, el destino del mencionado excedente. (...)*

Noveno: En todas las provincias se creará una Comisión Receptora de leña y carbón vegetal, presidida por un representante de la Delegación Provincial de Abastecimientos y Transportes e integrada por el Jefe del Sindicato Provincial del Combustible, un almacenista y un detallista: estos dos últimos, designados por el Sindicato Nacional del Combustible. Las guías de circulación irán consignadas a estas Comisiones provinciales de leña y carbón vegetal, las cuales las transferirán a los almacenistas que libremente elijan los remitentes. En caso de escasez, se establecerá, para la distribución ciclos rotativos de reparto entre los almacenistas. La Comisión anteriormente citada fijará, previa aprobación de la Comisaría General y el Servicio de la Madera, los coeficientes y el sistema que deberán regir la distribución entre los almacenistas de destino. Por el primero de estos Organismos se adoptarán las medidas que crea necesarias para la distribución al público de ambos combustibles.

Décimo: Para el reparto de la leña y carbón vegetal de mayoristas a detallistas se establecerá el mismo sistema de distribución que se implantó para los primeros. En todo momento la Comisaría General de Abastecimientos y Transportes podrá adoptar las determinaciones que estime necesarias en relación con este punto, dando conocimiento de las mismas al Servicio de la Madera. (...)»

In 1950, however, prices were set again by order[45].

«*La Orden de los Ministerios de Industria y Comercio y de Agricultura de 12 de noviembre de 1948 establece los precios máximos que deberán regir las ventas de maderas en rollo y aserradas en sus distintas clases, señalando para los rollizos destinados a la fabricación de envases y para los de empleo en mineria el precio de 260 pesetas metro cúbico sobre estación de origen. El hecho de contar con un punto de partida tan concreto como el que acaba de señalarse y la convenience de habilitar unos precios para las leñas y para los carbones vegetales que permitan la explotación, sin solución de continuidad de la totalidad de la riquza forestal nacional, por una parte, y por otra la necesidad de clasificar las leñas y los carbones vegetales, en cuanto a su precio, en forma que se consiga la mayor facilidad para el desarrollo del comercio de uno y otro producto, son razones que,*

[45]BOE num. 6, 6 January 1950, p. 63. Orden de 3 de enero de 1950 por la que se establecen nuevos precios de las leñas y carbones vegetales.

presididas por la finalidad esencial de conseguir el mayor rendimiento energético y la utilización más racional de los expresados combustibles, aconsejan modificar la Orden de esta Presidencia de fecha 27 de diciembre de 1946. En virtud de lo expuesto, esta Presidencia del Gobvierno, a propuesta de la Junta Superior de Precios y previo informe del Servicio de la Madera, afecto a los Ministerios de Agricultura e Industria y Comercio, ha tenido a bien disponer:

Primero. Se establecen para las leñas y para los carbones vegetales los precios máximos que, con expresión de las clases de los mencionados combustibles a que los mismos corresponden, se relacionen en el estado siguiente (see Table 3.20). *Los expresados precios se entenderán aplicables a la Tm. de leña o de carbón vegetal sobre vagón origen, cuando los mencionados productos alcancen, como mínimo, las calaidades que se definen a continuación.»*

Table 3.20: Biofuel prices in 1950 as set by the state.

Denominación de la clase	**Características de las leñas y de los carbones vegetales**	**Precio máx. por Tm.**
Leñas especiales	Leñas de costeros, madera de pino y ramillas de pino en gavillas	305
Leñas de 1ª clase	Leñas de olivo, encina y alcornoque	273
Leñas de 2ª clase	Leñas de cualesquiera robles, excepto los incluidos en otros apartados, y de haya, olmo, abeto, eucalipto, algarrobo y pinos	210
Leñas de 3ª clase	Leñas de álamo, plátanos, sauces y árboles frutales	180
Leñas de 4ª clase	Leñas de coscoja, madroño, boj, enebro, brezo, sabina, jara, etc., y tocones, capas de toda clase de árboles	160
Leñas de 5ª clase	Leñas de romero, aulaga, tomillo, ontina, etc.	120
Carbón de 1º clase	Carbones de encina, alcornoque y roble	925
Carbón de 2º clase	Carbones de haya, pino y eucaliptos	840
Carbón de 3º clase	Zargallas, procedentes de los carbones de las clases 1ª y 2ª	660
Carbón de 4º clase	Carbones de brezo, madroño, coscoja, boj y de tocones y raíces de otras plantas	528
Picón vegetal y cisco		484

Source: BOE num. 6, 6 January 1950, p. 63. See note 44.

This system established a more specific –albeit more complicated– system of classification of biofuels, specifying the concrete species of tree or bush used in each energy carrier and their corresponding price. Even specific details were accounted for:

«a) Leñas – La denominación de leñas de las clases primera, segunda, y tercera que se mencionan en el estado precedente, corresponderá a la de las especies que para cada una de ellas se detallan, asserradas en trozas de longitud inferior a un metro, en forma de rollo o rajadas, y con un

contenido en agua (humedad) inferior al 25 por 100 del peso de la leña seca. Este porcentaje máximo de humedad de la leña será de aplicación, igualmente a las de las clases especiales cuarta y quinta.

b) Carbones vegetales – Se podrá comerciar bajo la denominación de carbones vegetales únicamente los productos resultantes de carbonear en el monte la leña o de destilarla en instalaciones fijas, que alcancen una potencia calorífica de 6.500 calorías y no presenten porcentaje de contenido en ceniza, en agua (humedad) o en materias volátiles, superiores al 5, 15, y 20 por 100, respectivamente. Se clasificarán como de primera y segunda clase los carbones obtenidos de leñas de las especies forestales consignadas en el cuadro correspondiente de este apartado y que se presenten en trozos de un diámetro mínimo de 15mm. Con el nombre de zragallas, se designa el carbón que resulte como residuo en el cribado del de las clases primera y segunda y que se presente en trozos de diámetro comprendido entre 10 y 15 milímetros no conteniendo polvo de carbón ni ningún otro residuo terroso. Se designarán con los nombres de picón vegetal o cisco únicamente los carbones procedentes de ramillas y los obtenidos en la clasificación de las zragallas, cuando se presenten en trozos de diametros inferiores a 10 mm, pudiendo contener polvo de carbón, pero no residuos terrosos o de cualesquiera otra clase.

Segundo. Los precios de las leñas especiales de primera, segunda y tercera clase, que se indican en el apartado precedente, podrán recargarse con un sobreprecio de 35 pesetas por Tm., por el asserío de las mismas en trozas de 40 centímetros de longitud, pudiéndose elevar este sobreprecio hasta 70 pesetas cuando se hayan elaborado en astillas o tacos de 10 a 20 cm de longitud.

Tercero. Los precios máximos de venta al público de las leñas y de los carbones vegetales en sus distintas clases, elaborados y clasificados ya para su utilización en los hogares domésticos, serán los que para cada una de las provincias españolas se detallan en los anexos números 1 y 2. (see Table 3.21). *Cuando se trate de la venta al público de carbones vegetales y de leñas en cuantía superior a 1.000 kilogramos se deducirá de los precios que se detallan en los anexos un 10 por 100 como indemnización al comprador por la simplificación de la operación comercial correspondiente. (…)»*

Table 3.21: Maximum prices of biofuels per province in 1950.

Precios de venta al público de las diferentes clases de leñas en las provincias que se expresan						
Provincias	**Especial**	**1ª**	**2ª**	**3ª**	**4ª**	**5ª**
Alava, Avila, Badajoz, Baleares, Burgos, Cáceres, Castellón, Córdoba, Ciudad Real, Cuenca, Gerona, Granada, Guadalajara, Huelva, Huesca, Jaén, Las Palmas, León, Lérida, Lugo, Málaga, Navarra, Orense, Oviedo, Pontevedra, Salamanca, Santa Cruz de Tenerife, Segovia, Soria, Tarragona, Teruel, Toledo, Valladolid, Vizcaya y Zamora	0.50	0.46	0.38	0.34	0.26	0.19
Albacete, Alicante, Almería, Cádiz, Guipúzcoa, Logroño, Murcia, Palencia, Santander, Sevilla, Valencia, Zaragoza	0.56	0.52	0.44	0.40	0.32	0.24
Barcelona	0.60	0.56	0.48	0.43	0.34	0.26
Madrid	0.64	0.59	0.50	0.46	0.37	0.28
Precios de venta al público de las diferentes clases de carbones vegetales en las provincias que se expresan						
Provincias	**1ª**	**2ª**	**3ª**	**4ª**	**5ª**	**Herraj**
Alava, Algeciras, Avila, Badajoz, Baleares, Burgos, Cáceres, Ciudad Real, Córdoba, Cuenca, Gerona, Guadalajara, Huelva, Huesca, Jaén, León, Lérida, Lugo, Málaga, Navarra, Orense, Oviedo, Palencia, Las Palmas, Salamanca, Santa Cruz de Tenerife, Segovia, Santander, Soria, Tarragona, Teruel, Toledo, Valladolid y Zamora	1.23	1.12	0.89	0.72	0.66	0.83
Albacete, Almeria, Cádiz, Castellón, La Coruña, Granada, Guipúzcoa, Logroño, Pontevedra, Sevilla, Vizcaya y Zaragoza	1.28	1.15	0.93	0.75	0.69	0.83
Madrid	1.32	1.17	0.96	0.78	0.71	0.88
Alicante, Murcia y Valencia	1.39	1.26	1.04	0.86	0.79	0.83
Barcelona	1.47	1.36	1.12	0.95	0.89	0.88

Source: BOE num. 6, 6 January 1950, p. 63. See note 44.

A really significant fact stands out from Table 3.21: in the case of firewood, Barcelona is the second most expensive city –after Madrid– and in the case of charcoal, Barcelona is in fact the most expensive city. Considering all the different subsets of goods, firewood in Barcelona was 6 % more expensive than the average and 12 % more expensive in the case of charcoal (again, over the average).

Another order[46] increased the complexity of the biofuel transit-reporting process and consequently its bureaucratic rules and dispositions, while reassigning the currents set in 1948.

«*A. En relación con las leñas.* (see Figure 3.12)

Como productoras: Alava, Asturias, Ávila, Badajoz, Burgos, Cáceres, Castellón, Ciudad Real, Córdoba, Cuenca, Gerona, Granada, Guadalajara, Huelva, Huesca, Jaén, León, Lérida, Navarra, Salamanca, Segovia, Soria, Tarragona, Teruel, Toledo y Valladolid.

Como alibles o autoabastecidas: Baleares, La Coruña, Lugo, Málaga, Orense, Las Palmas, Pontevedra, Santa Cruz de Tenerife, Vizcaya y Zamora.

Como deficitarias: Albacete, Alicante, Almería, Barcelona, Cádiz, Guipúzcoa, Logroño, Madrid, Murcia, Palencia, Santander, Sevilla, Valencia y Zaragoza.

B. En relación con el carbón vegetal. (see Figure 3.12)

Como productoras: Ávila, Badajoz, Burgos, Cáceres, Ciudad Real, Córdoba, Cuenca, Gerona, Guadalajara, Huelva, Huesca, Jaén, León, Lugo, Navarra, Salamanca, Segovia, Soria, Teruel y Toledo.

Como alibles o autoabastecidas: Alava, Asturias, Baleares, Castellón, Lérida, Orense, Palencia, Las Palmas, Santa Cruz de Tenerife, Santander, Tarragona, Valladolid y Zamora.

Como deficitarias: Albacete, Alicante, Almeria, Barcelona, Cádiz, La Coruña, Granada, Guipúzcoa, Logroño, Madrid, Málaga, Murcia, Pontevedra, Sevilla, Valencia, Vizcaya y Zaragoza.

Price setting was discontinued in 1952 by the following order[47]:

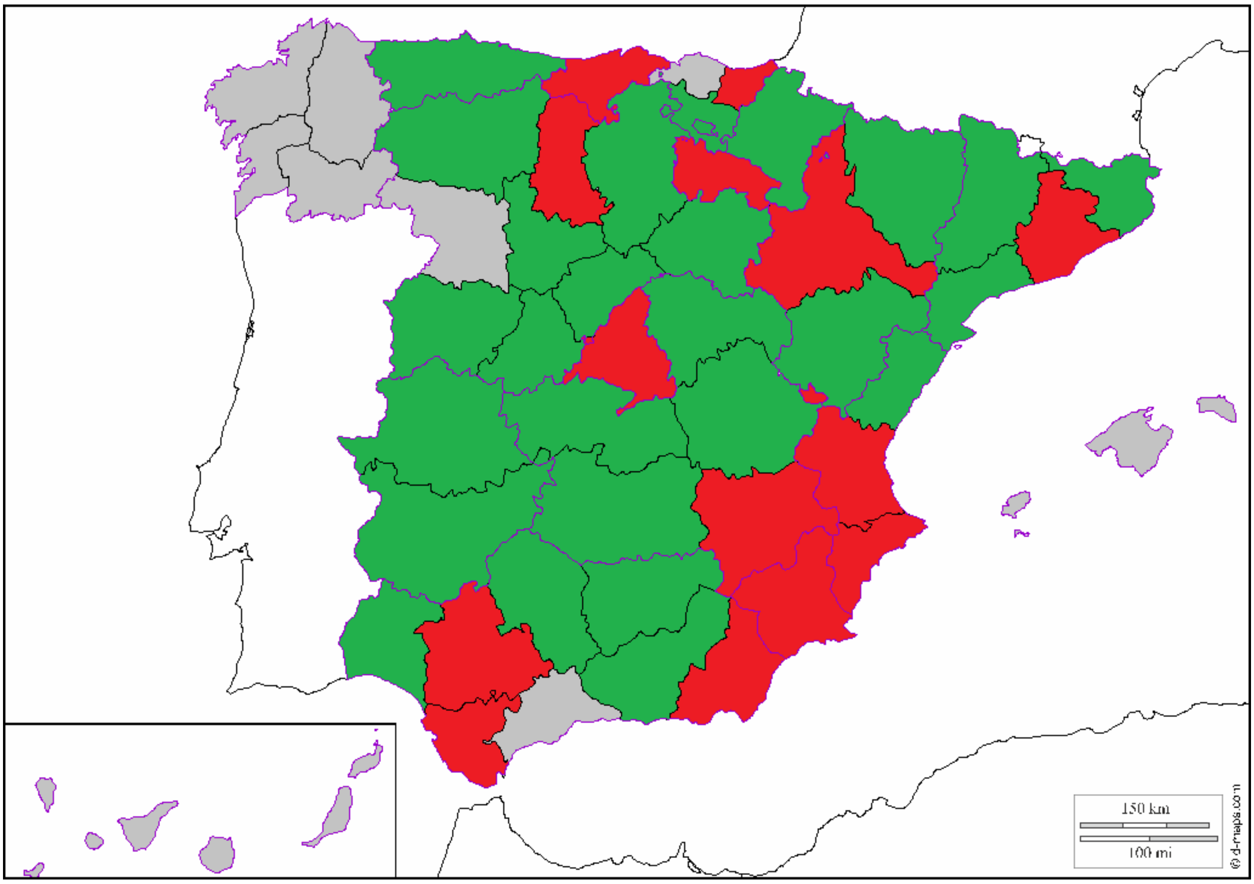
«*Suprimida la guía de circulación para las leñas y carbones vegetales por Orden conjunta de estos Ministerios de 13 de septiembre de 1951, ha podido comprobarse la convenience de aumentar la elasticidad de su mercado y de estimular la producción de carbón vegetal y el máximo aprovechamiento de leña, delcarando una libertad general de contratación de los mismos. En su*

[46] BOE num. 115, 25 April 1950, p. 1805-1809. Circular conjunta de ambos organismos número 740 de la C. G. de A. y T. y 21 del S. de la M. por la que se anulan la 698 y 5 y se señalan corrientes comerciales para leñas y carbones vegetales.

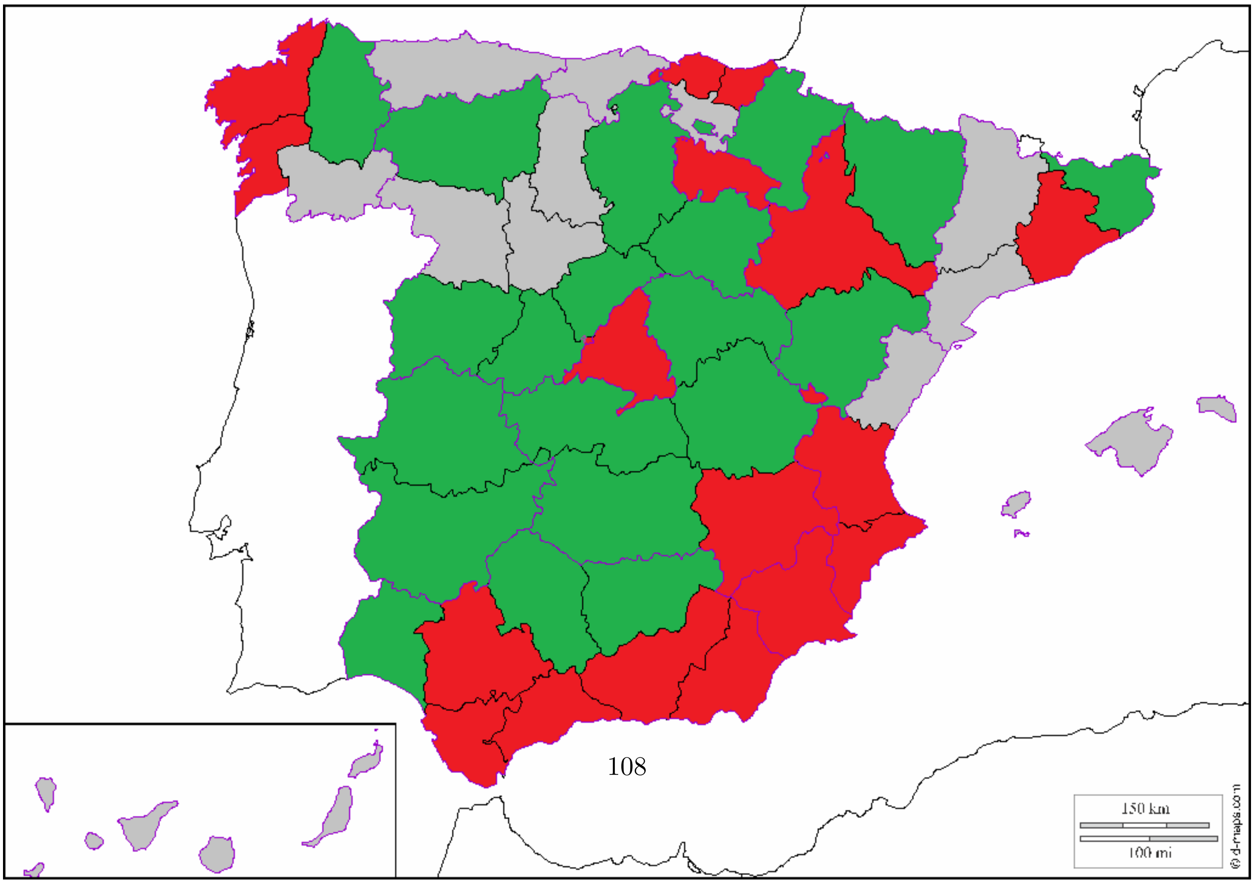
[47] BOE num. 213, 31 July 1952, p. 3537. Orden de 21 de julio de 1952, conjunta de ambos Departamentos, por la que se declaran libres de contratación y precio las leñas y carbones vegetales.

Figure 3.12: Comercial currents of 1950.

(a) Firewood

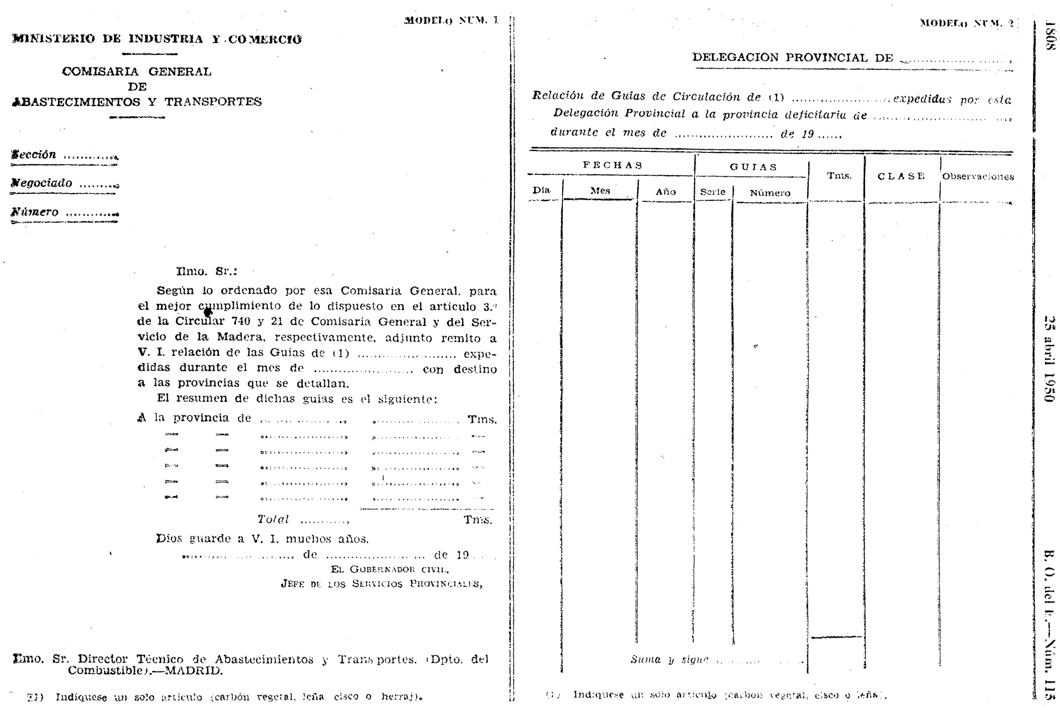


(b) Charcoal



Source: our own, from BOE num. 115, 25 April 1950, p. 1805-1809.

Figure 3.13: Guide for biofuel transportation, 1950.



MODELO NUM. 1

MINISTERIO DE INDUSTRIA Y COMERCIO

COMISARIA GENERAL
DE
ABASTECIMIENTOS Y TRANSPORTES

Sección ....
Negociado ....
Número ....

Ilmo. Sr.:

Según lo ordenado por esa Comisaría General, para el mejor cumplimiento de lo dispuesto en el artículo 3.º de la Circular 740 y 21 de Comisaría General y del Servicio de la Madera, respectivamente, adjunto remito a V. I. relación de las Guías de (1) .... expedidas durante el mes de .... con destino a las provincias que se detallan.

El resumen de dichas guías es el siguiente:

A la provincia de .... Tms.
— — .... —
— — .... —
— — .... —
— — .... —
— — .... —

Total ...., Tms.

Dios guarde a V. I. muchos años.
.... de .... de 19...
EL GOBERNADOR CIVIL,
JEFE DE LOS SERVICIOS PROVINCIALES,

Ilmo. Sr. Director Técnico de Abastecimientos y Transportes. (Dpto. del Combustible).—MADRID.

(1) Indíquese un solo artículo (carbón vegetal, leña, cisco o herraj).

MODELO NUM. 2

DELEGACION PROVINCIAL DE ....,

Relación de Guías de Circulación de (1) ....expedidas por esta Delegación Provincial a la provincia deficitaria de ...., durante el mes de .... de 19......

FECHAS			GUIAS		Tms.	CLASE	Observaciones
Día	Mes	Año	Serie	Número			
	Suma y sigue						

(1) Indíquese un solo artículo (carbón vegetal, cisco o leña).

1808 25 abril 1950 B. O. del E.—Núm. 115

Source: our own, from BOE num. 115, 25 April 1950, p. 1805-1809.

virtud, este Ministerio dispone: (...) A partir de la publicación de la presente Orden se declaran libres de contratación y precio las leñas y los carbones vegetales.»

Although price setting for biofuels had ended, a new energy carrier started to emerge not much later; in 1958, the butane cylinder was making its apparition, and an order[48] set its price:

« *Visto el escrito que en 17 de abril de 1958 eleva al Excmo. Sr. Ministro de Hacienda Butano S.A., en el que se propone el precio a que debe venderse el gas butano, Este Ministerio, de conformidad con la propuesta de dicha Entidad y de acuerdo con la Orden ministerial de 15 de junio de 1957, ha dispuesto lo siguiente:*

1.º Establecer, a partir de 1 de agosto de 1958, el precio del gas butano que se suministre a particulares franco domicilio usuario en 10,40 pesetas kilogramo.

2.º Fijar también desde dicha fecha en 130 el precio del butano contenido en las botellas que expende Butano, Sociedad Anónima, con un peso del producto de 12,5 kilogramos.

[48]BOE num. 177, 25 July 1958, p. 6779. Orden de 15 de julio de 1958 por la que se informa sobre el nuevo precio del gas butano.

> *3.º El canon para la renta de petróleos en el butano consumido en el ámbito del Monopolio de Petróleos se establece en 0,75 pesetas kilogramo, y el impuesto sobre el gasto de dicho producto, en 0,75 pesetas kilogramos que liquidará Butano, Sociedad Anónima, por mensualidades vencidas.*

To conclude this section, we have seen how sudden shocks to external fuel supply –such as both World Wars and the Spanish Civil War, in both biomass-based fuels and fossil ones– established contexts of relative domestic scarcity. In this context, governments resorted to mainly two market-oriented policies: prohibition of exportation and price-setting. While the latter case has been analysed by García and Barciela (1983) in the case of wheat, to our knowledge the aforementioned sources haven't been discussed much in the literature in the case of firewood and charcoal during the Francoist period. Although their correspondence with market prices may be faint at best, the growing corpus of legislation dealing with distinctions among various qualities of firewood and charcoal, as well as the relevance given to the "commercial currents" between provinces, provides us valuable insights on the state of domestic supply during the early Francoist period. The sources mentioned above are coherent with the "return to firewood" approach proposed by Iriarte-Goñi and Infante-Amate (2019).

4. Results: Fitting the puzzle of scant, distorted evidence

As the reader might have thought at this point, the sources presented in the previous section display a complex and heterogeneous corpus of sometimes outright contradicting evidence. Due to its statistical nature, this information can be compared with other similar sources, thus testing it against already established evidence. However, it would be daring to consider what here is presented as a complete or representative picture of fuel consumption throughout the period of our study. Nonetheless, we believe that by providing said exposition, a step is taken forward in the long and strenuous process of historical research of cities' energy and material metabolism.

Therefore, the following section provides *some* approximations towards the reconstruction of Barcelona's social metabolism. The first section (4.1) presents the construction of a long run price series, contrasting it with similar ones throughout the literature.[1] The second section (4.2) contains both a display of the general quantities by sector –land, railway, sea– and an attempt to reconstruct their evolution over time. The third section (4.3) presents our attempt to provide novel data on the consumption per capita of firewood, while contrasting it to that of coal in the city of Barcelona.

4.1 The Price historical series

Among the three sections of results, perhaps this one is the less estimative of the whole chapter. In this sense, three sub-series are used to construct a long run price data series. First, Vilar's data through Feliu is explained (4.1.1), followed by Nogués-Marco's series (4.1.2). In both cases a brief explanation is given regarding the nature of the source, especially highlighting the methodology behind the types and qualities of the products they have used. After that, the third section (4.1.3) analyses the results that can be obtained

[1] A preliminary version of an article dealing with this source was presented in the VI Annual Seminar of the SEHA (Madrid, 14 December 2018).

when combining the three aforementioned sources.

It is worth noting that throughout this study we have not used deflated prices. The reason behind this decision follows from the ideas expressed in Kander et al. (2013): in general terms, as bread and other foodstuffs constituted the bulk of the average consumption basket, with a substantial part of the remainder being attributed to fuel, we believe that using deflation in our timeframe results in sorts of overcorrection, as the trend of bread is projected onto the trend of any other product. We have preferred instead to employ ratios between products, in the understanding that in the topics that we are dealing with the price *per se* is not as important as the decision-making process which encompasses fluctuations in *both* substitutable products. Thus, ratios –compensated in terms of energy wherever possible– have been systematically used throughout the following section.

4.1.1 Feliu and Vilar: From 16th to 19th centuries

Chronologically speaking, the first author to present historical price series of biofuels for Barcelona was Vilar (1964), in the third volume of his *magnum opus Catalunya dins l'Espanya Moderna* – "Catalonia in(side) modern Spain". The original series have been recompiled and republished more recently by Feliu (1991, vol.II). The resulting series on firewood is a combination between the prices of oak firewood, its municipal tax and the price of pinewood bundles as paid by the convents and ecclesiastical institutions of the city. This price series begins in 1527, although observations aren't very regular until the 1550s, after which it will remain practically uninterrupted until 1805, the voids of the Spanish Succession War notwithstanding. In the case of charcoal, the source is the same: originally published by Vilar, and complemented by Feliu (1991, v.II). The charcoal series is based on three sources: the acquisition of charcoal by convents, the municipal tax and the price series by Vilar, based on both oak-charcoal and pine-charcoal bought by the *Hospital de la Santa Creu*. In this case, the first observation is from 1519, with the rest becoming regular from the 1580s onwards until year 1807. The data from this series is shown in Figure 4.1. For any further information, we refer readers to the source itself, as it is readily available for download.

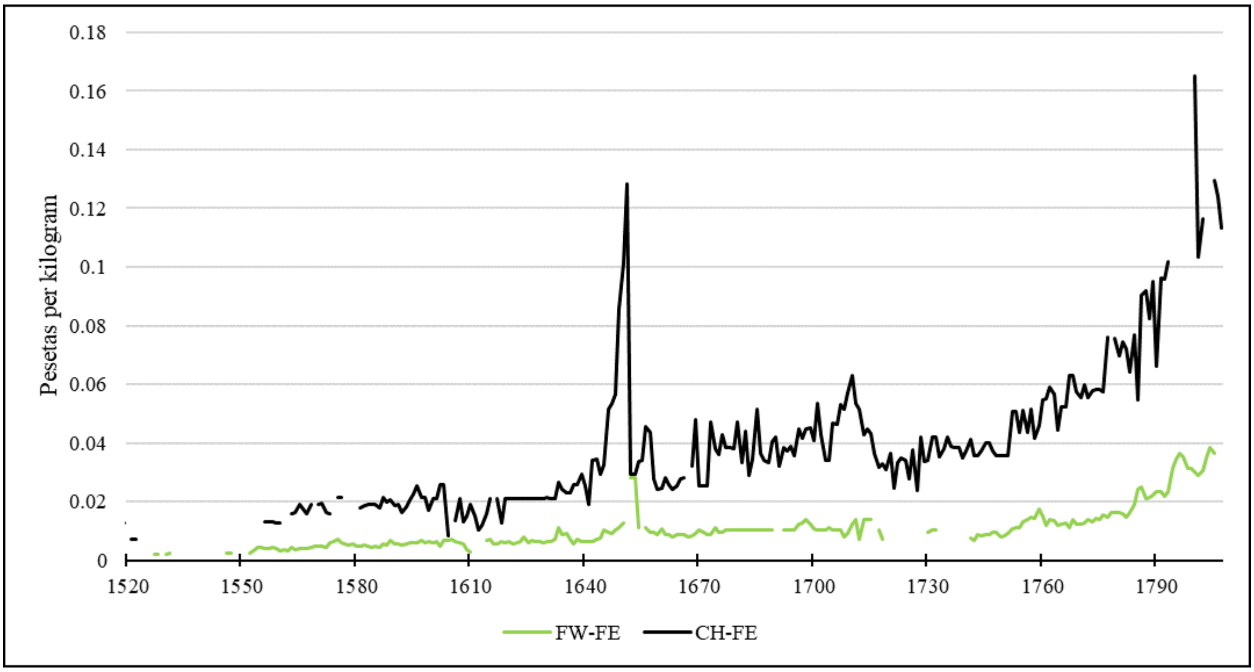
4.1.2 Nogués-Marco: From 1775 to 1844

In 2001, Pilar Nogués-Marco[2] wrote her master's thesis «Evolución del nivel de precios al consumo en Barcelona durante el periodo 1775-1844»; the information within was published afterwards (Nogues-Marco, 2005). Regarding point 1.1.1. of the master's thesis, corresponding to pages 8 to 12, is extremely interesting, as it describes the price sources of the late 18th and early 19th centuries and the debate on their usage.

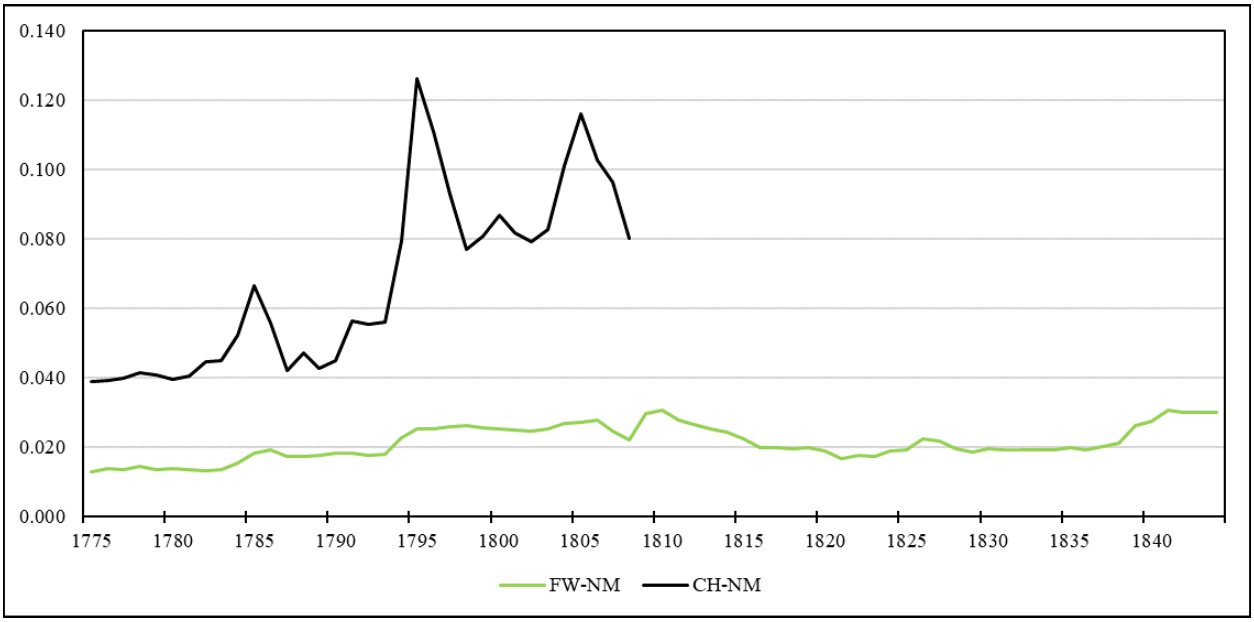
[2] We would like to thank her for kindly responding to our questions on the source itself, as well as on the question of currency conversion. Any mistakes we may have made on the latter are, however, entirely our own.

Figure 4.1: Firewood and charcoal prices in modern Catalonia according to Feliu (1991) and Nogués-Marco (2001).

(a) Vilar and Feliu's prices



(b) Nogués-Marco's prices



Source: our own, from Feliu (1991) and Nogués-Marco (2001).

In any case, the author continues Vilar's work (see section 4.1.1) by extending his series of the *Hospital de la Santa Creu*. Between 1775 and 1883, she employs the *Llibres del Racional*, which contain the daily accounts on transactions and therefore the amounts of outgoing money (Nogués-Marco, 2001, p.11). During the 1834-1844, she uses the *Llibres Majors*, which refer to the control of the warehouse, thus including the acquisitions of goods and the consumption and selling of products (Nogués-Marco, 2001, p.11-12).

As a result of her research, several price series on various goods can be made, the most complete of which correspond to olive oil, mutton, firewood, wheat and wine. Figure 4.1 displays the aforementioned data. There's data on more products that appear with less frequency and which weren't included in the posterior article (Nogues-Marco, 2005): carobs, rice, cod, charcoal, hemp, eggs and chickens, beans, straw, potatoes, bacon, semolina and noodles. Lastly, there's products which were consumed in an irregular fashion, and for which there's no information: sugar, barley, chocolate, fava beans, soap, wool, milk, blankets, honey, salt and lard, amongst others. For our research, the products which interest us the most are firewood and charcoal. In the case of the first, it's calculated through a simple arithmetic mean between the prices of "thick pine firewood" and "bundles of firewood"; the author points out that «supply was procured mainly through cabotage, from municipalities close to the city of Barcelona»(Nogues-Marco, 2005, p.15). Regarding charcoal, the author simply points out that the series ends in 1809. Again, on the question of the information on the data series, we would like to refer the reader to the source itself, as the author greatly details both the methods employed in its construction as well as its statistical intricacies. From the authors work on the latter, we have gathered many valuable insights which we have incorporated in our analysis, as alluded to in section 3.7.

4.1.3 Biomass and fossil energy prices in the long run

The construction of the BOPB price series as well as its statistical analysis has been explained in section 3.7, and the data is collected in Appendix B. Section 4.1.1 has displayed Vilar's prices compilation by Feliu, while section 4.1.2 contains Nogués-Marcos price series. The methodology behind the construction of the series is simple: we have averaged out the prices of those years of Feliu and Nogués-Marco's series for which there is overlap, which are situated in the period 1775-1808. Therefore, we have simply coupled up the three series, providing us an almost four centuries-long data series on firewood and charcoal prices, and a smaller length in terms of bread. Figure 4.2 displays the two Barcelonese price series which, when combined with the BOPB data, enable the construction of an over four hundred year price series: "FW" stands for firewood and "CH" for charcoal, while "FE" stands for Feliu and "NM" for Nogués-Marco. Figure 4.2.a displays the two Barcelonese price series which, when combined with the BOPB data, enable the construction of an over four hundred year price series of biofuels. Figure 4.2.b shows the evolution of prices of firewood and charcoal in terms of energy –according to Malanima (2006)– instead of weight, thus adjusting for the difference in energy density and quality of each commodity, since about five units of firewood were required to produce a single unit of charcoal. Table 4.1 shows the cumulative rates of growth for each product, with the inclusion of bread, during the entire timeframe.

Table 4.1: Cumulative rates of growth of Barcelonese prices for thee selected goods (1550-1932).

Period	Firewood	Charcoal	Bread	Period	Firewood	Charcoal	Bread
1550-1600	1.80%	1.30%	0.50%	1750-1800	2.40%	2.50%	1.00%
1600-1650	1.50%	3.20%	1.30%	1800-1850	0.00%	-0.30%	0.20%
1650-1700	-0.40%	-1.80%	-1.00%	1850-1900	1.10%	0.30%	0.30%
1700-1750	-0.50%	-0.30%	0.70%	1900-1932	1.00%	2.90%	1.80%

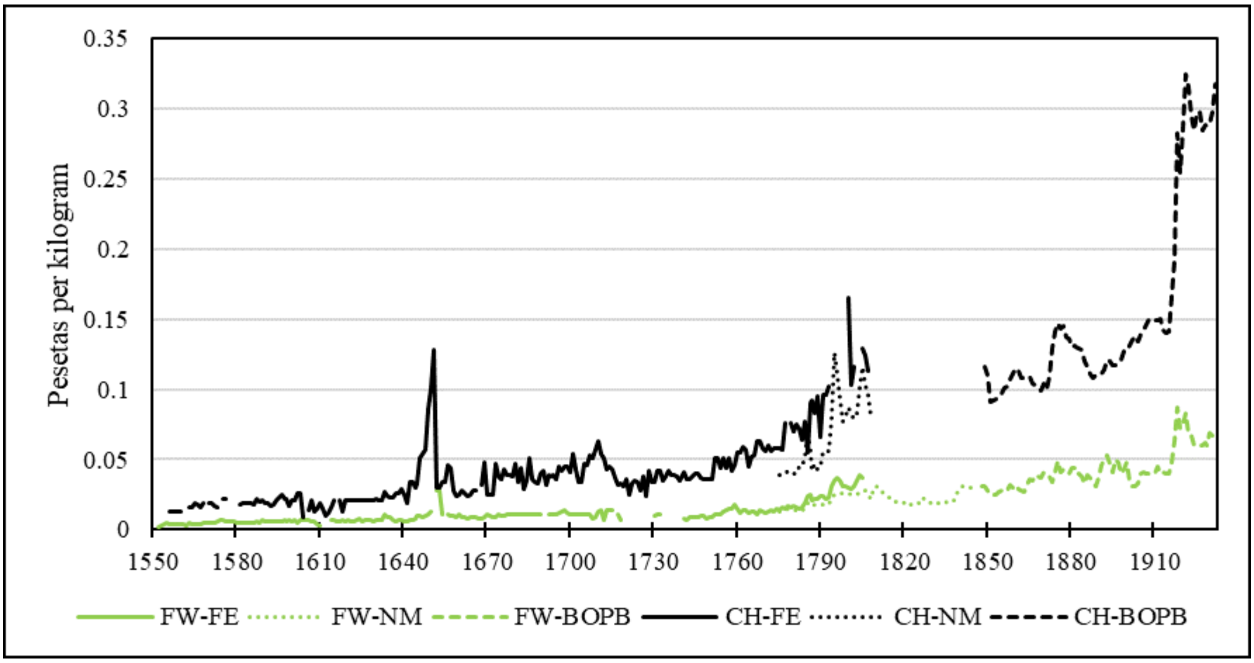
Source: our own, from Feliu (1991), Nogués-Marco (2001) and data from the BOPB. In the case of bread, the data until the early 19th century is from Feliu (1991, vol.I), Segura (1983)'s grain prices –converted to bread according to the grain-to-bread ratio present during the last quarter of century in Feliu (1991)'s prices.

Figure 4.2 displays that the prices of the two main biomass fuels grew steadily at an average annual cumulative rate of 1.8 and 1.3 % (for firewood and charcoal, respectively) during the inflationary second half of the sixteenth century (Table 4.1). Then, in the first decades of the seventeenth century, they remained quite stable until the sudden peak during the peasant rebellion of 1640 followed by a war with Spain up to 1652, and became steady again from the 1660s to the following peak during the War of Spanish Succession (1701–1714). From the 1720s inwards trends remained again quite flat until mid-eighteenth century. Afterwards, the trend of both firewood and charcoal prices experienced a new steady increase with a yearly cumulative rate of 2.4 and 2.5 % up to the end of the 1780s, when the price rise of biomass fuels was exacerbated during the years of war with France – the Convention War of (1792-1801) and the Napoleonic Wars (1798-1814). After a general price downturn up to the 1830s, they resumed growth with a yearly average cumulative increase of 1.1 and 0.3 % during the last half of the century, that became exacerbated once more during the First Wold War, with firewood staying at 1 % but charcoal rising to 2.9 %.

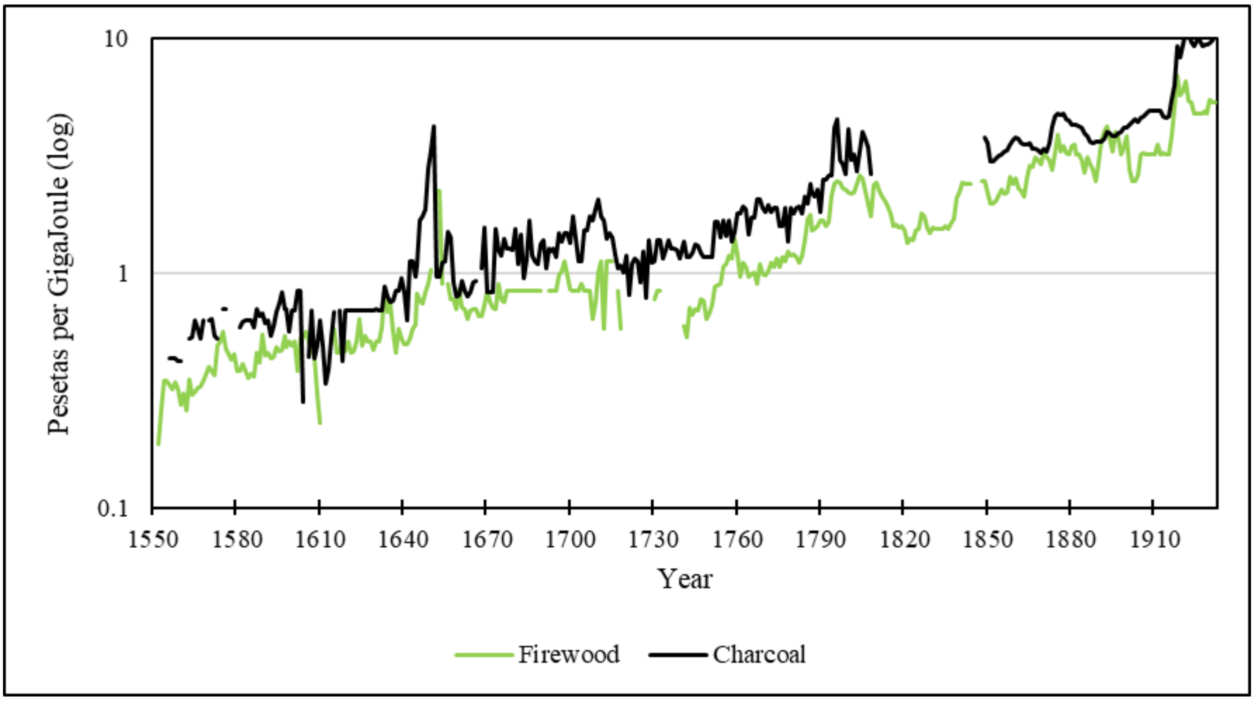
It is also interesting to consider the long run evolution of prices in both biomass products consumed for exosomatic energy needs –heating and cooking– in relation to the main component of endosomatic food intake: bread. Figure 4.3 shows index prices of firewood, charcoal and bread taking 1788 as the base year. The data for the "biofuel series" has been taken from the combined series of Feliu, Nogués-Marco and the BOPB prices, in this case by averaging the yearly price indices for firewood and charcoal. In the case of bread, the data until the early 19th century is from Feliu (1991, vol.I), Segura (1983)'s grain prices –converted to bread according to the grain-to-bread ratio present during the last quarter of century in Feliu (1991)'s prices– and data from our own BOPB series. The year 1788 has been taken as a base year as it relatively

Figure 4.2: Firewood and charcoal prices in Barcelona (1550-1932).

(a) Weight

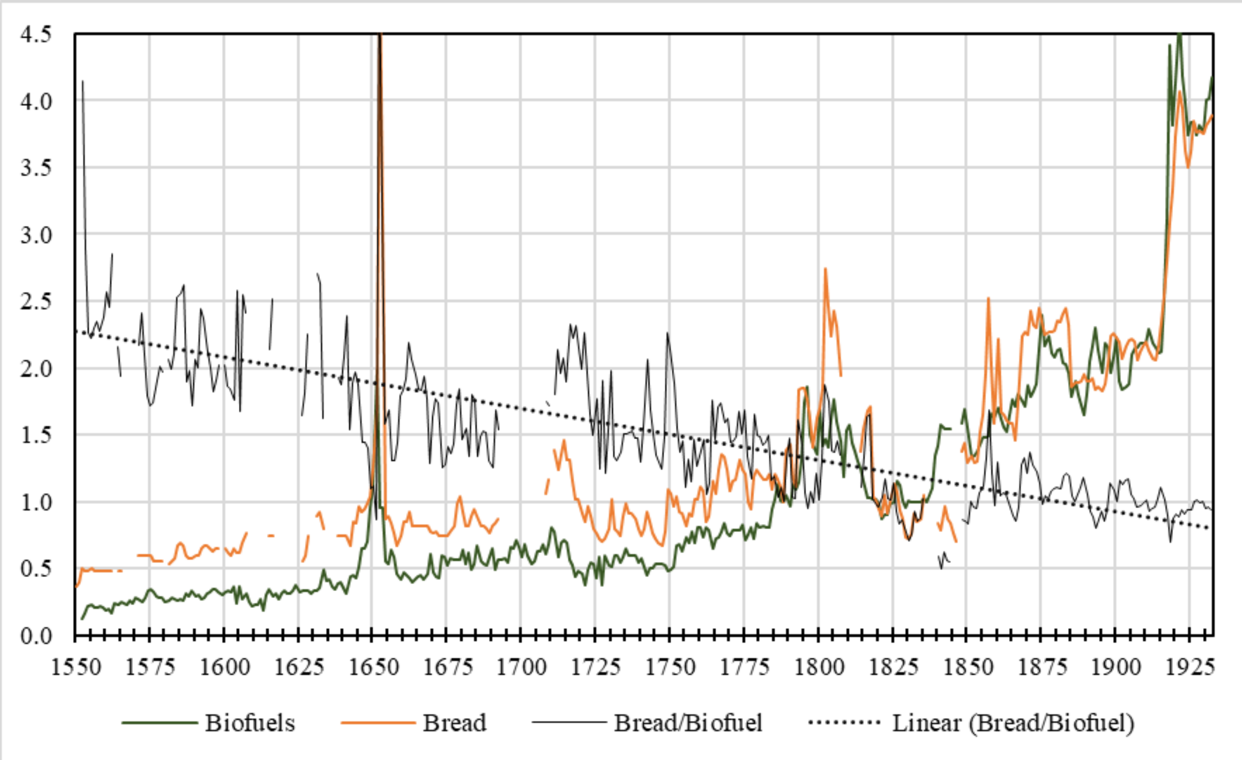


(b) Energy



Source: our own, from Feliu (1991), Nogués-Marco (2001) and data from the BOPB.

Figure 4.3: Bread and Biofuel index prices in Barcelona, 1550-1932 (i=1788).



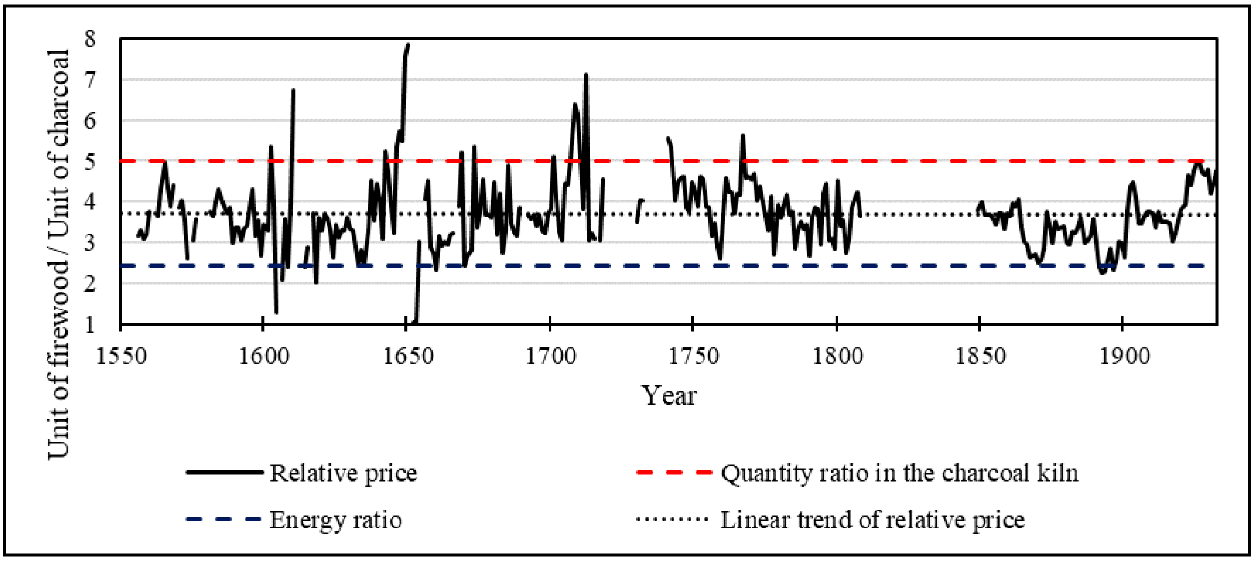
Source: our own, from Feliu (1991), Nogués-Marco (2001) and data from the BOPB. In the case of bread, the data until the early 19th century is from Feliu (1991, vol.I), Segura (1983)'s grain prices –converted to bread according to the grain-to-bread ratio present during the last quarter of century in Feliu (1991)'s prices.

stable in all products considered, it is at about the chronological midpoint of the series and it precludes the subsistence crisis of 1789 – the *Rebomboris del pa*, which spread throughout the province of Barcelona as a consequence of bad harvests and a price-hike on grain of about 50% in terms of the previous year.

The second half of the 18th century saw a parallel increase in the prices of the three energy carriers considered until the aforementioned wars with France. During the first half of the 19th century, firewood as well as wheat and bread prices plummeted until the mid-1830s. However, from then on, the price of fuel biomass resumed the increasing trend until the end of the period despite the oscillation in the growth rates, while the price of bread remained more stable until the eve of the Great War. Therefore, contrary to what happened during the 18th century when prices grew at a similar rate, during the second half of the 19th century biomass fuel prices rose systematically higher than the price of bread. World War I resulted in an inflationist spike for all products, but in its aftermath charcoal stood at a distinctly higher level than firewood, and even more than bread. The aforementioned issues are clear when considering the bread to biofuel ratio, which experienced a sustained downwards trend throughout the entire period.

One kilo of charcoal is obtained out of a quite fixed rate of five kilos of firewood, but due to the conversion

Figure 4.4: Relative price of charcoal in terms of firewood compared to the reference ratios of the weight conversion of one to another in the kiln, and their respective energy content (1550-1932).

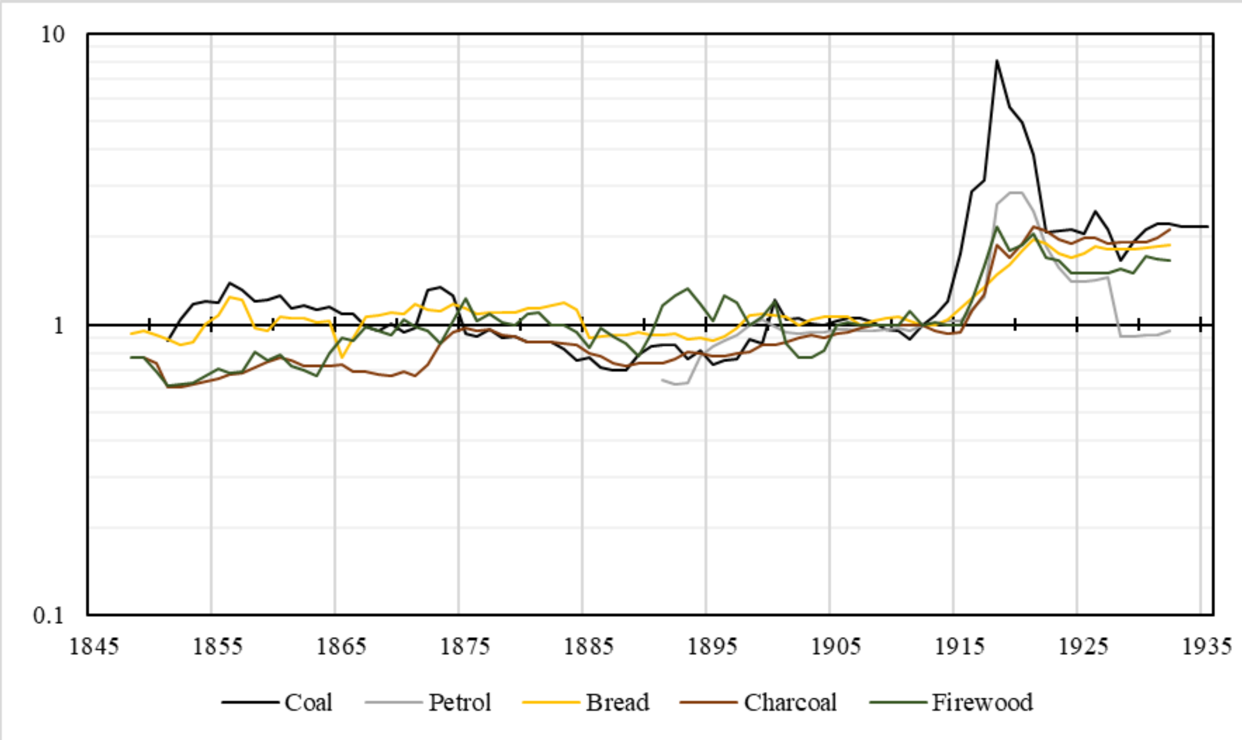


Source: our own, from Feliu (1991), Nogués-Marco (2001) and data from the BOPB. "Quantity ratio in the charcoal kiln" represents the 5:1 firewood to charcoal ratio, while the "Energy ratio" is the energy ratio from firewood to charcoal, from Malanima (2006)'s data on energy conversion factors.

losses in the kiln its calorific energy content remains only around 2.4 times higher. Figure 4.4 displays the relative price of charcoal in terms of firewood along the 1550-1932 period, in which despite the ever-present fluctuations a steady trend appears, according to which the price of a unit of charcoal equalled about 3.8 units of firewood. Furthermore, these relative prices remained in most cases between the upper boundary of the quantity ratio drawn in Figure 4.4, i.e. the units of firewood required to make a unit of charcoal in the kiln, and the lower boundary set by the energy ratio, i.e. the energy content of kilogram of charcoal in relation to a kilogram of firewood.

However, the 19th century saw the massive proliferation of a new energy carrier – coal, while in the 20th century the same happened with petrol (albeit the development block which enabled its extended use was not developed until the 1930s). Which was the underlying dynamic between these fuels? Figure 4.5 seeks to explain that question by setting 1912 as a base year –in the eve of the Great War– and combining information on various energy carriers for the period 1848-1935. Therefore, the picture displayed in Figure 4.5 displays the dynamics of competition between said four energy sources. During the first period, between 1848 and 1875, both charcoal and firewood were rising in price, while coal decreased and bread remained somewhat stable. Between 1875 and 1905, all energy carriers experienced a downwards tendency and posterior recuperation, with the exception of firewood, which rose in the 1890s. Prices remained somewhat stable until the Great War –during which coal rose the highest–, after which all energy carriers but petrol experienced similar rates

Figure 4.5: Bread, Firewood, Coal and Petrol index prices in Barcelona, 1848-1935 (i = 1912).



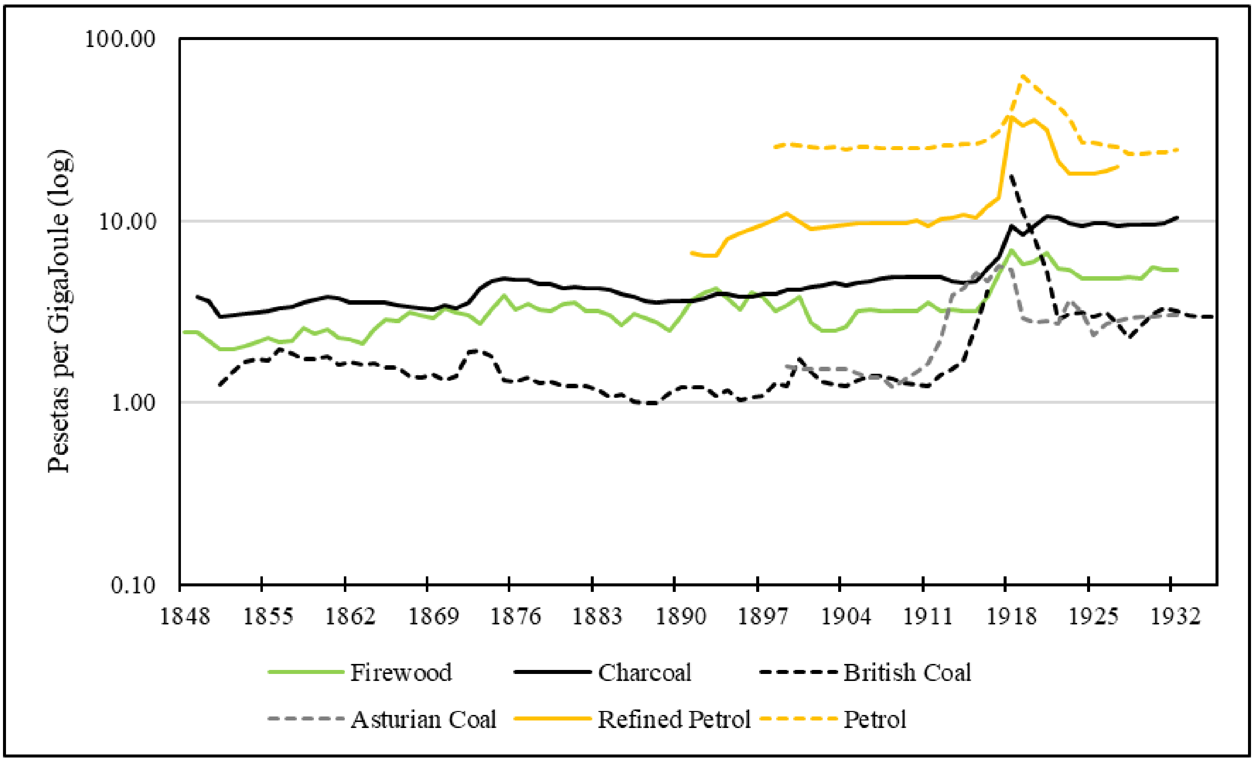
Source: our own, from the BOPB. "Firewood" is an average of firewood and charcoal index prices from the BOPB during that period; bread is also from the BOPB; while coal is constructed out of averaging the two series of coal given in Nadal et al. (2012) –which we have elongated with data from the *Memorias de la Junta de Comercio de Barcelona*, and petrol is an average between the data in the BOPB series with the addition of data on "Refined petrol" from the same MJCB series.

of growth.

Figure 4.6 displays prices per unit of energy in a logarithmic scale along a period in which Barcelona –city and province– underwent the first coal-based industrialization and started the electrification driven by the second one. In 1848 the first railroad came into operation (Pascual, 1999), and in 1911 the first hydropower plant began to sell electricity in Catalonia (Alayo, 2007; Urteaga, 2003). On the one hand, during the entire period considered –with the sole exception of the inflationist spike during the Great War– both British imported coal and Spanish coal from Asturias were always cheaper after accounting for differences in energy content. On the other hand, petrol and refined petrol were still the most expensive carriers per unit of energy delivered throughout that period, staying at an almost higher order of magnitude than coal. Finally, firewood and charcoal remained roughly at the same level albeit some short-term divergences in trend, with the greatest differences in price levels occurring after the Great War.

Finally, Figure 4.7 displays the prices of various commodities throughout the modern and contemporary periods. How do these prices compare with the European case? Figures 4.7.a 4.7.b show a comparative

Figure 4.6: Price per Gigajoule of biomass and fossil energy carriers, 1848-1935.

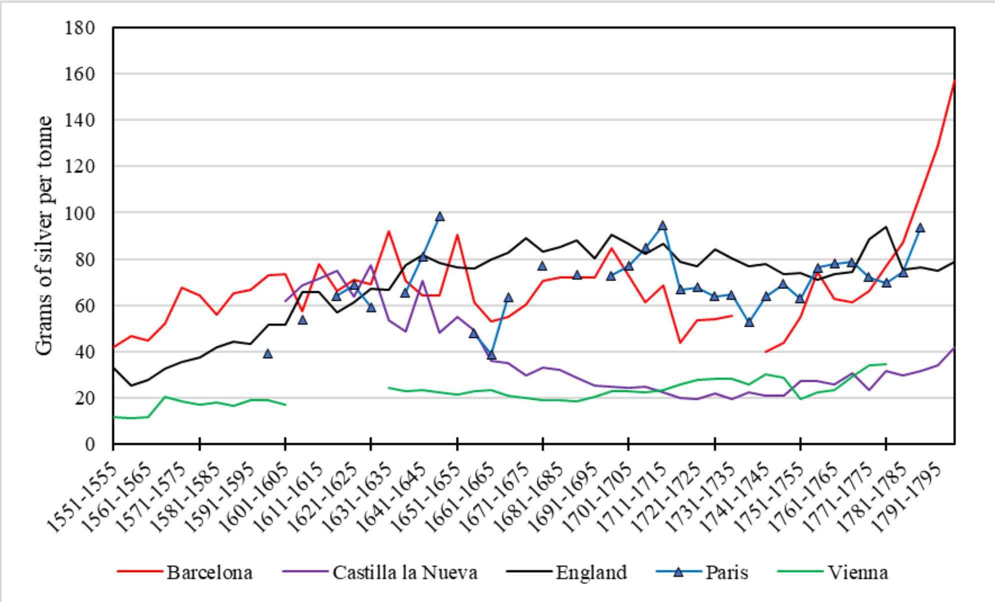


Source: our own; firewood, charcoal and petrol are from the BOPB. British Coal is constructed out of averaging the two series of coal given in Nadal et al. (2012) –which we have elongated with data from the *Memorias de la Junta de Comercio de Barcelona*, Asturian Coal and Refined Petrol are from the same MJCB series. Weights have been converted to energy according to the following criteria: one tonne of firewood equals 12.552 GJ and one tonne of charcoal 30.5432 GJ according to Malanima (2006); one tonne of bituminous coal (average) has been considered to be 29 GJ Kander (2002); UN (1987); finally, one metric tonne of motor gasoline has been considered to be 43.97 GJ with a density of 1,351 L per metric tonne, both according to UN (1987).

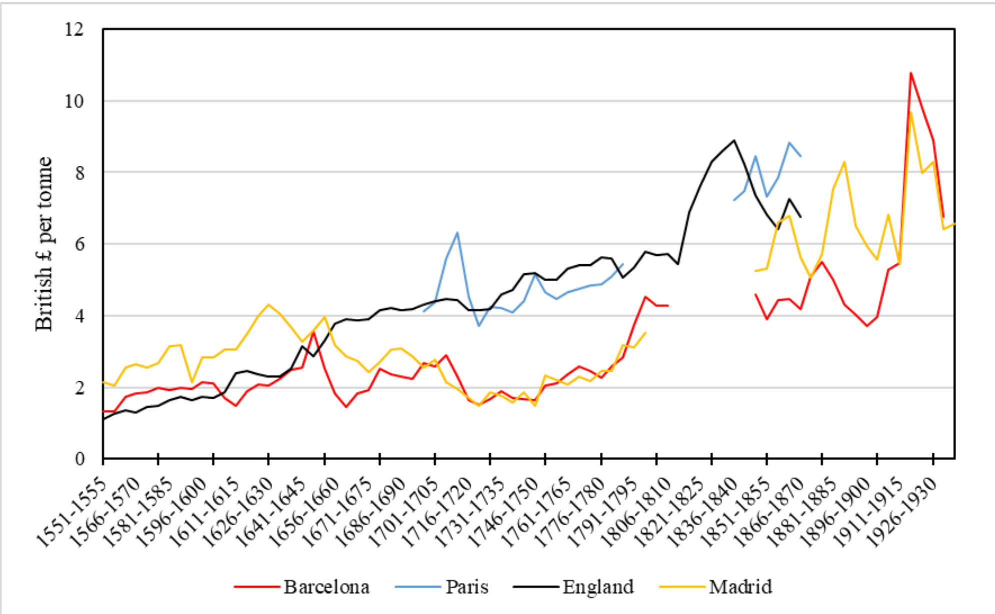
perspective for cities during the Modern Age for firewood and charcoal respectively. In the case of firewood (Figure 4.7.a), a general increasing trend is apparent from the 1550s until about the 1630s. After that point, London maintains an increasing tendency until the 1700s, while other cities experience a decrease; however, during the 1660s two diverging paths emerge: Paris and Barcelona follow the Londoner indices, to which they will adhere –in terms of trend– up until the Napoleonic Wars. On the other hand, both Madrid and Vienna adhere to a different, decreasing path, holding definitely lower prices for most of the period, with its steeper increase beginning in the 1750s at a much lower rate. In the case of charcoal (Figure 4.7.b), again a general pattern is followed until the 1640s, with Madrid displaying the higher levels. However, after that period, the two series diverge: Iberian prices appear much lower than the other European cases until the 1750s, when an abrupt increase is noticed. Unluckily, we do not have available data for the 1820s and 1830s for Barcelona and Madrid, and after the 1860s the same case occurs for Londoner and Parisian series;

Figure 4.7: Compared firewood and charcoal prices in an international perspective (1551-1935).

(a) Compared firewood prices, 5-year average (1551-1795).

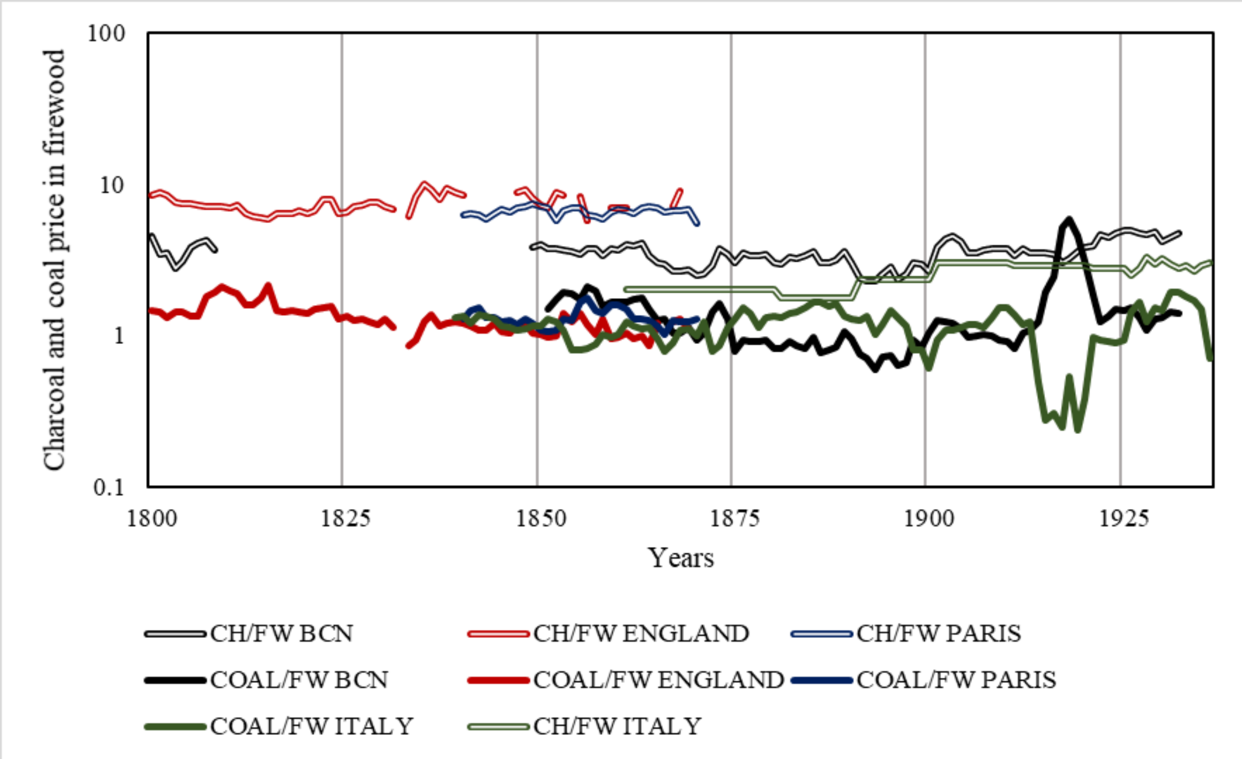


(b) Compared charcoal prices, 5-year average (1551-1935).



Source: our own. In both cases, data has been retrieved from the Allen-Unger Global Commodity Prices Database (AUGCPD)[3], the Global Price and Income History Group (GPIHG)[4] and the International Institute of Social History(IISH)[5] – note that data overlaps in said three sources. Firewood data for Barcelona and Castilla la Nueva is from Feliu (1991), while data for London, Paris and Vienna is from the AUGCPD. In the case of charcoal, data from Barcelona is from Feliu (1991) and our own BOPB series; Madrid is from Feliu (1991) for 1551-1808 and Reher and Ballesteros (1993a) for the 1848-1936 period. Prices for Paris and England are from the AUGCPD. Charcoal has been converted from volume to weight according to the average density of 0.208 g/cm^3 from Wolphram Alpha, while firewood density has been assumed to be 625 kg per cubic meter, according to Malanima (2006, p.30). Grams of silver have been converted to British Pounds according to the series in the AUGCPD until 1914, and afterwards using the conversion rate from Pesetas to Pound Sterling in Carreras and Tafunell (2006).

Figure 4.8: International price ratios of various fuels (in terms of firewood) in several European cities and countries (1800-1935).



Source: our own. CH stands for “charcoal”, while FW refers to “firewood”. The indices are calculated by a simple division of the price of a given commodity by the price of firewood in a certain year; notice the logarithmic scale. The sources for all commodities have been addressed before (AUGCPD, GIHG, IISH, BOPB), except the ones for Sweden, which are from Kander (2002) and for charcoal in Italy, which is from ISTAT (1976); both offer the indices based on the unconverted nominal units in which they are given. Additionally, in the case of Italian charcoal, observations between 1861 and 1926 are given in a ten-year basis.

however, when our Iberian series resumes, prices have almost risen to what appears as the European norm. In that last period, Madrilenian and Barcelonese prices exhibited similar trends albeit at different levels, excluding the 1870s, in which prices rose greatly for Madrid. Finally, it appears that the Great War ended with a relative convergence of Peninsular prices.

Figure 4.8 provides another comparison in an international perspective: the various indices display both coal and charcoal in terms of firewood throughout the 19^{th} and early 20^{th} centuries. It is worth noting that the relation between charcoal and firewood is a level higher than the one between coal and firewood for most of the period. However, this paradigm is truncated during certain periods, chiefly during the Great War. Additionally, the ratio of coal to firewood has a decreasing trend until the 1900s, after which no more data is available.

4.1.4 Temperature and prices

Temperature has been posited by many scholars as being linked in a causal relationship with the prices of many products, especially of those of agricultural origin. Furthermore, authors such as Sanz de la Higuera (2014) have defended the use of firewood and charcoal price series to infer information on this topic for those periods of history in which temperature series are lacking or insufficient. In our case, we have not attempted to approach this question as deeply as we originally wished due to time-concerns as explained in section 6.2. Nonetheless, in a very superficial approach, we have calculated 10-year averages for temperature from the series in Prohom, Barriendos, Aguilar, and Ripoll (2012), and compared it with the aforementioned price series, while also calculating the deviation from the mean in each period, as displayed in Table 4.2. The bottom of the Table displays the correlation coefficients of said variables, with the leftmost half analysing the values of the entire yearly series, which we have not reproduced due to spatial constraints, while the right half displays the correlation coefficients of the pictured 10-year average series.

Our approach shows that temperature displayed a lower degree of variation than prices in general, although this question is probably explained by our reliance on the overall average as a reference point. An adequate treatment of the question would require removing the economic component of the trend in prices, although it is unclear whether deflating said prices through a Consumer Price Index is the desirable approach –as stated in the previous subsections– due to the relative weight of bread in premodern societies' consumption baskets. If this approach was to be attempted at a monthly basis, dissecting the component of seasonality would also be desirable, both to compare it with that of prices and to remove it in a more thorough econometric analysis. In Table 4.2 we examine the correlation between temperature and prices, both at the yearly and 10-year averages intervals. Albeit the correlation coefficient between temperature and prices is positive, its explanatory power is low in the yearly data series and moderate in the 10-year average series, while in both cases correlation between prices is far higher than that of temperature. In any case, this very preliminary and superficial approach only allows us to postulate that, in a 10-year average, variability was higher in prices than in temperature, and that the positive correlation with temperature notwithstanding, prices displayed a high degree of correlation between themselves. Doubtlessly, this issue deserves a more adequate treatment in the future.

4.2 The Quantity historical series

Reconciling all the information in the previous chapter (3.1) and transforming it to a cohesive series from which information can be inferred has been not a small effort. In this sense, the following section provide sa

Table 4.2: Temperature and price variations, 10-year averages (1780-1930)

	10-y Average				Percentual deviation (%)			
Years	**Temp**	**Fw**	**Ch**	**Br**	**Temp**	**Fw**	**Ch**	**Br**
1780-1789	14.10	0.02	0.06	0.21	-0.5	-47.2	-51.9	-45.7
1790-1799	14.41	0.03	0.09	0.28	1.7	-23.4	-31.2	-27.4
1800-1809	13.85	0.03	0.10	0.40	-2.3	-16.3	-21.1	2.5
1810-1819	13.46	0.02			-5.0	-29.7		
1820-1829	13.99	0.02			-1.3	-43.1		
1830-1839	13.96	0.02			-1.5	-39.4		
1840-1849	14.29	0.03	0.12	0.35	0.8	-11.0	-10.6	-9.6
1850-1859	13.96	0.03	0.10	0.37	-1.5	-18.5	-22.9	-3.9
1860-1869	14.60	0.03	0.11	0.38	2.9	-1.3	-17.6	-2.7
1870-1879	14.33	0.04	0.13	0.42	1.1	21.3	-0.5	7.4
1880-1889	14.01	0.04	0.12	0.39	-1.2	12.9	-6.5	-0.8
1890-1899	14.55	0.05	0.12	0.35	2.6	35.2	-9.2	-9.0
1900-1909	14.15	0.04	0.14	0.39	-0.2	12.4	7.3	0.2
1910-1919	14.21	0.05	0.18	0.45	0.2	53.4	36.1	14.6
1920-1929	14.78	0.07	0.30	0.68	4.3	94.5	128.0	74.4
Average	**14.18**	**0.03**	**0.13**	**0.39**	**1.82**	**30.64**	**22.86**	**13.22**

	Correlation coefficient: yearly				Correlation coefficient: 10-year			
	Temperature	*Firewood*	*Charcoal*	*Bread*	*Temperature*	*Firewood*	*Charcoal*	*Bread*
Temperature	1.00				1.00			
Firewood	0.36	1.00			0.63	1.00		
Charcoal	0.27	0.90	1.00		0.54	0.92	1.00	
Bread	0.25	0.85	0.92	1.00	0.44	0.88	0.95	1.00

Source: temperatures are from Prohom et al. (2012), expressed in Celsius degrees. Fw, Ch and Br, stand for 'firewood', 'charcoal' and 'bread', respectively, and are expressed in Pesetas per Kilogram; its data is from the sources previously mentioned in the text: Feliu (1991); Nogués-Marco (2001) and the BOPB. 10-year averages have been calculated for every aforementioned variable, and the variance or deviation from the mean has been calculated by substracting the data point for a given period from the total average, and expressing it as a percentage of variation (thus, not relative to the average, but displaying the deviation itself). The averages for said variance have been calculated in absolute terms.

quantitative series, which reflects both the process of research we have followed, as well as a step from a more strict approach to a higher degree of estimation. In this, our intention is not to confound the reader, but to provide a well documented approach –with its corresponding data clearly displayed in the Appendices– in a progressive manner that enables "backtracking" in case of disagreement, error or dissonance. This is intended especially for any future researcher that may want to use the data we have compiled, thus establishing a distinction between "the sources themselves" and our interpretation in the form of an estimation of them. In any case, the following section will deal with the Quantity series, which is made out of very specific parameters –maritime and railway freight, generally ignoring other land-based trade–, but due to the variability and heterogeneity of sources it presents a novel, albeit limited perspective.

4.2.1 The land-based trade problem

Our problem when trying to reconstruct the land-based trade in the premodern situation is both lack of data and the conflicting nature of the information that is available. The three main sources which contain information on quantities before the development of the first railroad in 1848 are the Manifesto of 1823, Madoz's data for the period 1835-1839 and Figuerola's statistics for 1845-1847. The first of these three sources is based on an estimation, while the latter two are based on the duties levied at the gates. However, there are many problems: first, we have no available data for firewood in the 1840s. Second, Figuerola himself notes that "the quantities of charcoal cannot sustain even a fourth part of the population". Thus, in Table 4.3 we have tried to correct the initial data given by Figuerola by multiplying it by 4 – the rest of the data has been transcribed 'as is' for clarity. To calculate consumption per capita and per year, we have used the population series from López-Gay (2014), except for the year 1823, in which we have used the data given by the source itself – "about 120,000" inhabitants.

Table 4.3: Barcelona's land-based imports of biofuels (1823-1847).

Year	Charcoal	Firewood	Equivalent firewood	Corrected firewood	Kg/cap/year
1823	23,004	124,800	239,820	239,820	2.00
1835-1839	8,942	1,984	46,695	46,695	0.40
1845	2,310	–	11,550	46,200	–
1846	3,819	–	19,095	76,380	0.53
1847	3,858	–	19,290	77,160	0.46

Source: our own, from the Manifesto of 1823 (see 3.3), Madoz's data for the period 1835-1839 (see 3.4), and Figuerola (1993[1849]) (see 3.5). "Equivalent firewood" is the sum of firewood plus charcoal multiplied by five, reflecting the firewood to charcoal ratio expressed in the local literature.

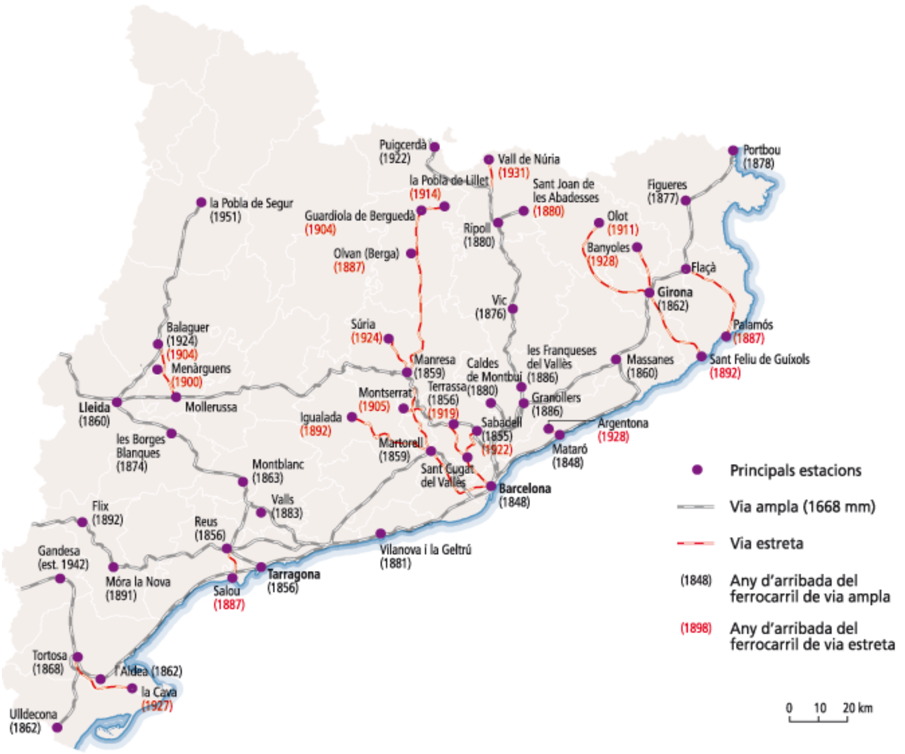
The information given in Table 4.3 is, in some aspects, conflicting, but revelatory in others. On one hand, the estimations of equivalent firewood in 1823 are almost five times higher than those from the 1830s and 1840s, as well as its resulting consumption per capita, and all that *despite* the fact that the inhabitants for 1823 are almost certainly overestimated. On the other hand, its interesting to note when we apply the corrections hinted to by Figuerola, our data for the 1830s and the 1840s seem to be situated at a similar level, even though the sudden increase between 1845 and 1846 – which was noticed by Figuerola, too. In any case, the rate of consumption oscillates between 0.40 kg/cap/day in 1835 to 0.46 kg/cap/day in 1847. Although interesting, we haven't found any year for which we posses land-based data and maritime imports, so we cannot attempt to establish a ratio of "land to sea" imports based on data from one or more coinciding years. Additionally, no chronological overlaps of premodern land-based trade and railroad are available either. However, we do have available data for the two following years after 1847. Nonetheless, the data points of 1848 and 1849 enable us to establish a continuity between both series, as we'll see in the following section.

4.2.2 Pascual: Railroad freight data

Pere Pascual has published recently a *magnum opus* on railroads in Catalonia (Pascual, 2016). Amidst the vast quantities of information it contains, there are several references report on the quantities of fossils in transit throughout the whole Catalan railway system between 1848 and 1935, of which we have selected all data referred to Barcelona. However, several problems arise from this approach. First, the fact that commodities were being moved along the railway to Barcelona does not necessarily imply that their final destination was indeed the city. In fact, during our period of study, several towns and cities in the province of Barcelona saw important increases in population, with potential energy demand following suit. Second, the information of fuel traffic is not always homogeneous: there's references to "charcoal and firewood" together or "charcoal" and "firewood" as separate; sometimes, «sarments i fogots»("vines and crop prunings"), «llenya i fogots»("firewood and prunings") or «llenya, palla i canyes»("firewood, straw and reeds"). Third, for some lines and periods, data are absent for certain years or periods (as in 1863-1865, 1868-1873, 1880-1882, 1893-1895, 1902-1904 or 1925-1926). Finally, as the railway network extended throughout the period considered, lines were constantly being added, linked or expanded, therefore changing the structure of data.

According to the typology of the data, we can distinguish among three periods: from 1854 to 1873, from 1878 to 1897 and from 1901 to 1930. The first period (1854-1873) is the most heterogeneous in terms of both commodity categories and the origin of its sources. From 1854 to 1861, for instance, there is data on the line Barcelona-Granollers (Pascual, 2016, p.95); from 1863 to 1865 and from 1868 to 1873, on the line Girona-Barcelona (Pascual, 2016, p.297); and from 1865 to 1867 and 1872 to 1873, from Tarragona to

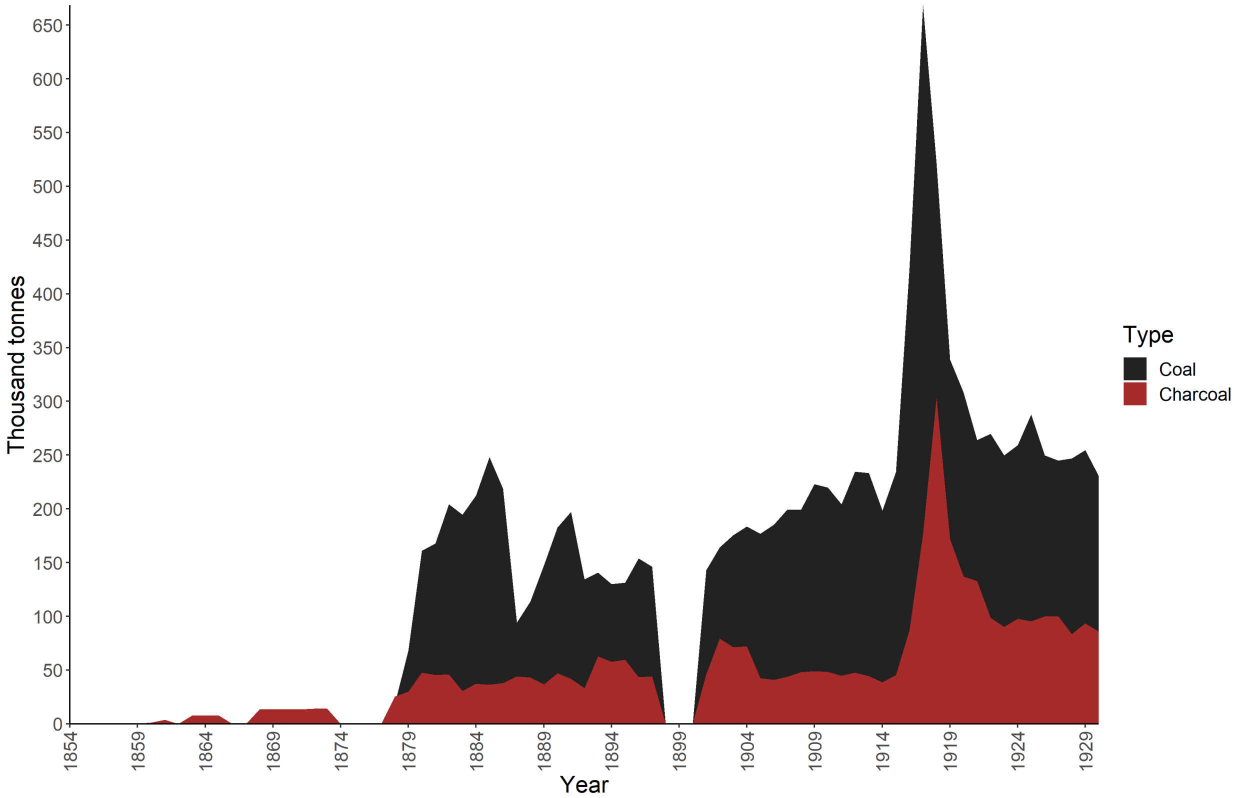
Figure 4.9: The development of the Catalan railway network (1848-1951).



Source: Nadal et al. (2012, II.2.8).

Barcelona (Pascual, 2016, 369). The second period (1878-1897) is comprised of data on "the structure of hauling traffic in the line from Tarragona to Barcelona" –corresponding to tables 1.5 and 1.6 of the second volume of Pascual (2016, p.34 and 137)– with some spare data on the "hauling traffic from the stations in Catalan lands from the line Barcelona-Zaragoza-Altsasu" for some triennial periods (Pascual, 2016, p.349, 353). Finally, the third and last period (1901-1930) its the most homogeneous in terms of data. They correspond to Table 4.9 of Pascual (2016, p.231), and they refer to the "traffic haul in the Catalan network of MZA", with the addition of some triennial data from the line Barcelona-Zaragoza (Pascual, 2016, p.357-358). Additionally, as charcoal and firewood appear under one item during the 20th century –"carbó vegetal y llenya" or "combustibles vegetals"– data has been split onto firewood and charcoal assuming 2 kilograms of firewood per kilogram of charcoal based on the tendency of the last years of the 19th century. Therefore, although our assumptions regarding the problems of data lie mainly of the heterogeneity of data, they are attenuated by he fact that as time progresses the series becomes more uniform and homogeneous, in parallel of the railway network itself. Additionally, although assuming that the entire traffic of charcoal was directed towards Barcelona might be risky in some aspects, we are certain that at least the majority of it had the Catalan capital as its final station for two reasons: first, it is definitely the city that experienced highest rates of demographic growth throughout the period; second, for those time-cuts where we have had access to data on *both* directions of charcoal traffic, expenditures *from* Barcelona are marginal at best –less than 50 tons–, while received quantities are very significant.

Figure 4.10: Railroad traffic of fuels towards the province of Barcelona



Source: our own, from Pascual (2016).

Figure 4.10 displays the evolution of the traffic of various commodities towards Barcelona in the period 1854-1930. Although the previously stated three periods can be clearly noticed, a continuity is apparent in the last two. Regarding the first period, its worth noticing that until 1876, Catalonia's rural areas were in an almost perpetual state of warfare between Carlists and Liberals, the former incidentally engaging in guerrilla tactics throughout the charcoal-producing mountains and forests and staging frequent raids on trains (Pascual, 2016, p.415-417).

4.2.3 The conflicting observations of 1848-1849

As previously mentioned in its corresponding section (3.6), the observations of 1848 and 1849 display clearly different values, noting a drop of about 80% in a year. When compared to population according to López-Gay (2014), the consumption per capita per year is equivalent to 8.37 kg/cap/year in the case of 1848 and

1.59 kg/cap/year in the case of 1849. In regards to the entire series, 1848 is clearly an outlier, but it is also the year for which data is better in terms of information and disaggregation. On the other hand, the information for 1849 is only portrayed in an aggregated version, thus being problematic to asseverate if any error had been made in accounting, for instance. In any case, it would be equally arbitrary to discard either value. If the data series was longer or denser, an option would be to simply discard the discordant value as an outlier; however, it is the only observation linking the early 19th century with the 1860s and 1880s, for which more data points are available. Therefore, we have opted for a slightly less problematic option –although not bereft of its own concerns–, that is, to average the quantity for the two dates. As risky as it might be in statistical terms, it permits us to resolve the problem stated in the previous section (4.2.1): if we consider the land-based quantity of 1847 to be similar to that which have would been in 1848, we can use both bits of information –land-based trade and maritime trade– to calculate a ratio of land to maritime freight and *vice versa*, as seen in Table 4.4.

Table 4.4: Land to sea ratio of overall equivalent firewood quantities (1847-1849).

Year	**Source of land**	**Land**	**Sea**	**Ratio (Land/Sea)**	**Ratio (Sea/Land)**
1848	Gate tolls - 1847	77,160	496,541	0.16	6.44
1849	Gate tolls - 1847	77,160	95,046	0.81	1.23
1848-1849	Gate tolls - 1847	77,160	295,794	0.26	3.83
1863	Railroad 1863	32,777	57,341	0.57	1.75
1864	Railroad 1863	32,777	68,224	0.48	2.08
1863-1864	Railroad 1863	32,777	62,782	0.52	1.92
1880	Railroad 1880	116,206	180,232	0.64	1.55

Source: our own, from Figuerola (1993[1849]), the Mercantile Balances of 1848 and 1849 (see 3.6), and Pascual (2016).

Therefore, we have set the “land” component of the table to be that of year 1847. As mentioned above, the extreme values of both 1848 and 1849 are discarded, in favour of the sea to land ratio of 3.83 to 1. As we have seen in the Balance of 1848’s section (see 3.6), foreign commerce amounted to less than 5% of overall trade: thus, in a premodern context, it can be assumed that overall bulk would not vary that much in the short term, and that in any case, increases in imports in land would be replicated by sea through the means available at that era. Although this ratio is based on one observation, and contested at best, it is our only proxy to infer what we can consider as premodern sea-to-land ratios, and its less arbitrary than other possible approximations, such as inferring a static quotient and multiplying it by population. Therefore, we have applied this ratio to all land-based observations previous to 1848 to infer their sea based trade for certain years, concretely for the period 1835-1839 and 1845-1847.

Additionally, in the case of years 1863-1864 and 1880, we do have complete data for railroad freight and sea-based trade; therefore, we can establish their land to sea ratios. In the case of 1863-1864, as the data from the original railroad source is obtained through a three year average, we can average sea trade too to "smooth out" outliers for the period. Using this methodology, we obtain a dynamic sea to land ratio between years 1847-1849, 1863-1864 and 1880, which oscillates from 3.83 in the first period, to 1.92 in the second and finally, 1.55 in the third. Using the ratios of these datapoints, we can interpolate its declension throughout said years. Thus, if we perform a linear interpolation for all the values for which we have data on sea imports during the period 1850-1879, we can obtain dynamic estimations of land-based trade while capturing the transition from traditional means to modern ones. However, **it is important to note** that we have only used the methodology explained in this last paragraph in the case of the consumption series in section 4.3 and in Appendix A.2, as some of the Figures in the following section distinguish between firewood and charcoal to provide information on its relative weight in the total quantities available, while this approach does not permit to do so.

4.2.4 Constructing the estimated quantity series

One of our main results is the construction of a series of the quantities that entered the city of Barcelona between 1848 and 1935 through various means: naval freight and railway. In light of the information adduced in the two previous sections, the Estimated quantity series has been constructed according to the following Formula (4.1):

$$Q_{bf} = Imp_{bf} - Exp_{bf} + Cab.in_{bf} - Cab.out_{bf} + RR.in_{bf} - RR.out_{bf} \tag{4.1}$$

where:

Q_{bf} = quantity of biofuel in thousand tonnes;

Imp_{bf} = imports of biofuel in kilograms or tonnes;

Exp_{bf} = exports of biofuel in kilograms or tonnes;

$Cab.in_{bf}$ = imports of biofuel through cabotage kilograms or tonnes;

$Cab.out_{bf}$ = exports of biofuel through cabotage kilograms or tonnes;

$RR.in_{bf}$ = quantity of biofuels going into the city through railways, kilograms or tonnes;

$RR.out_{bf}$ = quantity of biofuels going out of the city through railways, kilograms or tonnes;

Here, the term "biofuel" refers to either firewood, charcoal or equivalent firewood: the latter is obtained by adding up firewood with charcoal multiplied by five, which corresponds the ratio of units of firewood required to produce a unit of charcoal is between 5:1 and 5.5:1 (the latter, from Malanima, 2006, p.29), although this relation depends on the type of wood used, the technology employed, etc. In both graphical and statistical terms, this conversion *uncovers* the black box that charcoal is both literally and figuratively, as it is in fact a highly concentrated form of biomass. Therefore, the total amount of a given biofuel can be calculated by adding up the following:

- Imp_{bf} minus Exp_{bf}, that is, the imports and exports of a given commodity through international commerce. In general terms, our data is from the ECE (see section 3.9), although the data for the years 1848-1849 is from the *Balanza Mercantil* of 1848 (see section 3.6) with the additions mentioned in section 4.2.3.

- $Cab.in_{bf}$ minus $Cab.out_{bf}$, that is, the entrances and sorties of a given commodity through cabotage. In general terms, our data is from the AENC (see section 3.10), although some years have been either double-checked or obtained from the AECB (see section 3.11).

- $RR.in_{bf}$ minus $RR.out_{bf}$, that is, the quantities of a given commodity "sent towards Barcelona" through railroad. The data we use is entirely from Pascual (2016), as explained in section 4.2.2.

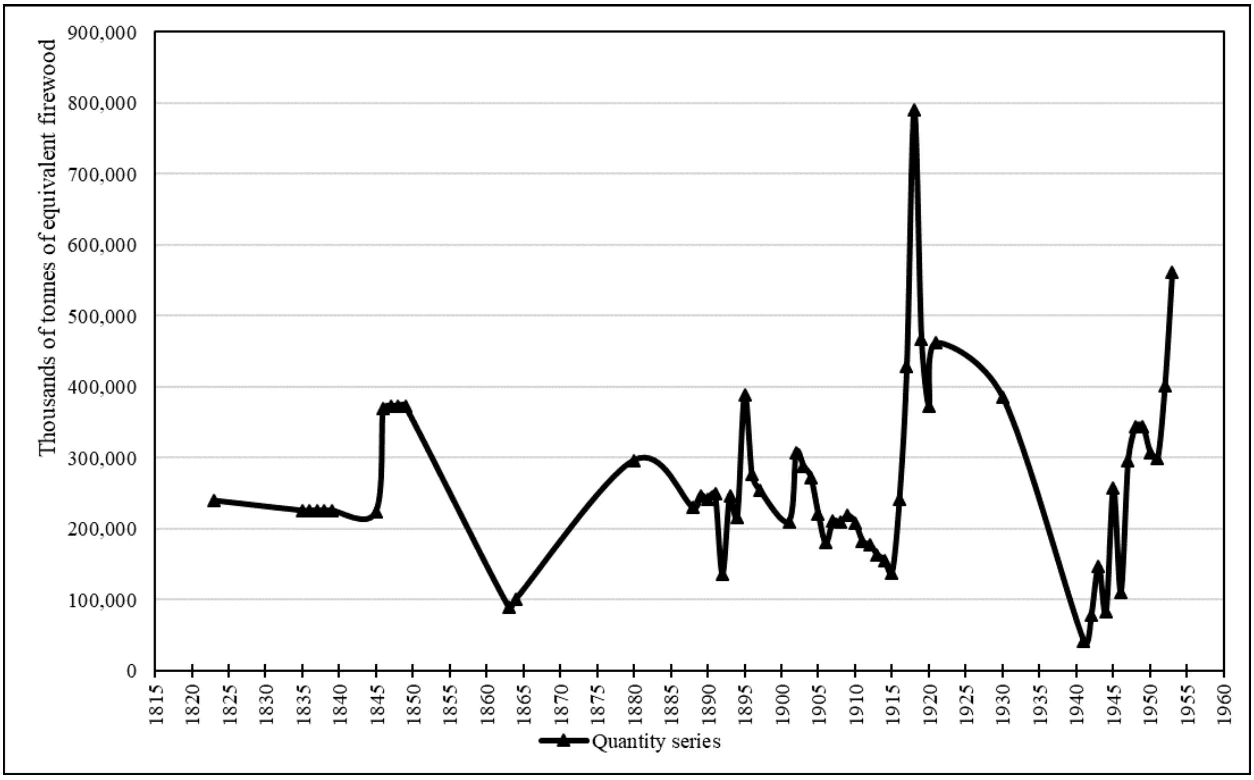
From all sources cited in the previous subsections of this chapter, we are able to construct a quantitative series for the period 1823-1953, albeit with various concerns that need to be properly addressed and explained. First of all, this quantitative time series is supply-based, mostly constructed out of maritime freight and railway data, with the exception being the year 1823, which as previously mentioned in section 3.3 is a nonetheless relevant coetaneous estimation, as it provides a benchmark for the beginning of the Industrial era. We have been unable to obtain a continuous data series on land-based transport aside from the periods 1835-1839 and 1845-1847 and that of railways in general, although admittedly carts and pack mules must have played an important role in pre-modern Barcelona; however, evidence presented in the previous subsections tends to favour the view that biofuels were mostly imported through maritime means. In any case, this problem has been dealt with in the previous subsection (section 4.2.1). Nonetheless, as the railway network developed, it became the dominant means of land-based transportation and it even entered in dynamics of competition with cabotage freight.

Second, there are several gaps for which not all items previously mentioned –which are the terms of Equation 4.1– are available. For instance, we have no *complete* data for the periods 1824-1847 and 1849-1879; although we do posses information of *parts* of overall quantities, including them would offset our perspective, indicating drops where perhaps we only lack data from a given source such as cabotage freight.[6] As the terms $Cab.out_{bf}$ and $RR.out_{bf}$ are generally-speaking negligible or entirely absent throughout the period –especially in terms of firewood–, we have not included them in the analysis. In the briefest terms possible, we have followed these steps:

[6]The whole dataset is displayed as a table and can be consulted in the Appendices.

- The database from the Quantity series, described in this section and the previous three has been used as the main source of information.
- We have discarded all years after 1849 for which no data from the ECE or railroads was available to avoid sudden drops due to gaps and voids in the data. Additionally, we have discarded data for the year 1866, as it is the only year in the series which displays charcoal exports but not imports, and the year 1878, because it was an outlier in the lower range.
- We have added the data from the Gate tolls, as explained in section 4.2.1.
- We have discarded the values for 1848 and 1849, and used an average of both years in both cases, as explained in section 4.2.3.

Figure 4.11: Biofuel quantities entering the city of Barcelona (1823-1953).



Source: our own, from all the sources cited in the text and previous tables.

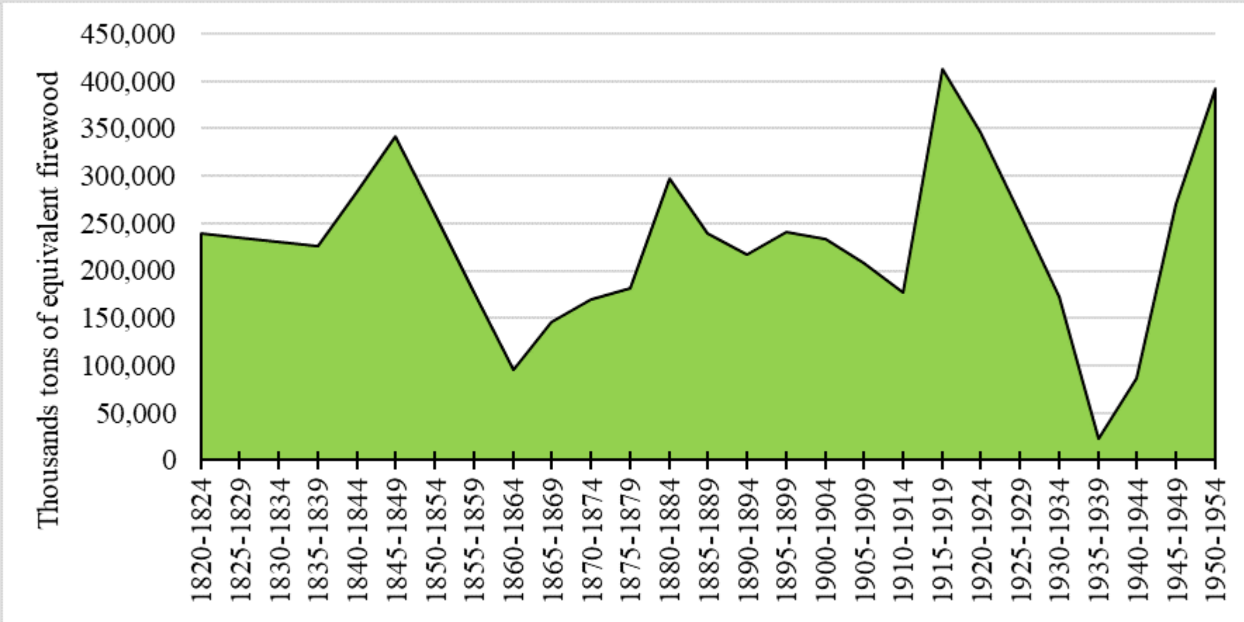
Figure 4.11 displays our Quantity series, with its constituent data points shown. In broad terms, seven periods can be distinguished: first, an apparent downwards trend from 1823 until 1845, which picks up in sudden fashion during the 1840s. However, as it has been stated in the previous sections, the data for the 1830s and 1840s has to be viewed critically, as no maritime imports are available for that period.

However, after peaking in 1848-1849, the second period is characterized by a downwards trend until the 1860s. Conversely, the third period is by an increase in quantities, peaking in the 1880s. It is important to assert that while the data from which the series is made is quite heterogeneous until the 1860s. Additionally, the data for 1823, the 1830s and 1840s has been deemed an "upper boundary" estimation, while the greater part of the series, starting in the 1860s, can be considered a "lower boundary" estimation, as it doesn't include land-based trade other than railroad freight. Therefore, what is depicted as a straight fall of quantities between 1849 and the 1860s might have not been as steep as depicted. In any case, the fourth period is marked by an decline, albeit an oscillating one, until 1915. The fifth period, between 1915 and 1920 –in the wake of WW1– is marked by a soaring tendency, after which the sixth period is characterized by a steep decline taking place until the 1930s, including both the Republic and the Civil War. Finally, the period of the 1940s and 1950s –the Francoist autarky– is set by an upwards tendency of unprecedented magnitude.

To provide a more aesthetic graphical representation, we have transformed Figure 4.11 into Figure 4.12, averaging out our data for 5-year periods. To do so, we have altered the data in the following way: we have averaged the data for the 5-year periods displayed, removing the more conflictive points for which there were no ECE statistics. In this sense, periods 1850-1854, 1855-1859 and 1875-1879 have been removed altogether. Additionally, the period 1880-1884 is based on the data from 1880, while the period 1885-1889 is based on the data from years 1888 and 1889. After performing these corrections, we have lineally interpolated the periods 1825-1829, 1830-1834, 1850-1854, 1855-1859, 1865-1869, 1870-1874 and 1875-1879 to provide a more visually-pleasing perspective.

Thus, Figure 4.12 is a stylized representation of the data in Figure 4.11, while the comments made on the latter remain valid, as oscillations have been removed. Although useful, both perspectives misse an important part of the Energy Transition, that is, the one that took place between energy carriers of different development blocks. This question is solved in Figures 4.13, as these figures include two categories of energy carriers: biofuels and mineral coal. However, to undertake this approach several decision had to be taken, especially in terms of restricting data years and energy carrier types. First, only those years which had available data for all terms of Equation 4.1 were included; these are years 1848, 1880, 1900, 1910, 1920, 1930, 1940, 1945, 1950 and 1955. Second, although the data for the 1940s and 1950s does indeed include other energy carriers such as gas and primary electricity (see section 3.11), we don't have access to data for similar energy carriers in other periods, so we have limited our approach to mineral coal. The data on coal imports is constructed in the following way: for 1848, it is from the Laureano Figuerola's account (see section 3.5), which as he himself notices is twice the amount of that in the Junta de Comerç's *Balanza Mercantil* of 1848 (see section 3.6). The data for the years 1880 to 1930 comes from two different sources: the book *Economía e Historia del Puerto de Barcelona* (Clavera, Carreras, Delgado, & Yañez, 1992), which includes data on

Figure 4.12: Biofuel quantities entering the city of Barcelona, 5-year averages (1820-1955).



Source: our own, from all the sources cited in the text and previous tables.

maritime imports for a few selected years[7], to which (second) Pascual's data on freight transportation is added (see section 4.2.2). Finally, for the 1940-1950s period, we have used the only available data from the AECB (see section 3.11), with two minor tweaks: the data from 1940 is actually from 1941, while the data from 1955 is actually from 1953.

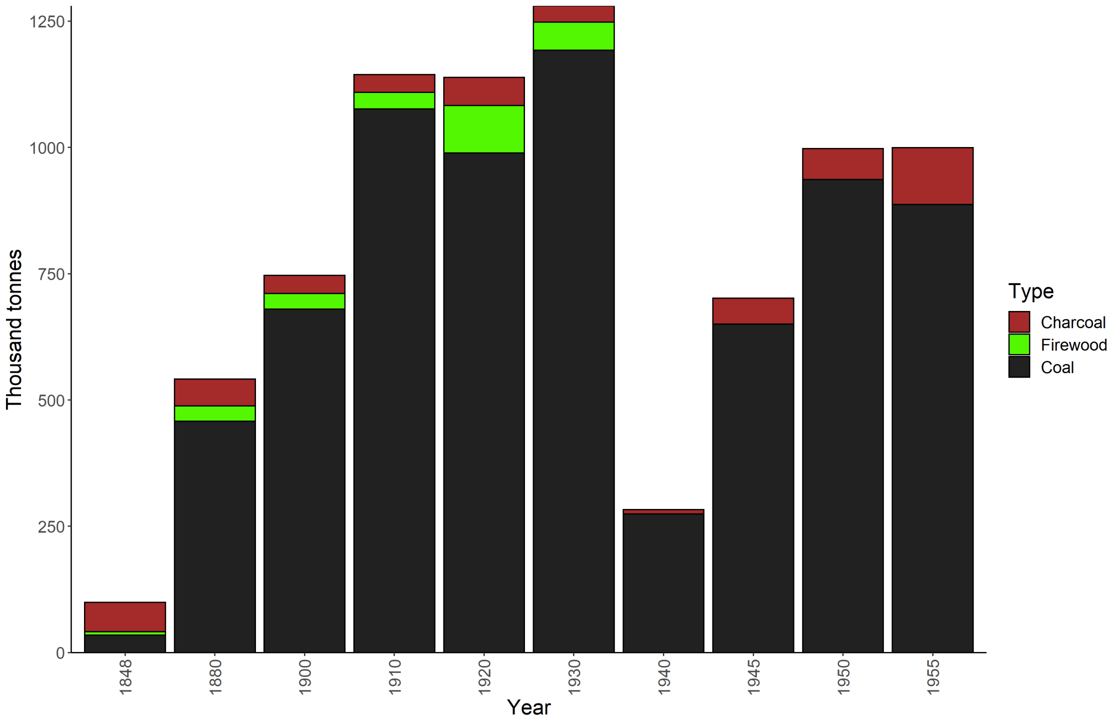
The resulting Figure (4.13) is extremely interesting. In subfigure a, the bulk of fuels entering the city of Barcelona throughout various selected years is depicted. From 1848 onwards, an extremely pronounced increase in the quantities of incoming coal is noted, especially until 1910; coincidentally, for that same period the quantity of charcoal is decreasing, while firewood is maintained or even increased. Between 1910 and 1920, the period of WW1, a drop in coal is paralleled by an increase in both biofuels; however, in 1930 the levels of 1910 are surpassed in terms of coal and firewood, with charcoal being maintained on similar terms. The drop of quantities between 1930 and 1940 due to the Spanish Civil War is manifest; although during the subsequent years both coal and charcoal are increasing, in the case of coal they will never reach antebellum levels. In the case of charcoal, is increase in quantity is also noted, both in absolute and relative terms (subfigure b), where it recovers its share in similar terms to those of 1880 or 1900.

However, Figure 4.13 display quantities of goods entering the city, therefore they express a relationship of material appropriation, based on *mass*. While it is useful to ascertain the *weight* of human impact in

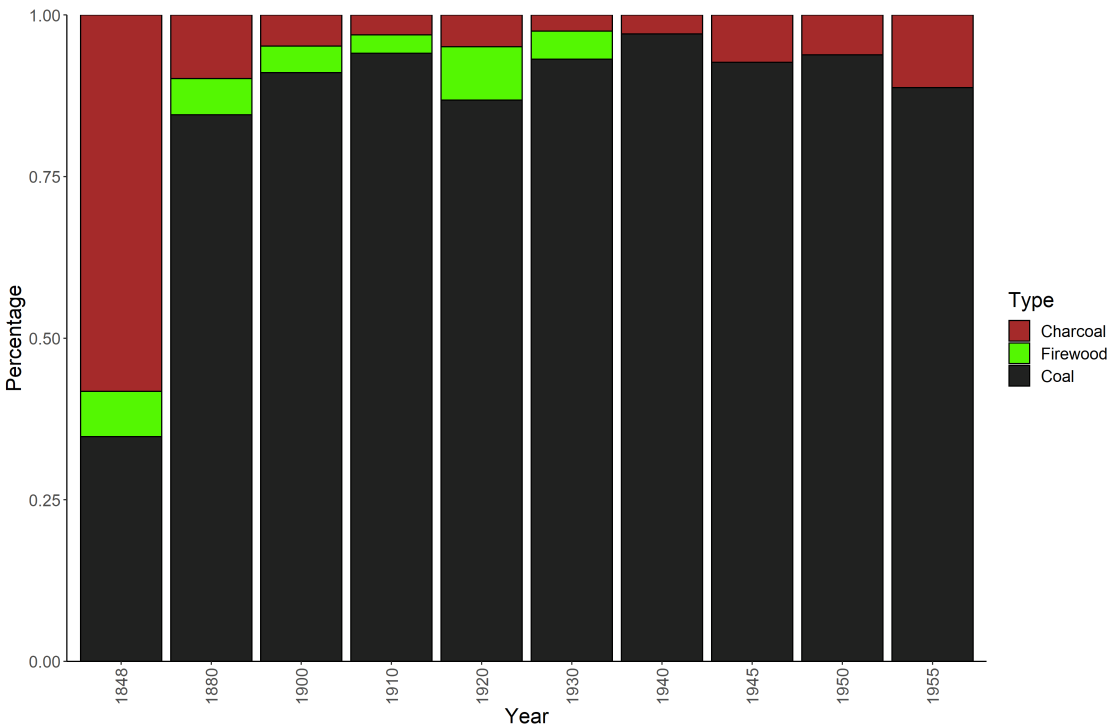
[7] Although we have also consulted sources such as the AENC or the ECE for coal data, due to the variability of sources and methodologies we have preferred to use already published and perhaps more established information.

Figure 4.13: Biofuel and coal consumption in the city of Barcelona (selected years).

(a) Absolute consumption:



(b) Relative consumption (share over total):



Source: our own, from all the sources cited in the text and previous tables.

terms of bulk, a conversion to energy yields a profile of a given society's energy metabolism, thus enabling a more adequate interpretation of the Energy Transition *in se*.

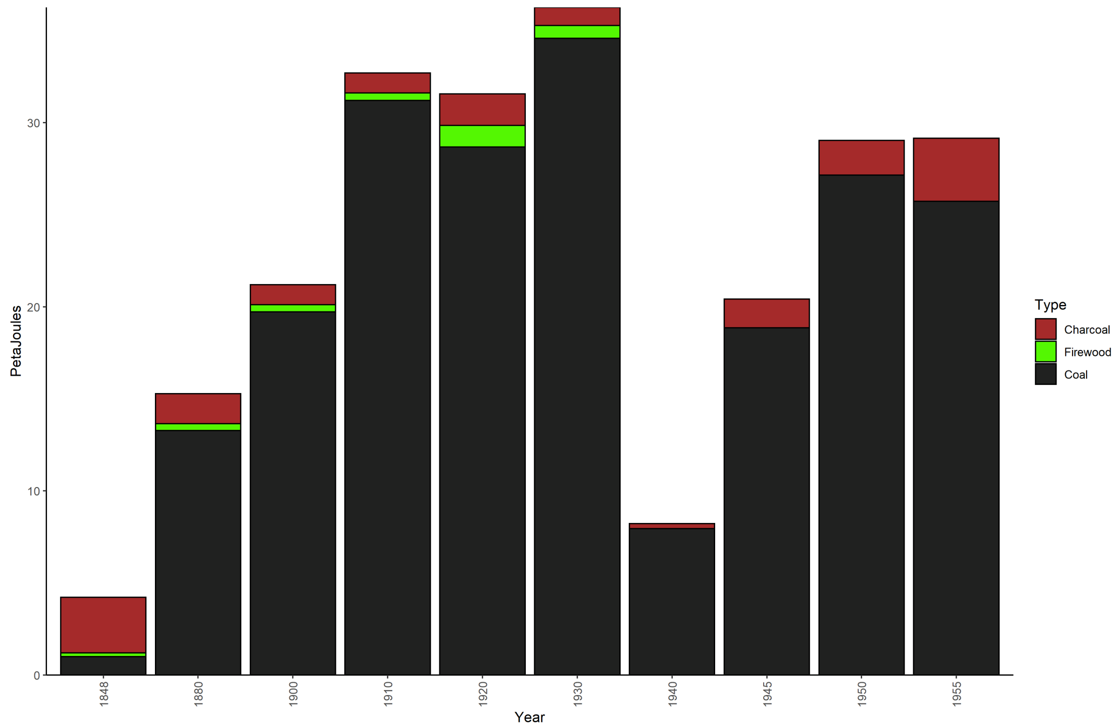
To transform Figure 4.13 into Figure 4.14 we have applied the following criteria: a ton of firewood has been set to be equivalent to 12.552 GigaJoules (Malanima, 2006); a ton of charcoal has been set to embody 30.5432 GigaJoules (Malanima, 2006), while a ton of coal is considered to contain 29 GigaJoules of energy (Kander, 2002; UN, 1987). While the units used for firewood and charcoal are slightly different than those in **?** –less than 10%–, they reflect better the characteristics of Mediterranean Forests (Malanima, 2006). On the other hand, choosing a right factor is extremely relevant. We have chosen to use the standard quotient, which perhaps better represents the quality of British coal rather than Spanish coal from Asturias; however, the coal brought in to Barcelona was almost exclusively British until WW1, and still played a preponderant role until the 1930s (Coll & Sudria, 1987; Sudrià, 1987). The use of these conversion factors results in a relatively mild correction of Figure 4.13, as the weight of firewood is diminished while that of charcoal is increased in relation to the rest of fuels. Biomass –the sum of firewood and equivalent firewood in charcoal– shows four phases: the first one, between 1848 and 1900, in which it experienced an absolute decline, albeit at a slow pace; in the second phase, between 1900 and 1920, biomass usage rose in absolute terms. In the following years, during the third period (1920-1940), it experienced a steeper drop than ever before. However, during the last period (1940-1955) biomass rose again in the overall terms. Conversely, coal consumption shows four period: the first one, until 1910, in which coal consumption rose; the second period (1910-1930) included a drop in consumption. The third phase (1930-1940) was characterized by a steep fall in coal consumption; finally, the last period of our series (1940-1955) coal consumption grew again, albeit at a lesser maximum total than before, and with a downwards tendency in the last two observations.

4.3 The rates of consumption by end users

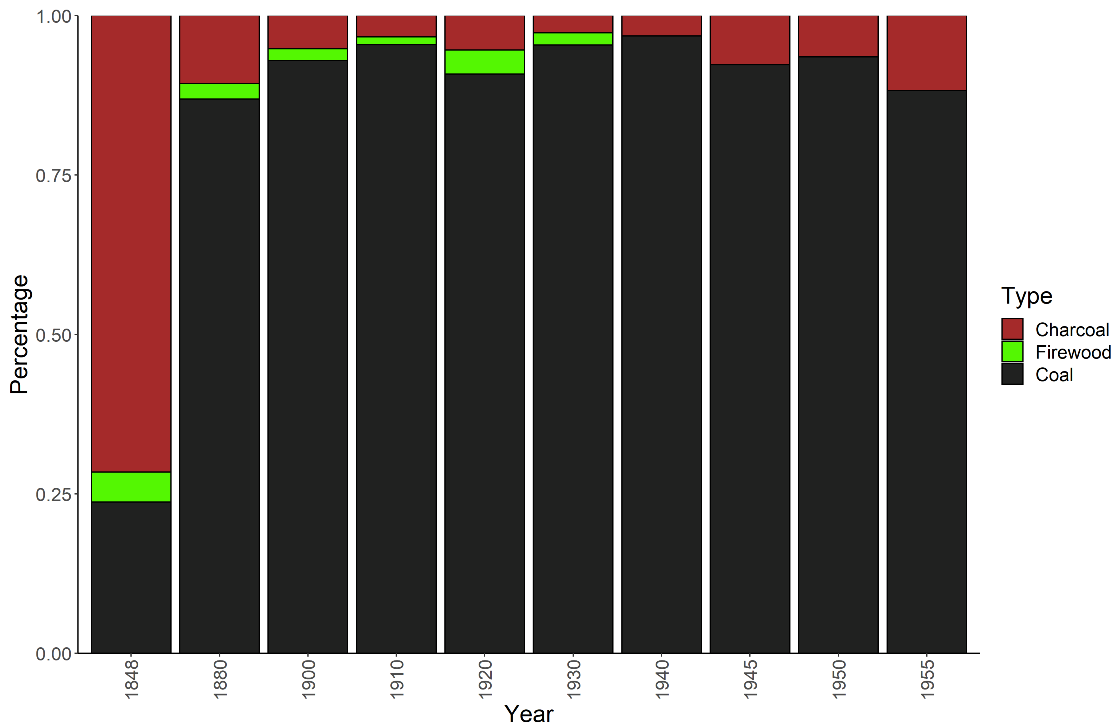
The Quantity series examined in the previous section (see 4.2) can be crossed with population data to obtain a consumption per capita series. However, a a brief note on demographic series is necessary: on one hand, while the most accepted demographic data series is that of the *Centre d'Estudis Demogràfics* at the Autonomous University of Barcelona, as it captures actual population, it only contains 3 observations in the 19^{th} century. On the other hand, while López-Gay (2014)'s series is based on contemporary sources, it does only consider legal population, therefore underestimating total population. Therefore, in the cases where broad comparisons are made, the CED data series has been used; on the other hand, in those cases where continuity of a data series was necessary, López-Gay (2014)'s information has been used instead. In any case, we have specified in the caption or text the data series we have used. In any case, the consumption per

Figure 4.14: Energy consumption in the city of Barcelona by energy carrier (selected years).

(a) Absolute consumption:



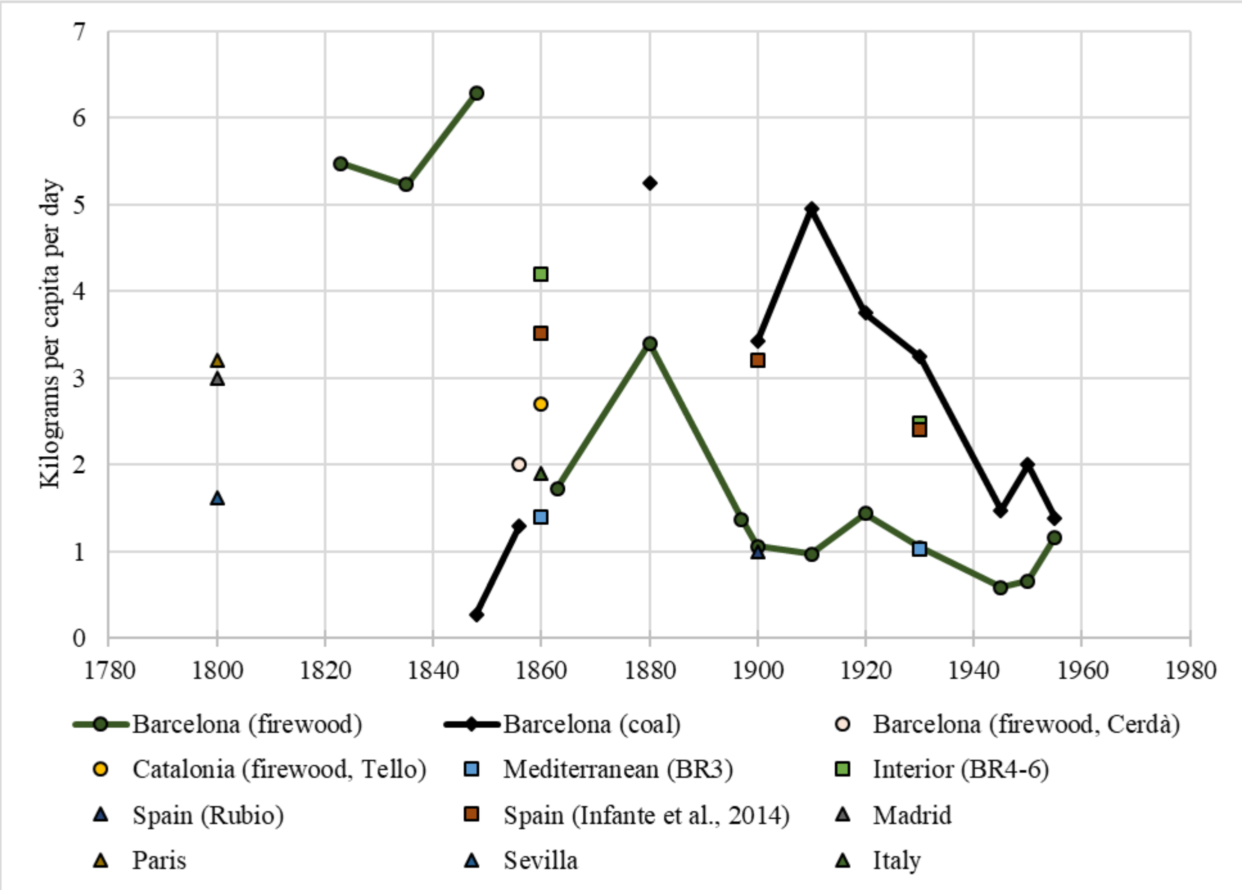
(b) Relative consumption (share over total):



Source: our own, from all the sources cited in the text and previous tables.

capita series is an extremely important insight in a period in which Barcelona's population doubled every few years. Figure 4.15 displays the resulting values from dividing the total quantities in the series by the population proposed by (López-Gay, 2014). It must be noted that population doubled between the start of the 19th century and the 1880s; it did so again between the 1880s and 1900s, and again in the 1930s, reaching the size of a million inhabitants.

Figure 4.15: Consumption of firewood per capita per day in Barcelona, compared (1800-1955).



Source: our own; Barcelonese data from all the sources cited in the text and previous tables. However, it is necessary to highlight the methodological difference in a part of the firewood series, especially in the first three estimates: the first one, from 1823, is based on data from a coetaneous estimation, the *Manifiesto* of 1823 (see section 3.3); the second one, from 1848 is based on the average between the quantities in the Mercantile Balances of 1848 and 1849 (see section 3.6); finally, the third observation, from 1856 is from the calculations based on Ildefons Cerdà's *Monografia estadística de la clase obrera en Barcelona* (see section 3.8). The 1856 datapoint for coal is based on Rafo's estimations on coal imports during 1858 from his *Proyecto para la mejora y el ensanche del Puerto de Barcelona* (p.541). Non-Barcelonese data points from Iriarte-Goñi and Infante-Amate (2019); Kander et al. (2013); Malanima (2006); Rubio (2005).

Therefore, we have crossed the data from the quantity series with that of the aforementioned demographic series –prioritizing data from the CED wherever possible–, thus obtaining the standard for comparison among the literature: the amount of kilograms of firewood –and coal– consumed per inhabitant per day, as seen in

Figure 4.15. We have used it to compare it to other relevant estimations, such as those in (Iriarte-Goñi & Infante-Amate, 2019; Kander et al., 2013; Malanima, 2006; Rubio, 2005), as seen in section 2.3. However, it is necessary to highlight the methodological difference in a part of the firewood series, especially in the first three estimates: the first one, from 1823, is based on data from a coetaneous estimation, the *Manifiesto* of 1823 (see section 3.3); the second one, from 1848 is based on the average between the quantities in the Mercantile Balances of 1848 and 1849 (see section 3.6); finally, the third observation, from 1856 is from the calculations based on Ildefons Cerdà's *Monografia estadística de la clase obrera en Barcelona* (see section 3.8). The 1856 datapoint for coal is based on Rafo's estimations on coal imports during 1858 from his *Proyecto para la mejora y el ensanche del Puerto de Barcelona* (p.541).

In terms of firewood, several important things can be stated: the first two data points register rates of consumption higher than 5 kg per capita per day. After the gap in the quantity series, two different and conflicting data points follow: Cerdà's observation of 1856, with a rate of firewood consumption of about 2 kg/cap/year; and the quantity series' 1880 point, of about 3.5 kg/cap/day. Cerdà's observation would put Barcelona in the same category as Malanima's Italy (Malanima, 2006) or the Mediterranean biorregion in Iriarte-Goñi and Infante-Amate (2019), and close to the 2.7 kg/cap/day in Tello et al. (2008) for Catalonia. Conversely, if the gap between 1848 and 1880 was covered by linear interpolation, rates of firewood consumption would rather fall into the "Interior" bioregions category of Iriarte-Goñi and Infante-Amate (2019), close to the 3.52 kg/cap/day estimation for Spain in Infante-Amate et al. (2014). In any case, in the next 20 years firewood consumption drops to the rate of 1 kg/cap/day proposed by (Rubio, 2005). An increase is noted *prior* to WW1, which was compounded on during the war, after which the consumption rates rose to about 1.5 kg/cap/day. Afterwards, consumption per capita dropped until 1930, was relatively stable during the 1930s and rose during the 1940s and 1950s. In the case of coal, it rose steadily from less than one kilogram per capita per day in 1848 to over a kilogram in 1856 and to over 5 kilograms per capita per day in 1880! In the following twenty years, coal consumption per capita dropped to about 3.5 kg/cap/day, after which it rose to 5 kg/cap/day again in 1910. This was the last high point of coal consumption per capita, as the rate dropped until the 1940s, with a brief upturn during the 1950s followed by yet another decline. This evidence has to be taken, however, with the proverbial grain of salt, as the figures include all coal and charcoal circulating inside the city, a relevant part of which was not employed in domestic consumption, but rather in manufacturing and industry, both *traditional* and *modern*.

5. Discussion: Domestic energy converters' affordability matters

The results presented in the previous section raise three main questions: What energies, organic and fossil-based, were available in the Barcelona province at the time of the First Energy Transition? What sectors could incorporate the new fuels and which not, and when? Does the Catalan case fit the 'Energy Ladder' or the 'Energy Stacker' view? To try to answer these questions, even tentatively and provisionally, the above presented evidence seems at first glance a difficult puzzle. While we do not have historical series on the quantities of the different types of fuel consumed, addressing this issue requires, first of all, combining the new price data with the existing literature on energy consumption in the province of Barcelona at that time. Even through this combination of evidences our price data raises new, more specific questions.

If per unit of calorific value (GJ) mineral coal was already cheaper than firewood and charcoal from the mid-nineteenth century onwards (Figure 4.6), why were biomass fuels continued to be consumed massively not only in rural households but in urban dwellings until well into the twentieth century? Why did this happen, despite the fact that firewood, and even more so charcoal, became much more expensive than bread for those city dwellers (Figure 4.3)? And, finally, why did charcoal consumption seem to have grown so much over that period despite being the most expensive domestic fuel after gasoline?

On the one hand, the purchasing of fuel for cooking and heating at home kept its traditional low price elasticity as a staple good. On the other hand, however, the greater availability of income by some urban households could imply a larger demand for fuel to heat more rooms than just one with a fireplace and a brick or stone chimney (Kander, 2002; Kander et al., 2013), as well as for cleaner fuels for cooking in the city's new iron-made kitchens, which could have resulted in greater income elasticity driven by class segregation among city dwellers. This set the context for the growing demand of domestic exosomatic energy carriers during the first energy transition, along with two other key conditioning factors: the existence and affordability of the new converters adequate to switch from biomass to fossil fuels at home; and the different transportation costs of organic and mineral supplies that were incorporated into their final retail prices in the urban markets.

Warde (2019) offers 8 factors which act as guidelines to account for different levels of consumption of firewood in various polities over time: its use in households for cooking and heating; other household uses, such as heating of animal fodder; availability of wood fuel and proximity to the forest; availability of alternative fuels, such as peat, coal, oil or gas; opportunity cost of labour; price and income effects; urbanisation and level of industrialization. Acknowledging that to solve this puzzle requires constructing long-term series of quantities of biofuels and fossil fuels consumed, we can try to understand the meaning of the evidence obtained through their prices by taking into consideration that the combination of population increase, income growth, industrialization and urbanization meant important consequences for domestic fuel demand. We'll examine some of the aforementioned topics in the following subsections.

5.1 Population, urbanization and income growth increased biomass fuel demand

One of the most relevant elements in the city of Barcelona in a historical perspective were their walls, and their profound effect on its urbanism and urban sprawl until the 19th century. The Roman enclosure was expanded on by Jaume I (1213-1276) and Pere el Cerimoniós (1336-1387), whom incorporated to the city the current area of the Raval. This new space, teeming with hospitals, convents and orchards and garden plots has been considered by authors as the "greatest and most ambitious urban planning project until the middle of the 19th century" (Batlle & Vinyoles, 2002). Within the walls, hygiene and salubrity decreased as population density increased: the most common type of building was a combination of a shop or workshop in the ground floor with housing facilities in its higher floors (Batlle & Vinyoles, 2002). Outside the walls, the *Pla de Barcelona* was scarcely urbanized, with an important presence of orchards and plots, *masos* and fortified houses. Swamps, rushes, marshes and pasturing grounds abounded around the estuaries of the Besòs and Llobregat rivers, while the mountainous areas around Collserola were forested by "alders, oaks, holm oaks, elms, trees, hawthorns, walnuts, fig trees, buckthorns, olive trees and fruit trees" (Batlle & Vinyoles, 2002).

However, the context described above greatly changed during the 18th and 19th centuries. Catalonia almost doubled its population from 1718 to 1787 (Ferrer, 2007), while Barcelona's inhabitants tripled from about 36.000 to near 100.000 inhabitants. The medieval walls were becoming a nuisance for Barcelona's urban expansion, and they were finally torn down in 1854-1856 after a series of discrepancies with the Spanish government, which wanted to preserve them for military purposes and which had prompted a bombardment of the city by the Spanish General Espartero in 1842. In parallel, port facilities were being expanded to cope with an upsurge in trade – especially in terms of coal and cotton. After the walls were torn down, the Municipal government opened the urban planning of the city expansion project to public competition, which was won by Antoni Rovira, but this decision was overruled by the Spanish government to put Ildefons Cerdà in charge. Cerdà, following the social hygienist theories of that era and the example of Hausmann in Paris, designed the now-idiosyncratic Barcelonese district of the Eixample in what was termed the "Cerdà Plan". As a more detailed analysis is perhaps tangential to our topic, it is nonetheless necessary to highlight that the Cerdà Plan contemplated the adaptation and usage of the *modern* technological elements of the period, such as the use of modern waterworks, the connection and integration of railways within the city, and the deployment of gasworks and pipes. In any case, in 1857 the city reached 235 thousand inhabitants that doubled again in less than forty years to 544 thousand inhabitants in 1900, and surpassed the million mark in 1930. Aside from population growth, two other processes were at play: rural exodus to urban areas from Catalonia and other parts of Spain, and the industrial urban expansion of a network of cities in the Barcelona province, exerting a remarkably stronger attraction for migrant workers than even the capital of the state (Madrid) or the highly industrialized Bilbao.

Table 5.1: Population in the city and province of Barcelona, 1515-1930.

Year	**1515**	**1717**	**1787**	**1857**	**1900**	**1930**
Total population (province)	16,452	172,778	345,042	713,734	1,054,541	1,800,638
Barcelona (city)	6,613	37,365	100,160	235,060	544,137	1,005,565
Urban population	6,613	54,523	133,592	365,058	716,439	1,440,335
Rural population	9,839	118,255	211,450	348,676	338,102	360,303
% urban pop.	40.20%	31.56%	38.72%	51.15%	67.94%	79.99%
% rural pop.	59.80%	68.44%	61.28%	48.85%	32.06%	20.01%
% of BCN in total pop.	40.20%	21.63%	29.03%	32.93%	51.60%	55.84%
% of BCN in total urban pop.	100.00%	68.53%	74.97%	64.39%	75.95%	69.81%

Source: our own; data from the *Centre d'Estudis Demogràfics* – also present in IDESCAT, *Evolució de la població de fet*. Data for 1717 has been recalculated increasing IDESCAT's data for that year by a factor of 40 per 1000 inhabitants, as explained in Ferrer (2007). We have considered population to be 'urban' for every city over 5,000 inhabitants.

Population growth and urbanization might have resulted either in a massive increase in demand for biomass fuels that would boost the exploitation of nearby forest resources, or rather in a fast switching to cheaper and more dense fossil energy carriers imported. This phenomenon is apparent in the increasing number of *carbonerías* in the city of Barcelona: 99 in 1852 according to Cerdà, 378 in 1902 according to the AECB and 994 in 1945 –64 wholesale and 930 retail– according to Zamora (1996, p.66). What did the resolution of that crossroads depend on? First, we have to consider the factors underlying the evolution of the relative prices of each option. In addition to labour and other costs of cutting firewood and charcoal-making in forests, and when compared to labour and other costs of coal mining, a key factor that determined the spatial energy footprint of those growing industrial cities were transport costs per unit of weight.

On the one side, the terrestrial carriage of firewood was subject to the *iron law of transport* that set clear boundaries in terms of forest supplying areas for city dwellers, and that meant a strict restriction for urban growth in all preindustrial economies over centuries (Fischer-Kowalski et al., 2013; Gingrich et al., 2012; González de Molina & Toledo, 2014; Kim & Barles, 2012; Krausmann, 2013; Sieferle, 2001). Due to its high water content, firewood was an expensive commodity per unit of weight and calorific value, and it had to be brought in carts. It made little sense to consume more (endosomatic) energy in feeding the mules that pulled the cart than the (exosomatic) energy they carried in it, setting a limit to the affordable distances that firewood could travel. Besides resorting to fluvial or sea navigation when possible, the only way out to this carriage iron law was turning firewood into charcoal in order to allow this denser biomass energy carrier to be extracted and hauled from more remote forest supply areas.

Table 5.1 shows that in the province of Barcelona the share of urban population living in towns or cities over 5,000 inhabitants stood around 30-40 per cent up to 1787, grew up to 51 per cent in 1857, to 68 per cent in 1900 and attained 80 per cent in 1930. By expanding the demand for fuel, urbanization also displaced the energy footprints of those 1.4 million inhabitants of cities and towns to ever further distances, which generated a clear incentive to switch to charcoal. This helps explain why an ancient activity such as charcoal making experienced a great surge during the first stage of the energy transition to a fossil-fuelled industrial society, with charcoal prices increasing the steepest price hike before 1912 as seen in Figure 4.5. On the other hand, coal was an even weightier mineral that could be even less affordably carried by carts. The opening of new navigation routes and terrestrial railway networks, which were developed precisely due to coal mining, led to a sharp decrease in freight costs that put in motion the First Globalization up to the Great War (O'rourke, 2002). In fact, this also explains why imported coal became cheaper than any other fuel in the Barcelona province from the mid-nineteenth century onwards (Figure 4.6). Coal could be sent in large quantities from a single mine to a port by rail, then sailed by sea and disembarked again in Barcelona, thus avoiding large trips by land by cart (N. Wrigley & Lowe, 2010).

However, if the resolution of that crossroads would had depended solely on the relative price of each energy carrier, we could not understand the long persistence of biomass fuels in household consumption that coexisted with the first energy transition to fossil fuels in the factories and industrial facilities of Catalonia.

Barcelona is a seaport, a railway network was developed in the province from 1848 to 1898 (Pascual, 2016), and our historical series show that coal was cheaper per unit of energy content than any other biomass fuel in the urban markets of this province from mid-nineteenth century onwards (Figure 4.6). Why then it was not consumed massively for domestic uses during the nineteenth century and the first third of the twentieth century? We deem that the answer lies in the quality of each fuel and the different converters necessary for its proper use.

In this Mediterranean region, firewood had been used over centuries in fireplaces and chimneys that cogenerated almost all the final energy services needed for cooking and heating at home, together with the animal heat stemming from the stables located below the bedrooms. Switching from firewood to charcoal allowed heating more rooms by means of braziers and replacing fireplaces by iron-made kitchens and ovens, which in turn could also be fuelled with mineral coal. A thorough switch to coal would also require iron-made stoves and radiators for household heating. Without these new domestic converters, it was not very attractive to switch from biomass to fossil fuels. The inhabitants of the working-class neighbourhoods of Barcelona experienced this dilemma when energy poverty forced them to choose to either get sick from cold or from air pollution with acid smoke. In any case, both aggravated the extremely bad health conditions during the first half of the nineteenth century: overcrowded housing and an unsafe water access that became a breeding ground for infectious diseases (Miralles, 2014). Understandably, whenever possible the working class households resorted to *cisco*, the cheaper charcoal they could afford. The Spanish expression "*armar un cisco*" means to tussle, or to take part in a loud turmoil, something that those Barcelonese poor dwellers did very often to protest for the high prices and taxes of the staple goods needed for their "eating, drinking and burning" (Renom, 2016b).

Table 5.2: Demographic growth related to biofuel price growth, 1515-1930.

Period	**1515-1717**	**1717-1787**	**1787-1857**	**1857-1930**
Population growth (city)	5.65	2.68	2.35	4.28
Pop. growth (province)	10.50	2.00	2.07	2.52
Firewood price increase	5.36	1.83	1.44	2.51
Charcoal price increase	2.52	2.10	1.52	2.84
Bread Price increase	2.30	0.97	2.27	1.51

Source: our own; population data from the *Centre d'Estudis Demogràfics* – also present in IDESCAT, *Evolució de la població de fet*. Data for 1717 has been recalculated increasing IDESCAT's data for that year by a factor of 40 per 1000 inhabitants, as explained in Ferrer (2007). We have considered population to be 'urban' for every city over 5,000 inhabitants. For price data, Feliu (1991), Nogués-Marco (2001) and our own BOPB series. Firewood price data for 1515 is from 1527, for charcoal 1517 and for bread, 1522.

Another technological solution was to turn to the much cleaner coal gas that was piped from coke furnaces. But again, cooking with the so-called "city gas" (*gas ciutat* in Catalan) remained a luxury. Pipe connection to coal gas only existed in the city of Barcelona, where at first was mainly installed for lighting, and only reached 59 per cent of households in 1952 (Arroyo, 2003; Arroyo & Matos, 2009). All this data allows us to assume that the case of Barcelona would probably have followed an Energy Sticker instead of and Energy Ladder transition path, a hypothesis that must be confirmed when historical data or better estimates on the quantities consumed of each fuel become available. Meanwhile, this hypothesis is consistent with the evolution of relative prices of charcoal shown by our historical series, whose increase exceeded that of firewood from the 1787 onwards or bread after 1857, probably driven by an even higher growth rate of the urban population in the Barcelona province (Figure 4.2 and Table 5.2).

From 1515 to 1717, the rate of urban population growth in the city of Barcelona was parallel to that of firewood prices, probably because it was still the main source of fuel. Despite its significant long-term growth rate, the total number of urban dwellers remained limited. In 1717 Barcelona did not exceed 40,000 inhabitants, and the rest of the 47,000 who lived in smaller cities and towns could still be supplied with firewood by a rural population that was 1.5 times larger. Charcoal was then primarily an industrial input or a luxury consumed by the elites, and its price had grown at a slower pace than firewood from 1515 to 1717. Then, from 1717 to 1787 charcoal prices began to grow faster than those of firewood, stimulated by an even greater increase in the population of the city of Barcelona and the other cities and towns of the province. This probably began a change from firewood to charcoal that lasted throughout the nineteenth century and until the 1930s, when urban dwellers became 80 per cent of the total population in the province of Barcelona (1.4 million people with only 360,000 rural inhabitants).

In any case, wherever we consider the data from either Cerdà in 1856, or the datapoints for 1862 and 1880 valid, it is clear that biofuel consumption appears to be falling throughout the second half of the 19th century, as seen in Figure 4.15. It is interesting to notice how the consumption per capita gravitated during this period below the consumption estimations of the Interior bio-regions in Iriarte-Goñi and Infante-Amate (2019) as well as the datapoints of Infante-Amate et al. (2014) and along if not above the Mediterranean ones. The observation in year 1900 is especially interesting, as the rate of firewood consumption is set at the same level as estimated by Rubio (2005), although it must be noted that it is perhaps a simple coincidence. In this sense, it is important to note a twofold issue: on one hand, Barcelona was perhaps the city in Spain most advanced in terms of the Energy Transition, with relatively high access to exogenous coal, as the consumption per capita reflects. A growing port, well connected in the international trade networks provides the example of the utmost *Mediterranean* example of the homonymous biorregion in Iriarte-Goñi and Infante-Amate (2019). On the other hand, it is hard to believe that the degree of access to coal that Barcelona enjoyed was a general case among Spanish cities –with the exception of Bilbao and Madrid, perhaps–, and much less among the provinces. In this sense, either Rubio (2005)'s estimate posits a much earlier transition than was actually possible, or it compensates the discrepancies among the Spanish state. However, it's worth noticing that the author's estimation of firewood relies entirely on a fixed constant of consumption. In any case, after reaching an unprecedented low point during the early 1900s, firewood consumption rose during the Great War. Conversely, coal saw a recuperation after the fall during the 1880s and 1890s, and afterwards it fell almost continuously in the end of the period. However, the extremely high rates of population growth of the city must be taken into account, especially in the periods in which firewood consumption rose: 1920 and the 1940s and early 1950s. In both cases, commercial isolation was a relevant factor in the degrees of implementation of the Energy Transition, as energy consumption had to be satisfied by *shifting back* on those domestic sources that were available or, in the case of the lower classes, by reducing overall energy consumption. The following section will examine which were these sources, and which effects ensued in the wake of such societal transformations.

5.2 Diminishing forests pressured domestic supply

As already pointed out by Pierre Vilar (Vilar, 1964), during the eighteenth century population growth and agrarian change entailed in Catalonia a strong pressure "*towards two general phenomena of that period: exhaustion of forests and the search for new fuels*". Contemporary observers such as Josep Masdevall (1784) argued in favour of coal use to "save the forests of Montseny", a mountainous area in the province of Barcelona largely exploited to extract bio-energies (Martí, 2002). However, forest and environmental historians have questioned to what degree these reports reflected a real crisis, or were rather a mere defence of the absolutist monarchies' interventionism through idealized views on the pristine conditions of Mediterranean forests in the past confronted with the 'ruined landscape' motto so prone to Enlightened writers of the time (Cervera, Garrabou, & Tello, 2015; Grove & Rackham, 2001; Warde, 2006, 2019).

During the nineteenth century Spanish forests became another battleground in the conflict between the *Ancien Régime* forces and the tides of liberalism where individual and communal landownership rights became a contested issue. Liberal reforms put into circulation many lands formerly belonging to the clergy, noblemen as well as common lands of villages and the state, resulting in a process of unprecedented land privatisations and reduction of the commons (GEHR, 1994). The adoption of the liberal-oriented General Ordinances of Forests in 1833 enforced the legal rights of proprietors, allowing owners to enclose their lands, making trespassing, hunting and fishing illegal and abolishing the former Spanish Royal Navy's privileges of wood extraction (Cervera et al., 2015; Iriarte-Goñi, 2013; Maynou-Felker, 2014). Despite the initial ideological claims of liberalism, and the subsequent laws enacted to protect forestland, the private exploitation of woods promulgated by liberalism proved to be useless as a means of forest conservation.

Between 1914 and 1925, the new autonomous government known as Mancomunitat de Catalunya addressed the issue of the unsustainable pressure on woodlands by creating a forestry service, compiling traditional knowledge about forests and enacting policies of preservation and reforestation guided by an underlying nationalist spirit (Cervera et al., 2015; Tello et al., 2014). In 1916, the Spanish Law of Natural Parks was a first step towards conservationism, reinforced in 1918 by a Forest Defence Law that made for the first time public permission mandatory for landowners to exploit their forests in a climate of international tension and warmongering that increased state interventionism up to the outbreak of the Spanish Civil War (Cervera et al., 2015; Cervera, Pino, Marull, Padró, & Tello, 2019).

Along this period forest areas decreased in Catalonia from 1,972,112 ha in 1860 to 1,735,435 ha in 1932, mainly due to the expansion of cropland combined with the growing demand for firewood charcoal and wood materials such as sleepers for railways in the 1890s, construction materials in the 1920s, and pit props and packaging in the 1930s. A particularly relevant aspect of that deforestation process in the Barcelona province was a widespread vineyard expansion driven by wine and liquor exports to Northwestern Europe up to the arrival of the Phylloxera plague from North America, which ravaged grapevines throughout Europe (Badia-Miró & Tello, 2014; Badia-Miró, Tello, Valls, & Garrabou, 2010; Cervera et al., 2015; Iriarte-Goñi & Ayuda, 2008).

However, from an environmental and economic history perspective several somewhat contradictory factors can be highlighted. First, vineyard expansion competed with forests for land, therefore potentially decreasing firewood and charcoal supply. Second, grapevines had been traditionally considered a multifunctional crop that generated pruning and uprooting byproducts which accounted for up to 40 per cent of overall firewood consumption in several areas (Infante-Amate & Iriarte-Goñi, 2017; Infante-Amate et al., 2014; Iriarte-Goñi & Infante-Amate, 2019; **?**). Finally, the Phylloxera plague resulted in the death of all previous vineyards, whose uproot in order to be replanted with vines grafted with strains resistant to the insect led to an ample supply of biomass fuel. Although we can't further delve into this process, a deeper investigation of the vineyard expansion and crisis could be relevant to the topic at hand.

In Table 5.3 we can calculate extension of forests that would have been needed to fuel Barcelona if all equivalent firewood or coal came from domestic sources, either at the provincial level (BCN) or in regards to Catalonia (CAT); this idea follows the seminal one put forward by E. Wrigley (1990) in the case of Great Britain. The data is from section 4.2, specifically from the same series as in Figure 4.13; the total area of the province of Barcelona and Catalonia has been considered to be the current one: 7,726 ha in the case of the province of Barcelona, and 32,108 ha in the case of "Spanish Catalonia"[1]. We have assumed the

[1] We refer to "Spanish Catalonia" to mean the territories of historical Catalonia under the current administration of the Spanish state under the structure of the "Autonomous Community of Catalonia". Therefore, the territories of Northern Catalonia –under French administration– or the "Western strip" –under the administration of the Autonomous Community of Aragón–,

common figure of 1,5 tonne of sustainable firewood yields per hectare, while in the case of coal we have used the “ghost acreage” in Kander et al. (2013, p.114), quoted from (E. Wrigley, 1990), of 1 ton of coal per 0.4 hectares of forest.

Table 5.3: “Ghost acreage”: land-impact of fuel consumption as a % of total area of the Province of Barcelona and Catalonia.

	Firewood				**Coal**			
	Quantity	Equivalent area	area BCN	area CAT	Quantity	Equivalent area	area BCN	area CAT
Year	*thousand tonnes*	*km2*	*%*	*%*	*thousand tonnes*	*km2*	*%*	*%*
1823	240	1,599	20.7	5.0				
1848	511	3,404	44.1	10.6	35	139	1.8	0.4
1880	296	1,976	25.6	6.2	458	1,832	23.7	5.7
1900	210	1,402	18.2	4.4	680	2,720	35.2	8.5
1910	209	1,392	18.0	4.3	1,076	4,305	55.7	13.4
1920	373	2,484	32.2	7.7	989	3,955	51.2	12.3
1930	215	1,432	18.5	4.5	1,193	4,770	61.7	14.9
1940	42	278	3.6	0.9	275	1,098	14.2	3.4
1945	257	1,713	22.2	5.3	650	2,602	33.7	8.1
1950	307	2,049	26.5	6.4	937	3,746	48.5	11.7
1955	562	3,748	48.5	11.7	887	3,549	45.9	11.1

Source: our own. Quantities series from section 4.2; calculated by multiplying total quantity by a “sustainable yield” of 1.5 tonnes of firewood per hectare, and dividing by the total area of the province of Barcelona (7,726 km^2) and Spanish Catalonia (32,108 km^2). Note that the higher boundary estimate has been taken for 1848, based on section 3.6.

The evidence displayed in Table 5.3 points to a perhaps obvious but nonetheless impactful idea: that if Barcelona had had to rely on its domestic sources of firewood, the *total area of the province* dedicated to fuelling the city would have oscillated between *almost half of the entire province* in 1848 and 1/5 and 1/3 in the early 20th century, climbing up again to almost 1/2 in the 1950s in the case of the equivalent firewood. In the case of coal, it climbed steadily from a mere 1.8% in 1848 to 1/5 in the 1880s and over half the entire province in the 1930s! It must be noted that 1940 is a “bad year” in terms of data, as it pertains to the aftermath of the Spanish Civil War and fraud, black market and diminished consumption probably entailed in an lower reporting of actual quantities. Albeit this is a relatively “crude” approach –the constant of 1,5 tons per hectare can be contested and could be made dynamic, as well as the ratio in E. Wrigley (1990)– and the “equivalent areas” could be compared to known forest areas –thus entering a in another historiographical debate–, the basic notions portrayed are several. First, the same notion that E. Wrigley (1990) drove attention to: without coal, Barcelona –the city– would have required a ranging space of between 1/3 and 1/2 of its entire province exclusively to maintain its energy consumption of modern energies! And

are not included under our use of “Catalonia”, although there are vast historical, economical and cultural connections.

that without considering the consumption of other cities or the need for food and feed of its population, both human and animal. The same ideas are valid in the case of firewood, but with an additional twist, as its lower energy intensity and the constraints of the *Iron Law of Transportation* made it unfeasible to be transported from certain areas within the province – thus the resort to charcoal. In any case, if we were to add up the total area of both energy carriers –equivalent firewood and coal–, almost throughout the entire timeframe, between 1/2 and 4/5 of the area of the entire province would have been required to be forested in order to sustain consumption.

Conversely, the literature supports the vision of a diminishing forest area through a process that took off in the eighteenth century, increased in the nineteenth and early twentieth centuries, and reached a last peak in the Great War. Our price series corroborates this long-term trend that remained in place despite the fact that the imported coal was sold in the Barcelona province at a cheaper price from mid-nineteenth century onwards. These seemingly contradictory evidences can only be reconciled by considering that fuel biomass extraction grew substantially in a decreasing forest area, firewood and charcoal imports increased, or both. Regarding the first, there is ample evidence that pressure on forests increased, especially during periods of strife such as the Great War – as seen in section 3.12 and Cervera (2017, p.44-45). The second notion –increasing firewood and charcoal imports– will be examined in the following section.

5.3 Decreasing transportation costs opened up new areas for supply

As earlier pointed out, the main constraint for both production and consumption of biofuels in agrarian, solar-fuelled preindustrial societies was the iron law of transport that restricted the movement of bulk commodities at distances over 10-50 km (N. Wrigley & Lowe, 2010). The only factors that could mitigate that limit were access to the seaports and navigable riverways, like in the cases of Paris and Vienna (Gingrich et al., 2012; Kim & Barles, 2012; Krausmann, 2013). While Barcelona had maritime connections around the Mediterranean even back in the Medieval Ages, the two major rivers in its hinterland –the Besòs and Llobregat– were hardly naviable with commodities in bulk. Fluvial trade was only important in the Ebro River and its delta, where barges (*llaguts*) pulled by donkeys, mules, oxen or horses through towpaths (*camins de sirga*) brought grains, wool and wood from as far as Aragon and the Pyrinees, and then moved through sea cabotage to Barcelona (Riera, 2003).

On one hand, price increases during the late eighteenth century led Pierre Vilar to affirm that "forest resources must have diminished, at least in relation to necessities" (Vilar, 1964, p.239). Whereas in the early seventeen hundreds the immediate forested hills of Barcelona sufficed for the provision of firewood for domestic use, a charcoal shortage was already recorded in 1770 in the city (Ibid, p.240). Vilar also noticed that firewood prices decreased as distance to Barcelona, the coast or other cities increased (Ibid, p.238). The growing demand of biofuels in Barcelona exerted a market pull that had to overcome the constraints of land transportation –bad roads and a steep countryside lacking navigable rivers– via maritime networks both at the regional and international level, as it had done over the previous centuries mainly through cabotage (Clavera et al., 1992, p.39).

On the other hand, Zamora (1996, p.35) quotes Francisco de Zamora's remarks on the cities of Sant Celoni, near the mountains of Montseny, and their relationship to Barcelona, as well as the consumption patterns of Barcelona itself during the late 18th century:

> On Sant Celoni: «*Hay mercado concurrido, y aquí es donde se trae a lomo el carbón de rabassa que vienen a buscar carros de Barcelona, que producen los montes de Montseny y sus contornos.*»On Barcelona: «*En Barcelona se consume mucho carbón, que le viene del Vallés, y de Tosa, Lloret y de muchas otras partes, y muchos fajos de sarmientos y bastante leña que le traen de los pueblos cercanos y de fuera del Corregimiento.*»

This notes are extremely important, as several ideas are asserted: first, that the Montseny massif was a relevant source of charcoal, which was brought by carts to Barcelona through Sant Celoni and Granollers, both cities in the Vallès county. Additionally, the role of maritime freight is again vindicated, especially in the case of ports in the province of Girona. Finally, the role of *sarmientos* or vineyard crop residues, is noticed, as well as firewood contribution from towns in the immediate hinterland of Barcelona. Therefore, a dual dynamic is postulated: bulkier and less energy dense energy carriers –crop residues and firewood– are brought in from towns close to the city, while charcoal is brought from increasingly further distances. This idea is coherent within the framework of the *Iron Law of Transportation*, implicitly showing that importing firewood from areas in the Vallès county and the province of Girona –both further than 50km away from Barcelona– was only feasible if first "concentrated" in the form of charcoal.

To further add upon the role of the Montseny-Vallès area as a provider of charcoal, Zamora (1996) further mentions a case of Garolera, a forest owner in the 19th century in the town of Arbúcies – at the feet of the Montseny massif. Without mentioning the extension of his lands, he records a yearly production of 5,000 cargues of oak-charcoal (at about 3 tonnes per hectare per year), which at around 120 kg per carga would result in about 600 tons of charcoal per year – from an individual proprietor! Zamora then adds that the Garolera family sent to Barcelonese retailers 25 to 30 cargues –3 to 3.6 tons– of charcoal every fortnight, resulting in a relatively different quantity from the aforementioned number: 312 to 374 tonnes of charcoal per year. On the other hand, the naturalist pioneer (Llobet, 1947, also quoted in Zamora (1996)) stated that the Montseny area in 1936 produced "around 10,000 tonnes of charcoal per year of various qualities", albeit noticing that during those times the Montseny area didn't export as much to Barcelona due to competition, supplying instead to the growing industrial cities of Granollers, Terrassa and Sabadell in the Vallès county.

In any case, in the middle of the nineteenth century, the maritime hinterland for firewood and charcoal of Barcelona had to be expanded, comprising much of the Barcelonese coast –-especially the Maresme county-– and the coast of Girona, the Ebro delta, the province of Castelló and the Balearic Islands. A statistical survey of Barcelona for the year 1849 –the Balanza of 1848– mentioned firewood imports coming from Palma, Eivïssa and Andratx in the Balearic Islands, as well as from Arenys de Mar, Sant Feliu de Guíxols and Tortosa in the Catalan coast, while charcoal did so from Alcúdia, Andratx and Sòller in Mallorca, and from Arenys de Mar, Sant Carles de la Ràpita, Tortosa and L'Escala in Catalonia – as seen in sections 3.5 and 3.6. In that same year, long-haul international commerce was relatively minor, amounting for about 4,000 tons, 4 per cent of overall maritime imports of these commodities, chiefly originating in Italy and France, as seen in section 3.6.

Then, the second half of the nineteenth century saw the last wave of expansion of traditional sail-based cabotage until its eventual demise in the early twentieth century due to and implementation of modern fossil fuel-based steamships and the competing role of railroads (Frax, 1981, 1987; Pascual, 2016). Regarding the latter, as the railway network developed, land-based trade grew overall and extended over to new spaces. In this sense, railway stations provided new hubs to where previously not cost-effective goods could now be brought to, with Barcelona extending its market pull and opening up the spaces of the rugged geography of Catalonia. However, this process did not take instantaneously, as seen in Pascual (2016)'s data: probably, as the railroad developed, transport by carts switched to rail in the areas not immediately adjacent to the city, while overall decreasing transportation costs –what had to be transported from the foot of valleys to the city now could be transported to railway stations instead– opened up new areas for commercial firewood extraction which previously were "further" in terms of transport time and thus, cost. Thus, the rising tendency in consumption during the 1830s and 1840s seen in section 4.2 can be attributed to a process of intensification in a premodern technological context, with rising population and manufacturing in the city requiring additional energy. The establishment of the railway network would have then precipitated a dual phenomenon: first, it would have resulted in an extension of the total potential supply area – thus increasing Barcelona's ecological footprint. Second, it would have changed the local dynamics of firewood to charcoal ratio, as the drop in transportation cost would have decreased the price gap in "energy content per unit of weigh/volume" between both commodities, rendering firewood exports as a now viable for areas where it previously wasn't, and the distance constraints could only be saved by converting said biomass to charcoal.

The IACSI in 1928 ((IACSI, 1928), see section 3.12) mentions the price-structure of charcoal-making in both the Vallès county –adjacent to Barcelona– and in Olot, an inland city in the province of Girona at the feet of the Pyrenees. In the latter case, before the second half of the 19th century the direct land transportation to Barcelona wasn't economically feasible, as around 100 kilometers separated Barcelona from Olot, and thus charcoal had to be transported by land to the commercial ports of the Gironese coast, after which it was shipped to Barcelona. The railway connection between Barcelona and Girona in 1862 and in 1911 between Girona and Olot opened up the entire area of the La Garrotxa county, resulting in an increase and almost specialization of some municipalities in charcoal production.

However, contemporary sources, such as the *Memorias de la Junta de Comercio de Barcelona*, which record international commerce in Barcelona by origin, attest that in 1912 there were imports from Algiers (975 tons), France (13,578 tons), or Italy (8,873 tons). In 1928 contemporary sources attest foreign competition as one of "the determining causes of the charcoal crisis in Spain and especially in Catalonia", with "a minimum of 85,000 tons of charcoal coming from France, Algeria, Corsica and Sardinia" through "the ports of Barcelona, Valencia and others", and also "in trucks through Irún or Port-Bou" (section 3.12). In 1935, another document among the MJCB attests various countries by their contribution to imported charcoal: the French Protectorate of Algeria (463 tons), France through the sea (2,418 tons) or through the land-border in Portbou (1,068 tons) and Italy (1,526 tons). Additionally, a letter from the 1930s recommended the prohibition of charcoal imports through Morocco to avoid the introduction of foreign goods. Even with the internal expansion of railways, domestic supply either couldn't match the internal demand, or do so in internationally competitive terms, especially during the First Globalization.

The partial shutdown of international commerce in the wake of the Great War had already pressured the constraints of domestic system, and charcoal exports were prohibited in 1916 (see 3.12). Twenty years later, during the Spanish Civil War (1936-1939), the convoluted international situation pushed the governments of the Republic and the Generalitat to establish a set of regulations in regards to charcoal production and commercialization. This situation was exacerbated after the victory of the para-fascist regime of Franco, in which military officials were put in charge of the economy in a system characterized by the emergence of black markets and widespread corruption. Price controls were put in place, while the autarchic nature of the system, combined by the international isolation of the first decade of the regime, exerted an ever more strenuous pressure in the sphere of domestic resources. As explained in section 3.12, the lack of liquid fossil fuels pushed for the use of the adoption –and conversion of older vehicles– of wood gas motors, a technology that the also internationally-isolated Italy of the 1930s had adopted in wake of the trade sanctions put forward due to the Abyssinian War. According to the sources in section 3.12, however, charcoal production shifted towards high qualities, to benefit from the higher set prices of wood-gas charcoal, although the relatively higher standards of production for said fuel were not always met, leading to widespread fraud.

Nonetheless, an apparent scarcity of fuels in general and firewood and charcoal specifically was already present in 1942, when the BOE issue of the 14th of October put into motion an express prohibition to transport said fuels between provinces. Regulations on this subject, especially in terms of quality standards and prices were published throughout the 1940s. In 1948, the first *corrientes comerciales* were published, establishing the sources from which provinces had to procure biofuels. This order established a three-tiered system of provinces in terms of their status in terms of their production, which was either at a surplus, a deficit or neural. Barcelona was set as running a deficit in both charcoal and firewood, and during that year, the provinces of Girona, Huesca and Lleida were to provide it firewood, while charcoal was to be supplied from the provinces of Burgos, Ciudad Real, Girona, Guadalajara, Navarra, Soria and Toledo. This system was reinforced by order again in 1950, and stayed into place at least until 1952, where price setting was discontinued. Among other things, this period is especially interesting, as the locally domestic sources of both the province of Barcelona and Catalonia as a whole, as well as its traditional offshoots in the Balearic Islands and the northern Valencian coast, were recognized as insufficient to maintain supply. Additionally, in the context of absence of international trade, those zones which had become net suppliers of Barcelona in terms of firewood and charcoal –France, Italy, Sardinia, Algiers– had to be substituted by railway transportation inputs from Spain.

Therefore, when analysing the expansion of firewood and charcoal supply to Barcelona, we can sketch three main periods in terms of the origin of said goods. First, if we exclude the Roman or Visigothic periods due to lack of sources, we can generalize a "premodern supply area", comprising the immediate forests of Barcelona, the Vallès county and the coasts of the contemporary provinces of Barcelona, Girona, Tarragona in Catalonia, Castelló in the Valencian Country and the Balearic Islands themselves. This premodern supply area was at least still in operation in 1848, to which the international markets were added at some point during the second half of the 19th century, which is where our second period begins. This second period is characterized by the *addition* of new spaces to the premodern supply areas due to the effect of modern vehicles such as steamships, trucks and railways. While the former two reinforced the connections with Italy, France, and various overseas provinces, the latter transformed the internal dynamics of the premodern supply area by opening up new areas and changing its internal composition dynamics, as seen by the declension of cabotage freight in favour of railways. The second period took off at some point during the second half of the 19th century, catching the winds of the First Globalization, and had some fluctuations during the 1910s and 1920s which were abruptly ceased in the late 1930s due to the Spanish Civil War and the posterior dictatorship. Thus, the third period began, comprising the autarchic Francoist period between 1939/1942 and 1952, when firewood and charcoal production, distribution and commercialization was liberalized. This third period was characterized by an entirely different dynamic: the shifting of the paradigm based on the Mediterranean areas of supply onto one based on railway trade from continental Spain. Although our study ends precisely at this point (chiefly due to lack of sources), we could postulate a latter fourth period: that which took place between 1953 and the 1960s, corresponding to the point where the charcoal industry was let go of due to its competition with the butane cylinder. In conclusion, throughout the entire timeframe domestic charcoal production was still in place: it is likely that the industrial expansion of maritime commerce and the overall reduction of transportation costs acted as a key factor in compensating local supply due to growing urban demand and forest depletion. The growth and internationalization of Barcelona as a commercial and industrial port was probably paramount in establishing this network of external supply both for charcoal and coal.

5.4 Energy converters limited the implementation of the Energy Transition

The substitution of biomass energies with fossil fuels seems to have taken place at an unequal and fluctuating pace depending on the interplay among the abovementioned factors. An especially intense drive for technological development in the province of Barcelona stands out in the literature: the early stages of the Industrial Revolution in Catalonia were characterized by an increasing use of hydraulic power combined with a selective use of fossil fuels. The city of Barcelona was one of the early adopters of coal gas, and hydroelectricity experienced a massive growth in the early twentieth century. British coal quickly became the leading imported commodity through the port of Barcelona, althought transportation costs increased its price greatly pushing textile and metalworking industries towards hydropower motion that grew from 73,279 TCE (Tonnes of Coal Equivalent) in 1841 to 509,485 TCE in 1910 (Clavera et al., 1992; Nadal et al., 2012).

However, when domestic uses are taken into account we found two constrasting evidences. On the one hand, Figure 4.6 attests that despite the transport costs of importing them from abroad, fossil fuels were cheaper per unit of energy than traditional biofuels. On the other hand, biomass energies kept increasing in price throughout almost the entire period, attesting that they were still very consumed. The only way to understand both things is looking at the process by which any energy carried is converted into another desired form of final energy service, which is dependent on the access to the adequate converters that can become a key limiting factor.

As different tasks require different technologies, to analyse the specificities of the Energy Transition it is useful to operate with a classification consisting of five main categories of energy demand, each of them representing the basic tasks performed by the exosomatic energy consumption of society: industry, transportation, illumination, heating and cooking. In terms of industrial consumption, firewood and –especially– charcoal have been used throughout history in various activities such as smelting and forging metal implements, making pottery and glass, lime, saltpetre, etc., which often lead to the deforestation of nearby areas. The steam engine and further innovations in smelting techniques inaugurated the First Energy Transition to the coal age in industry from the late eighteenth century onwards led by Great Britain. Although the degrees of implementation of this new energy package varied between countries, in the case of Barcelona it is accepted that by the 1840s an ever-growing number of industrial subsectors were adopting the development block of coal. It has been suggested that the lack of domestic coal reserves and the energy scarcity of sources adequate for this development block influenced the Catalan industrialization towards less energy intensive industrial sectors, such as textile industries, and towards the use of hydropower that could easily be turned into hydroelectricity when the Second Energy Transition came about. In 1929, Catalan industry was considered to be wholly reliant on electricity (Boleda, 2012).

In the transport energy service, the railway network grew from the 1840s onwards interconnected with maritime and coastal cabotage steamships. As a result, industry and transportation constituted the main consumers of coal, while household use of coal only accounted for less than 10 per cent of the total consumption until the 1920s and 1930s (Coll & Sudria, 1987, p.364). In the case of illumination, gas lightning made its way onto Barcelona city in 1841. Although initially the public sector was its main claimant factories and shops increasingly requested pipelines to be made in order to further extend working hours (Arroyo, 1996). Illumination through coal gas was on the rise during the second half of the nineteenth century, although its consumption was limited to the main streets, wealthy households and factories.

The arrival of electricity in the 1880s opened a period of competition between gas and electricity firms, with the former companies diversifying onto the latter to maintain a presence in the market. Implementation of urban domestic electric lighting rose throughout the early twentieth century, although the Spanish Civil War and Francoist autarchy delayed its full implementation up to the 1950s. Until then prices of electricity remained high, except for big companies that got special rates (Iriarte-Goñi & Infante-Amate, 2019). Therefore, it is well documented that industry, transportation and lighting had already engaged in the Energy Transitions to fossil fuels and electricity throughout the late nineteenth and early twentieth century.

Domestic consumption remained instead a much less prolific field of study. We know that late medieval and modern houses in Barcelona were very limited in terms of space –especially among working class dwellings– and thus, it was common for people to share beds or for apprentices and slaves to sleep in the workshop. There was no space for superfluous furniture inside the house, to the point that chairs were rented when celebrations took place in the streets, thus giving place to the popular expression "*n'hi ha per* *llogar-hi cadires*, roughly meaning that "something relevant, important or unexpected has happened" (Batlle & Vinyoles, 2002). Regarding kitchens, fire was kept burning throughout the day, although a clear class bias existed (Batlle & Vinyoles, 2002, p.130):

> «*És ben significatiu que a les cases més humils no hi ha llar de foc, ja que hi couen en petits fogonets, no hi trobem ni asts, ni olles metàl·liques, ni graelles, per la qual cosa hem de pensar que no hi podien fer brous de carn, ni potatges de llegums, que necessiten llarga cocció, ni fer carns rostides, ni a la brasa. Hi havia només alguna olla de terra i una paella que devien servir per bullir sopes o verdura, fregir cansalada, alguna freixura o peix petit. En canvi, a la majoria de cases menestrals hi havia ferros foguers, lleves, asts, graelles, és a dir tots els elementsal servei de la llar de foc, a més d'algun fogonet metàl·lic o de terrissa, que oferien la possiblitat d'una cuina més elaborada i probablement una alimentació més variada i més completa.*»
>
> Which can be roughly translated as:
>
> «It's very significant that in the most humble dwellings there's no fireplaces, as they cook in small stoves; we do not find rods, metal pots or grills, so we must think that they could not make meat broths, or vegetable stews, which need long cooking times, or cook roasted or grilled meats. There were only a few earthenware pots and a frying pan that were to be used to boil soups or vegetables or to fry bacon or small fish. On the other hand, in most artisan houses there were fireplace-related iron tools, cams, rods, grills, that is to say all the basic elements of the fireplace, in addition to some metal or earthenware stoves, which offered the possibility of a more elaborate cuisine and probably a more varied and complete diet. »

However, during the contemporary period, sources are much scarcer. In the case of heating, authors such as Rodríguez in 1858 or Vicuña in 1874 stated that the most common device for heating urban dwellings was the brazier (Barca, 2013), which is consistent with the increase in demand and prices of charcoal. Besides that, we have not found many references in academic literature, aside from some isolated comments or literary accounts of the period. As Mediterranean temperatures near the coast are remarkably milder than in North European areas, it is safe to assume that most of the population still relied on heat as a by-product of cooking in fireplaces with a chimney, while wealthy urban households could afford supplementing them with the growing use of braziers.

In the case of cooking we have to resort to the evidence mainly coming from architectural and cultural studies. During the nineteenth and early twentieth centuries many changes took place in urban nutrition, diet and patterns of consumption (Cussó et al., 2014; Garrabou & Cussó i Segura, 2007). However, fewer changes occurred in the kitchen, either in terms of space or the energy converters employed. When referring to working class dwellings in the 1920s in the city of Barcelona, (Rosselló, 2018) states that "in these apartment buildings, elements of the kitchen were defined that would persist for decades. (...) The kitchen was small with a straight or L-shaped workbench. This workbench contained wood or coal stoves and a sink". In the case of the wealthier classes, "the arrangement of the kitchen in the dwellings of the wealthy was insignificantly different from that of the basic dwellings described above. (...) Similar to the kitchen arrangement, the amenities did not differ much from those in modest kitchens. They included a straight or L-shaped workbench, two or three small stoves depending on the category, and a sink with a draining board for dishwashing". Despite the 1859 transformation of the city through Ildefons Cerdà's Plan for the Expansion of Barcelona, workers' dwellings did not change much in the affected areas: "(...) the elements that comprised the kitchen, coal stoves were still present, either two or three depending on the dwelling, and a sink". In the higher end flats, "the kitchen form was almost identical to that described above. The main change was the presence of a kitchen range in some dwellings from the start of the 1890s. In some cases, kitchens were equipped with two types of cookers, namely, stoves and a kitchen range. The coexistence of these two types continued long after this period (some examples could be found from the 1930s)", with coal bunkers or sheds being an everlasting presence. In any case, Rosselló (2018) notes that "the only improvement was the replacement of wood or coal stoves for kitchen ranges at the end of the 19th century and the start of the 20th century, but this change only occurred in the houses of the wealthy".

Much more common and earlier adopted by urban dwellers were the kitchen workbenches, usually brick-made, which together with a tap and water sink they had one or several iron-made rings placed above inner drawers where biofuel or coal was filled to serve as cooking stoves. Importantly, these different sorts of "economical kitchens" could be indistinctly fuelled with firewood, charcoal, cisco or coal, depending on the circumstances, and despite their differences in terms of calorific power and the quantity and quality of the smoke released (Rosselló, 2018). We do not know the exact pace of the widespread adoption of these transitional "economical kitchens", although all the descriptions we have highlight the differences in their sizes and capabilities between poor and wealthy dwellings. In the case of Barcelona, we deem that the spread was probably linked to the expansion of the city over the former agricultural plain through the construction of l'Eixample planned by Ildefons Cerdà after the demolition of the old walls in 1854-1856. All those different types of kitchens coexisted throughout the long expansion of the city, which grew from 235,060 inhabitants in 1857 to 1,005,565 in 1930. The main innovation was the adoption of iron-made kitchens, separated from the traditional fireplace. Yet the one-piece, iron-made kitchen ranges with oven remained a luxury that was only produced and spread by the Catalan metalworking industries from the 1890s onwards, when they already competed in Barcelona city with modern coal gas stoves (Arroyo, 2003).

During the 1920s and 1930s, a process of social segregation between rich and poor areas was clearly visible in the city, with the former incorporating running water and sewerage services at home (Ostos & Tello, 2014; Tello & Ostos, 2012), together with electricity for domestic lighting, coal gas for cooking and even for water heaters in luxury bathrooms, whereas the latter had to grow "without urbanization, that is, without any services or facilities" (Rosselló, 2018, p.353). Dwellings in working-class neighbourhoods being built on that period shared similar –if not worse– conditions than similar neighbourhoods in the old city centre, without access to tap water and sewerage services, nor access to the electric grid, and only small kitchens still fed with biofuels and coal (Rosselló, 2018). Only at the end of the period here studied the full iron-made kitchen ranges and the coal gas cookers gained momentum. In some cases, kitchens were equipped with the two types of cookers, gas stoves and kitchen ranges, a coexistence that remained in place up to the 1930s. Coal storage in special bunkers located in the kitchens or courtyards became more and more present, particularly when heating systems with a separate stove and radiators in every room were also adopted by the wealthier households from the 1890s onwards. Despite avant-gardist proposals by architectural movements such as the GATCPAC, neither gas nor electricity networks reached most of working class homes before the Spanish Civil War. In fact, in 1927 they were being presented as a novel innovation. Although beyond the chronological scope of this article, (Rosselló, 2018) argues that efforts by gas companies in the kitchen area would have probably led to an eventual adoption of gas cookers, but the Spanish Civil War and the subsequent supply problems of electricity, gas and coal during the Francoist autarky represented a setback to changes in the kitchen. The full Energy Transition in the kitchen would only occur some decades later, during the late 1950s and early 1960s, when the mass-diffusion of the butane cylinder both in the city and rural villages and towns took place. Until then, firewood and charcoal remained essential basic need, mainly given that different means of generating energy for domestic heating, cooking and illuminating were simply not available and widespread.

5.5 International prices: Barcelona in an European perspective

When faced with the question of firewood and charcoal prices in international terms, concerns such as commensurability and standardization, although important, are not as much of a problem aside from their lack in the contemporary literature. In many cases we are limited to Modern Age comparisons, as many states and polities stopped producing documentation pertaining to biofuels as biomass energy consumption was displaced by fossil fuels. In the case of Europe, countries in the Mediterranean and Scandinavian regions tended to keep records for a longer timeframe; in the former area, due to a general situation of diminishing supply during the early 20th century; in the latter case, probably due to the contrary, with a continual use of an extensive supply, deeply ingrained in culture and tradition.[2]

Table 5.4: The Price of Energy in Europe, 50-year averages (1450-1800)

Grams of silver per million BTUs, average for half century beginning in:									
	1400	**1450**	**1500**	**1550**	**1600**	**1650**	**1700**	**1750**	**1800**
Amsterdam			1.81	2.64	4.48	4.47	4.88	6.39	11.61
Antwerp	4.00	3.45	3.14	6.35	6.03	7.12	7.95	7.20	7.37
Barcelona (avg)			2.95	5.50	6.51	6.32	5.47	8.49	14.83
Barcelona (fw)			1.97	4.39	5.32	5.13	4.20	6.64	12.26
Barcelona (ch)			3.93	6.60	7.70	7.50	6.75	10.35	17.40
Florence				3.17	4.69	6.36	5.63	5.58	10.23
Gdansk			2.00	3.49	3.59	3.79	3.58	6.00	9.79
Leipzig				3.43	4.78	2.96	4.12	3.62	
London	3.74	2.18	1.86	2.67	3.26	5.00	5.26	6.47	8.16
Lwow			4.02	4.83	5.09	4.78	4.47	6.68	
Madrid				10.86	14.31	11.91	7.58	10.14	14.25
Naples				7.61	9.03		5.37	6.13	8.75
Paris					8.62	8.51	8.84	9.64	
Strasbourg	1.94	1.30	1.22	2.38	2.98	3.01	3.41	5.46	11.28
València	7.45	6.41	6.70	11.27	13.26	12.81	8.54	11.28	
Vienna	1.42	1.15	1.01	1.61	2.07	2.10	2.35	2.82	2.98
Warsaw				3.07	6.46	5.44	5.16	8.84	

Source: original idea and data from Allen (2003), with the addition of Barcelona. 'fw' stands for firewood, while 'ch' stands for charcoal and 'avg' for the average of the two; prices are from Feliu (1991), and have been converted to energy according to the criteria set forward by Malanima (2006), which is 12.552 GJ/tonne of firewood and 30.5432 GJ/tonne of charcoal, and then to million BTUs according to UN (1987). The price average has been calculated in 50-year intervals, with Barcelona's price series starting in 1517 and 1527 in the case of charcoal and firewood respectively, with both ending in 1807.

Nonetheless, several authors have sought to explain the role of prices in the Energy Transition in their respective national cases as in Clark and Jacks (2007); Fouquet and Pearson (2006); Kanda (2009) or at an European scale or broader perspective, such as Allen (2003); Fouquet (2016); Kander et al. (2013). According to Allen (2003), the cities of Amsterdam, Antwerp and London had already shifted to fossil fuels –coal and peat– in the late 16th century, while the transition in other cities is somewhat unclear. The cheapest energy is found in Austrian, German and Polish cities due to the access of those cities to abundant forests in their respective regions. Conversely, Madrid and València display the highest energy prices throughout the period, a situation Allen attributes to the relative scarcity of forests –when compared to Central and Eastern European cities– and the lack of access to coal and peat which was present in England and the Low Countries. Table 5.4 inserts the case of Barcelona in the analysis of Allen (2003). In this sense, Barcelona displays a dissimilar price level of energy provisioning to its Iberian counterparts until at least the late 18th century, a fact perhaps attributable to higher extensions of forests in its hinterland, its relatively low population or

[2]For an interesting take on this topic, see Lyall (2013).

its secondary situation among European cities during what has been considered the period of decadence in Catalan national historiography.

Figure 4.7.a presents an interesting perspective on the matter; firewood prices during the first half of the 17th century tended to be at a similar level, with the exception of Vienna. However, it is past that point when trends diverge, with two different patterns; one of relatively cheap firewood prices, followed by Madrid and Vienna, and one of relatively higher levels, that of London, Paris and Barcelona. At the end of the 18th century a spike in prices is general, perhaps due to the French Revolution and Napoleonic Wars, with the two levels of price still being maintained. In the case of charcoal (Figure 4.7.b), the pattern is quite similar: relatively similar prices until the first half of the 17th century –with Madrid experiencing the highest prices– with the same subsequent divergence on price levels and the same spike in the late 18th century. However, as the timeframe for the comparison is somewhat longer in the second case, it is worth mentioning that prices in both Barcelona and Madrid had risen almost up to the higher tier, with a noticeable difference during the last quarter of the 19th century, which will be discussed later. Unluckily, as we didn't have access to prices for London and Paris after 1870, we cannot affirm whether the general pattern was for price convergence or the tiered differentiation was maintained.

However, some ideas can be interpreted from the data; first, cities with higher firewood prices during the late 18th centuries seemingly experienced higher rates of industrialization during the first half of the 19th century than the rest. From this notion, we could infer that high firewood prices present an incentive for switching to other fuels, which in turn are part of the development block of the First Industrial Revolution. On the other hand, this assertion doesn't quite stand in the case of charcoal; however, if we take into account the literature, firewood and charcoal consumption was falling in Paris from the 1810s (Kim & Barles, 2012) while in Barcelona it was growing or, at least, maintaining its relative importance, as seen in Figure 4.12. While London had access to coal supply from as early as the 16th century and Paris increasingly did so in the second half of the 18th century, Madrid did not have railroad access to coal from Asturias until the line was completed in 1884. Barcelona, on the other hand, saw a continued expansion of British coal imports from the 1840s onwards, as it had no domestic coal reserves nor good access to Spanish coal. In this sense, it could be argued that the raise in charcoal consumption –and supply areas– during the late 18th and early 19th of those two South European cities reflects an increasing need for energy in the wake of industrialization and demographic upheaval in an environment with no easily accessible fossil fuels, as the elevation of price levels of charcoal during the 19th century to almost European standards shows in Figure 4.7.a.

Figure 4.8 adds further detail to this idea, displaying the relations between charcoal and coal in terms of firewood. Again, two different tiers appear; a higher one, containing the charcoal/firewood ratio (CH/FW), and a lower one, in terms of coal/firewood (COAL/FW). Until the Great War, and in general terms, CH/FW tended to keep relatively stable, while COAL/FW experienced a progressive downward trend. It may be argued that the further both indexes appear for a given country, the more that polity is immersed in the Energy Transition, as coal is much cheaper than charcoal; on the other hand, the closer those two indices are, the greater the incentives are for fuel substitution. However, when COAL/FW rises above CH/FW, a situation of coal scarcity might be at hand; such seems to be the case of Italy in 1870s or Barcelona during the Great War. It is interesting to dwell further upon an idea expressed in (Kander et al., 2013, p.204): "*there are not 'national' prices as such, but prices at a greater or lesser distance from the source of coal, firewood, or peat*". In this sense, Barcelona had negligible domestic coal, was extremely distant from coal sources and had no capacity to intervene in the price of coal, but displayed ratios of coal to firewood similar to England for those periods for which we have available data – in fact, those trends are quite similar among the countries considered in Figure 4.8. Conversely, Barcelona displayed lower charcoal to firewood ratios than those countries with access to coal. A potential explanation behind this phenomenon might be found in the capacity which Barcelona *did have*; that is, to pressure its domestic resources as much as it could. This explanation is consistent with the data shown in Figure 4.4: by shifting as much from firewood to charcoal production, potential supply areas in its hinterland could be much better covered, as charcoal was feasible to be transported upon bigger distances. However, this process might have reached a critical point during the Great War, when the First Globalization met its demise, and especially after the Francoist autarchy, when foreign coal was no longer available. Thus, the inner limits of the hinterland were pressured to the extreme, as the constant references to the dismal state of forests during the first half of the 20th century reflected. If these processes were indeed at play, they would explain the rise in the FW/CH ratio during the early 20th century –when commerce was partially shut down–, the following downwards trend –when it reopened, albeit at a lower level– and its final increasing tendency during the 1920s and 1930s, as seen in Figure 4.4.

6. Conclusions: Biomass energies in the Energy Transition of Barcelona

6.1 Conclusions

The first definitive conclusion of this thesis is that the sources we have reproduced present an extremely complicated interplay of conflicting factors. However, all the pieces of evidence referred to throughout the text, combined with our new price series, indicate that industry, transportation and city street lighting had already incorporated the development blocks of the First Energy Transition to a fossil-fuelled economy as far back as the mid-nineteenth century, and started to do so with the Second Energy Transition in the first third of the twentieth. However, in parallel to this process, the areas which supplied firewood and charcoal to the city of Barcelona were growing –at least throughout the 19th and 20th centuries– as the legal framework concerning factors such as trade or price did in turn. As the aforementioned sectors became more enmeshed and dependent on international trade networks, charcoal imports followed the same path. However, when the general context disallowed the entry of foreign fossil fuels, the reliance on biomass was paramount in sustaining consumption, thus sentencing its permanence among energy sources at least until the 1950s; this is consistent with recent evidence of a "return to firewood" taking place during the early Francoist period (Iriarte-Goñi & Infante-Amate, 2019). Additionally, the permanence of charcoal specifically may be explained as an attempt to extend the inner frontiers of the Barcelonese hinterland by escaping the constraints of land-based transportation. Undoubtedly, railroads played an increasingly important part in the provision of energy sources; even more so during the Francoist autarchy, where for the first recorded time, inland Spanish provinces had to supply Barcelona with both firewood and charcoal.

The permanence and prevalence of charcoal and biofuels in general may also by explained by the reliance on these sources for domestic consumption –heating and cooking–, as kitchens remained highly dependent on biomass consumption up to the 1930s. Despite 'modern' energy carriers being increasingly available throughout the nineteenth and early twentieth centuries, the lack of a widespread implementation of more adequate energy converters meant that biomass fuel consumption did not only persist, but actually grew during that period. Although in technological and economic terms the First Energy Transition to the coal age was indeed feasible in the domestic space, it did only happen partially, and at a very slow pace, because these new energy converters were only incorporated within the households of the upper classes.

For the rest of urban dwellers firewood and charcoal remained essential to sustain material life until the 1950s and 1960s. Workers, and also a share of middle classes, did keep using either traditional (fireplaces with chimney) or transitional energy converters ('economical kitchens') that allowed them to come and go from biofuels to coal, or vice versa, in search of flexible and adaptive solutions to meet their household needs of heating and cooking through stacking strategies. The steady rise of firewood and –even more so— charcoal prices from mid-eighteenth to early twentieth centuries meant a situation of continued consumption, determined by a growing demand, an increasing supply area and a very slow paced and class-skewed path of substitution by coal in the domestic space. Contrary to the one-way modernization avenue of the Energy Ladder Theory, the available historical evidence leads us to assume that both in Barcelona city and the whole industrializing province, the long-lasting growing household energy demand spurred by population growth and urbanization could not be met neither solely nor mainly with imported fossil fuels. Combining various energy carriers became both a necessity and preferable option for many urban dwellers that used these fuels for cooking and heating at home in a context of limited supply, growing demand, and class segregation. In this social context, biomass and fossil energy sources were neither substitutive nor exclusively used, but rather added one to another, mainly because the diffusion of the energy converters adequate to each type of fuel became a limiting factor in that Energy Transition.

In any case, while some of the initial objectives we set at the beginning of this document are at least partially fulfilled, we cannot consider none of the original hypotheses either confirmed or refuted in an absolute and definitive sense. Chiefly, the sources –the only ones which we have found– present serious inconsistencies that haven't enabled us to follow the example of other case studies insofar as methodology is concerned; however, we have tried to present them in such a way that they can be made useful for potential researchers on this topic. Nonetheless, we believe that both the data and the interpretations we have given have at least elucidated such a scantly-researched phenomenon in the Catalan case. We have shown that biomass energies *remained* as a significant source of energy which *did rise* in both relative and absolute terms during certain periods of the 20th century, therefore confirming two of our main hypotheses. While we could not establish the relationship between charcoal and butane cylinders in a quantitative fashion, both the aforementioned points make us ponder whether the Energy Transition was feasible with domestic resources alone, as when foreign trade was out of the question, biomass consumption rose again. This last idea becomes especially thought-evoking if we consider whether the current, *much higher level of energy consumption per capita* can or cannot be sustained without an international framework geared towards the procurement of cheap fossil fuels.

6.2 Further research

As it is perhaps somewhat common in this kind of investigations, in the initial stages of the PhD programme we thought that our research was going to be wider in scope, in both chronological and spatial terms. However, due to various concerns, certain issues were dropped, especially for the sake of the text's structural coherence and completion. Each of the following paragraph discusses the potential avenues of inquiry and gaps which we haven't adequately and thoroughly exposed, analysed and discussed in this dissertation, but which may be of interest for either our own or other scholars' research.

First, we would have liked to reconstruct the entire energy metabolism of Catalonia or Barcelona over time. That goal was unachievable without a data series on firewood consumption, which ended up taking more time than initially expected. However, this dissertation may be to some yet another step towards that endeavour, both at the city, province and nation level. Any attempt at said approach will undoubtedly be based to some extent on the contributions of Nadal et al. (2012), as well as many other works on the industrial history of Catalonia.

Second, it would have been extremely interesting to dedicate more attention to the relationship between climatic variables and prices. Authors such as Sanz de la Higuera (2014) have defended the use of firewood and charcoal price series to infer information on this topic for those periods of history in which temperature series are lacking or insufficient. However, the main concern which has prevented us from engaging in this avenue of discussion –besides time– is the sheer amount of literature and methodologies used to analyse and discuss these topics. Although we have indeed been engaged in trying to ascertain whether temperature and humidity influenced biomass prices in given months or years –with or without a time delay– our research hasn't been carried out in such a thorough and systematic perspective which would enable us to publish any certain and statistically sound findings. Nonetheless, we believe that the publication and amalgamation of quantity, consumption and –especially– price series in this dissertations sets an initial basis for any scholars interested in engaging in this particular topic. In this sense, the Meteorological Service of Catalonia[1] provides an excellent database on precipitation and temperature series, holding the data files for aforementioned series published in Prohom et al. (2012); Prohom, Barriendos, and Sanchez-Lorenzo (2016), which covers a longer period (1780-2020, monthly data) than the one in Carreras and Tafunell (2006) (1838-2001, yearly data).

[1] Servei Meteorològic de Catalunya, at: https://www.meteo.cat/wpweb/climatologia/el-clima-ara/serie-climatica-de-barcelona/.

Third, we would have liked to extend the price series from 1932 to the present. However, several problems arose: first, the specific series we use –the BOPB– ends somewhat abruptly at 1932. Second, the Spanish Civil War (1936-1939) is the first instance of total war by industrial means in Catalonia, and the price records we have found cannot be fashioned into a cohesive series. Third, the aftermath of the Civil War, well unto the 1950s, was characterized by a dual system of fixed prices and black market; we do have records of the former, which by definition were more theoretical than real, and we have found no sources on the latter. Finally, the available data on prices for the period after the 1950s comes from such a different source –the forestry service– that the resulting series' coherence could be uncertain. Nonetheless, a critical discussion of sources –both the ones presented in this text and potential new or unpublished ones– and a construction of a cohesive price series could be a relevant contribution to the literature. On one hand, the government-set prices of the Francoist autarchy are probably divergent from real market prices of the period, and should be approached in a very critical fashion. On the other hand, two potential sources of prices from already published research may be used to cover the gaps of our series: first, the data from the Spanish Forestry Service, especially during the latter half of the 20th century, has information on overall firewood values and quantities for given years. However, it does also present several methodological problems, such as changing degrees of aggregation throughout its publications, as well as other problems of amalgamation and the critical issue of whether they reflect (urban) market prices or not. Second, the various statistical surveys and yearbooks of commerce can be used to calculate prices by dividing the total value of items by the total bulk of said commodities; nonetheless, this approach yields many problems of its own, which we won't address in this document. Finally, a third potential source might be found in so-called microhistorical approaches, consisting on the examination of documents such as the accounts of a company involved in the forestry sector. In this latter proposal, the correspondence of a single firm within the existing market relations of a given polity must be examined conscientiously by the potential authors of this approach, but may yield interesting results at the local level. In the case of Catalonia and its environs, perhaps the most relevant locations for this hypothetical companies may be found in some of the supply areas we have detailed throughout this dissertation, such as the Montseny massif, the La Garrotxa county or certain municipalities in the Balearic and Pityusic Islands.

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Appendices

A. Quantity series on firewood and charcoal flows

A.1 Quantity series: total maritime and railroad traffic (1854-1953).

Table A.1: Quantity series: Total maritime and railroad traffic (1854-1935).

Year	Q_{bf}	Q_{bf}	Q_{ch}	Imp_{ch}	Exp_{ch}	$Cab.in_{fw}$	$Cab.in_{ch}$	$Cab.out_{ch}$	$RR.in_{fw}$	$RR.in_{ch}$
1854	36,860	36,860							36,860	
1855	575,540	72,690	100,570						72,690	100,570
1856	2,582,310	549,060	406,650						549,060	406,650
1857	26,232,362	211,890	5,204,094				4,983,034		211,890	221,060
1858	669,400	155,900	102,700						155,900	102,700
1859	523,600	145,850	75,550						145,850	75,550
1860	4,812,020	275,870	907,230						275,870	907,230
1861	18,522,120	158,120	3,672,800						158,120	3,672,800
1862	65,095,569		13,019,114	13,019,114						
1863	90,117,358	1,339,107	17,755,650	11,468,117					1,339,107	6,287,533
1864	101,001,028	1,339,107	19,932,384	13,644,851					1,339,107	6,287,533
1865	33,329,907	1,339,107	6,398,160						1,339,107	6,398,160
1866	327,698		65,540		45,087					110,627
1867	18,420,633		3,684,127				3,672,700	99,200		110,627
1868	42,106,168	6,231,902	7,174,853						6,231,902	7,174,853
1869	46,460,668	6,231,902	8,045,753				870,900		6,231,902	7,174,853
1870	47,945,168	6,231,902	8,342,653				1,167,800		6,231,902	7,174,853
1871	52,786,668	6,231,902	9,310,953				2,136,100		6,231,902	7,174,853
1872	61,157,693	6,231,902	10,985,158				3,025,800		6,231,902	7,959,358
1873	60,756,093	6,231,902	10,904,838		420		2,945,900		6,231,902	7,959,358
1874	13,643,000		2,728,600				2,728,600			
1875	12,043,500		2,408,700				2,408,700			
1876	11,057,500		2,211,500				2,211,500			
1877	13,897,500		2,779,500				2,779,500			
1878	88,746,600	18,109,600	14,127,400	377,000			6,336,900		18,109,600	7,413,500
1879	96,504,200	20,482,700	15,204,300				5,597,900		20,482,700	9,606,400
1880	296,438,378	30,484,322	53,190,811	28,528,000			7,518,400		30,484,322	17,144,411
1881	116,206,378	30,484,322	17,144,411						30,484,322	17,144,411
1882	132,053,378	30,484,322	20,313,811				3,169,400		30,484,322	17,144,411
1883	69,986,400	20,925,400	9,812,200						20,925,400	9,812,200
1884	96,960,000	24,036,000	14,584,800				1,290,000		24,036,000	13,294,800
1885	88,404,600	23,258,600	13,029,200						23,258,600	13,029,200
1886	86,063,200	26,034,700	12,005,700						26,034,700	12,005,700
1887	102,105,100	29,658,100	14,489,400						29,658,100	14,489,400
1888	230,285,700	29,886,200	40,079,900	26,190,000			559,600		29,886,200	13,330,300
1889	247,112,800	20,799,400	45,262,680	28,794,000	78,520		511,000		20,799,400	16,036,200
1890	241,998,840	28,830,900	42,633,588	24,183,088	10,600		263,600		28,830,900	18,197,500

Year	Q_{bf}	Q_{bf}	Q_{ch}	Imp_{ch}	Exp_{ch}	$Cab.in_{fw}$	$Cab.in_{ch}$	$Cab.out_{ch}$	$RR.in_{fw}$	$RR.in_{ch}$
1891	249,347,815	25,032,500	44,863,063	27,730,717	854	193,500			25,032,500	16,939,700
1892	135,657,630	21,535,500	22,824,426	11,284,326	7,600				21,535,500	11,547,700
1893	246,415,097	42,680,633	40,746,893	20,442,202	1,276				42,680,633	20,305,967
1894	215,223,352	36,991,933	35,646,284	14,832,387	970				36,991,933	20,814,867
1895	388,376,507	37,349,333	70,205,435	47,890,768					37,349,333	22,314,667
1896	276,783,775	24,775,500	50,401,655	31,485,355					24,775,500	18,916,300
1897	255,110,615	27,421,500	45,537,823	28,856,423					27,421,500	16,681,400
1898	130,110,000		26,022,000	26,022,000						
1899	157,114,650		31,422,930	31,422,930						
1900	86,423,250		17,284,650	17,284,650						
1901	210,348,423	30,764,667	35,916,751	20,254,070	354		280,702		30,764,667	15,382,333
1902	307,464,471	53,240,847	50,844,725	24,038,229		371,669	371,907		52,869,178	26,434,589
1903	288,230,880	47,870,082	48,072,160	23,790,270		409,971	551,834		47,460,111	23,730,056
1904	272,505,209	48,568,231	44,787,396	20,751,740		496,920			48,071,311	24,035,656
1905	221,344,342	28,860,533	38,496,762	24,313,095		493,200			28,367,333	14,183,667
1906	180,154,827	27,661,071	30,498,751	16,106,012	4,698	456,604	795,204		27,204,467	13,602,233
1907	210,606,452	29,769,748	36,167,341	21,170,313		477,815	351,061		29,291,933	14,645,967
1908	208,935,060	32,443,390	35,298,334	19,123,884		330,990	118,250		32,112,400	16,056,200
1909	218,562,964	33,276,090	37,057,375	20,713,308		587,957			32,688,133	16,344,067
1910	208,752,128	32,660,757	35,218,274	18,876,074		504,490	289,067	25,000	32,156,267	16,078,133
1911	182,775,961	30,792,160	30,396,760	15,263,317	19,501	977,293	245,511		29,814,867	14,907,433
1912	177,266,770	33,323,570	28,788,640	12,314,408	41,191	1,558,170	632,723		31,765,400	15,882,700
1913	163,674,322	30,931,126	26,548,639	11,221,188	131,073	1,359,259	672,591		29,571,867	14,785,933
1914	155,473,423	25,806,067	25,933,471	12,643,023	247,881		635,296		25,806,067	12,903,033
1915	138,091,451	32,339,502	21,150,390	5,361,979	45,886	2,028,569	678,830		30,310,933	15,155,467
1916	241,070,754	59,307,920	36,352,567	7,344,000	19,200	1,252,387			58,055,533	29,027,767
1917	428,225,424	120,775,908	61,489,903	130,365		3,092,841	2,518,005		117,683,067	58,841,533
1918	790,341,726	213,952,716	115,277,802	58,624		11,693,916	14,089,778		202,258,800	101,129,400
1919	466,747,613	127,717,523	67,806,018	5,000		12,956,123	10,428,718	8,400	114,761,400	57,380,700
1920	372,675,617	94,008,197	55,733,484	6,226,288		2,532,797	3,800,592	31,096	91,475,400	45,737,700
1921	461,677,560	90,283,759	74,278,760	17,737,152		1,613,692	12,238,826	32,251	88,670,067	44,335,033
1922	329,230,787	65,802,933	52,685,571				19,899,798	115,694	65,802,933	32,901,467
1923	249,841,322	60,178,733	37,932,518				7,846,688	3,537	60,178,733	30,089,367
1924	319,582,147	65,203,978	50,875,634				18,276,995	3,350	65,203,978	32,601,989
1925	278,465,897	63,628,578	42,967,464				11,154,175	1,000	63,628,578	31,814,289
1926	257,791,154	66,659,111	38,226,409				4,969,145	72,292	66,659,111	33,329,556
1927	333,775,147	66,918,133	53,371,403				19,917,336	5,000	66,918,133	33,459,067

Year	Q_{bf}	Q_{bf}	Q_{ch}	Imp_{ch}	Exp_{ch}	$Cab.in_{fw}$	$Cab.in_{ch}$	$Cab.out_{ch}$	$RR.in_{fw}$	$RR.in_{ch}$
1928	214,789,322	55,634,333	31,830,998				4,015,906	2,075	55,634,333	27,817,167
1929	218,008,233	62,288,067	31,144,033						62,288,067	31,144,033
1930	385,323,467	57,158,133	65,633,067	37,055,000	1,000				57,158,133	28,579,067
1931	185,150,000		37,030,000	37,030,000						
1932	114,775,000		22,955,000	22,955,000						
1933	118,220,000		23,644,000	23,644,000						
1934	59,845,000		11,969,000	11,969,000						
1935	22,795,000	4,559,000		4,559,000						

A.2 Quantity series: Total estimated provisioning series (1823-1953).

Table A.2: Estimated biofuel quantities entering the city of Barcelona (1823-1935), as displayed in 4.2.4. Red colour marks estimations based on sections 4.2.1 and 4.2.3.

Year	Quantity	Railroad	Land	Sea	Source/Exclusion
1823	239,820,000				1823 Manifesto
1835	225,702,969		46,695,468	178,843,641	Madoz
1836	225,702,969		46,695,468	178,843,641	Madoz
1837	225,702,969		46,695,468	178,843,641	Madoz
1838	225,702,969		46,695,468	178,843,641	Madoz
1839	225,702,969		46,695,468	178,843,641	Madoz
1845	223,308,122		46,200,000	176,946,000	Figuerola
1846	369,183,428		76,380,000	292,535,400	Figuerola
1847	372,953,565		77,160,000	295,522,800	Figuerola
1848	372,953,565		76,906,327	295,793,565	Average: Balances
1849	372,953,565		76,906,327	295,793,565	Average: Balances
1854	36,860				No RR
1855	575,540				No RR
1856	2,582,310				No RR
1857	35,333,868	1,317,190	9,101,506	24,915,172	No ECE
1858	669,400	669,400			No Sea
1859	523,600	523,600			No Sea
1860	4,812,020	4,812,020			No Sea
1861	18,522,120	18,522,120			No Sea
1862	96,811,470		31,715,901	65,095,569	No RR
1863	120,053,117	32,776,773	29,935,758	57,340,585	
1864	136,618,817	32,776,773	35,617,788	68,224,255	
1865	33,329,907	33,329,907			No Sea
1866	207,138	553,133	-120,560	-225,435	Negative value
1867	28,093,838	553,133	9,673,205	17,867,500	No ECE
1868	42,106,168	42,106,168			No Sea
1869	48,877,752	42,106,168	2,417,083	4,354,500	No ECE
1870	51,227,772	42,106,168	3,282,604	5,839,000	No ECE
1871	58,868,991	42,106,168	6,082,323	10,680,500	No ECE
1872	69,886,585	46,028,693	8,728,892	15,129,000	No ECE
1873	69,366,447	46,028,693	8,610,354	14,727,400	No ECE
1874	21,727,030		8,084,030	13,643,000	No RR
1875	19,277,408		7,233,908	12,043,500	No RR
1876	17,791,308		6,733,808	11,057,500	No RR
1877	22,479,877		8,582,377	13,897,500	No RR
1878	109,773,191	55,177,100	21,026,591	33,569,500	Low ECE (outlier)
1879	114,289,478	68,514,700	17,785,278	27,989,500	No ECE
1880	296,438,378	116,206,378		180,232,000	
1881	116,206,378	116,206,378			No Sea
1882	132,053,378	116,206,378		15,847,000	No ECE
1883	69,986,400	69,986,400			No Sea
1884	96,960,000	90,510,000		6,450,000	No ECE
1885	88,404,600	88,404,600			No Sea

Year	Quantity	Railroad	Land	Sea	Source/Exclusion
1886	86,063,200	86,063,200			No Sea
1887	102,105,100	102,105,100			No Sea
1888	230,285,700	96,537,700		133,748,000	
1889	247,112,800	100,980,400		146,132,400	
1890	241,998,840	119,818,400		122,180,440	
1891	249,347,815	109,731,000		139,616,815	
1892	135,657,630	79,274,000		56,383,630	
1893	246,415,097	144,210,467		102,204,630	
1894	215,223,352	141,066,267		74,157,085	
1895	388,376,507	148,922,667		239,453,840	
1896	276,783,775	119,357,000		157,426,775	
1897	255,110,615	110,828,500		144,282,115	
1898	130,110,000			130,110,000	No RR
1899	157,114,650			157,114,650	No RR
1900	86,423,250			86,423,250	No RR
1901	210,348,423	107,676,333		102,672,090	
1902	307,464,471	185,042,122		122,422,349	
1903	288,230,880	166,110,389		122,120,491	
1904	272,505,209	168,249,589		104,255,620	
1905	221,344,342	99,285,667		122,058,675	
1906	180,154,827	95,215,633		84,939,194	
1907	210,606,452	102,521,767		108,084,685	
1908	208,935,060	112,393,400		96,541,660	
1909	218,562,964	114,408,467		104,154,497	
1910	208,752,128	112,546,933		96,205,195	
1911	182,775,961	104,352,033		78,423,928	
1912	177,266,770	111,178,900		66,087,870	
1913	163,674,322	103,501,533		60,172,789	
1914	155,473,423	90,321,233		65,152,190	
1915	138,091,451	106,088,267		32,003,184	
1916	241,070,754	203,194,367		37,876,387	
1917	428,225,424	411,890,733		16,334,691	
1918	790,341,726	707,905,800		82,435,926	
1919	466,747,613	401,664,900		65,082,713	
1920	372,675,617	320,163,900		52,511,717	
1921	461,677,560	310,345,233		151,332,327	
1922	329,230,787	230,310,267		98,920,520	No ECE
1923	249,841,322	210,625,567		39,215,755	No ECE
1924	319,582,147	228,213,922		91,368,225	No ECE
1925	278,465,897	222,700,022		55,765,875	No ECE
1926	257,791,154	233,306,889		24,484,265	No ECE
1927	333,775,147	234,213,467		99,561,680	No ECE
1928	214,789,322	194,720,167		20,069,155	No ECE

Year	Quantity	Railroad	Land	Sea	Source/Exclusion
1929	218,008,233	218,008,233			No Sea
1930	385,323,467	200,053,467		185,270,000	
1931	185,150,000			185,150,000	No RR
1932	114,775,000			114,775,000	No RR
1933	118,220,000			118,220,000	No RR
1934	59,845,000			59,845,000	No RR
1935	22,795,000			22,795,000	No RR
1941	41,750,000				AECB: consumption
1942	77,750,000				AECB: consumption
1943	147,250,000				AECB: consumption
1944	82,650,000				AECB: consumption
1945	257,000,000				AECB: consumption
1946	110,500,000				AECB: consumption
1947	295,142,500				AECB: consumption
1948	343,560,000				AECB: consumption
1949	344,240,000				AECB: consumption
1950	307,695,000				AECB: consumption
1951	298,920,000				AECB: consumption
1952	401,455,000				AECB: consumption
1953	562,240,000				AECB: consumption

A.3 Biofuel quantities entering the city of Barcelona, 5-year averages (1820-1955).

Table A.3: Quantity series: Biofuel quantities entering the city of Barcelona, 5-year averages (1820-1955) as displayed in Figure 4.12. Red colour marks interpolated years, as explained in the corresponding section.

Years	Total quantity	Exclusion/Sources
1820-1824	239,820,000	
1825-1829	235,114,323	
1830-1834	230,408,646	
1835-1839	225,702,969	
1840-1844	283,986,709	
1845-1849	342,270,449	
1850-1854	260,033,364	Deleted: no ECE
1855-1859	177,796,279	Deleted: no ECE
1860-1864	95,559,193	Only 1863 and 1864
1865-1869	145,778,989	
1870-1874	169,009,055	
1875-1879	181,188,928	Deleted: no ECE
1880-1884	296,438,378	Only 1880
1885-1889	238,699,250	Only 1880 and 1889
1890-1894	217,728,547	
1895-1899	241,499,109	
1900-1904	232,994,447	
1905-1909	207,920,729	
1910-1914	177,588,521	
1915-1919	412,895,394	
1920-1924	346,601,487	
1925-1929	260,565,951	
1930-1934	172,662,693	
1935-1939	22,795,000	
1940-1944	87,350,000	
1945-1949	270,088,500	
1950-1954	392,577,500	

B. Price series on energy carriers in the BOPB

B.1 BOPB. Units and currencies by period and energy conversion factors

Table B.6 displays the monthly data of the BOPB series. “F” stands for firewood, “C” for charcoal, “B” for bread, “S” for straw, “O” for oil. Number 1 displays nominal prices, number 2 stands for converted prices and number 3 stands for interpolated results. The units of weight, volume and currencies for each period are detailed in Table B.1, while conversion factors used for each unit are explained in Table B.2

Table B.1: BOPB: Units and currencies by period.

Product	**Starting date**	**Ending date**	**Unit**
Bread	OCT 1848	NOV 1864	libra y media
	JAN 1864	JUN 1865	24 onzas
	AUG 1865	NOV 1865	1.7 kg
	FEB 1866	AUG 1932	0.7 kg
	MAY 1866	EXCEPTION	70 dag
Straw	OCT 1848	AUG 1863	arroba
	SEP 1863	JUN 1865	quintal
	AUG 1865	NOV 1865	quintal métrico
	MAY 1866	EXCEPTION	quintal métrico
	FEB 1866	AUG 1932	6 kg
Firewood	OCT 1848	MAY 1863	arroba
	JUN 1863	JUN 1865	quintal
	AUG 1865	NOV 1865	quintal métrico
	FEB 1866	AUG 1932	kilogram
Charcoal	JAN 1849	JUN 1865	arroba
	AUG 1865	NOV 1865	quintal métrico
	MAY 1866	EXCEPTION	quintal métrico
	FEB 1866	AUG 1932	kilogram
Olive oil	JAN 1849	JUN 1865	arroba
	AUG 1865	NOV 1865	hectolitre
	MAY 1866	EXCEPTION	hectolitre
	FEB 1866	AUG 1932	litre
Petrol	APR 1898	AUG 1932	litre
Currency	OCT 1848	JAN 1856	Reales y maravedís
	FEB 1856	JUN 1865	Reales y céntimos
	AUG 1865	JUN 1870	Milésimas de Escudo
	JUL 1870	AUG 1932	Céntimos de Peseta

Table B.2: BOPB: Conversion factors, weights and volume from Alsina et al. (1990) and currencies from Nogués-Marco (2001).

Weight and volume		***Currency***	
Unit	**Equivalent SI units**	**Unit**	**Equivalent**
libra y media	0.7036395 kg	1 Peseta	1/5 duro
24 onzas	0.6901392 kg	1 Duro	20 Reales
arroba (@)	11.5 kg	1 Peseta	4 Reales
quintal	46.008 kg	1 Real	34 maravedíes*
quintal	4 @	1 Escudo	10 Reales
arroba (olive oil)	12.563 L	1 Escudo	2.5 Pesetas

B.2 BOPB. Yearly data series (1848-1932).

Table B.3: BOPB. Yearly data series (1848-1932).

Year	Firewood	Charcoal	Bread	Straw	Olive oil
1848	0.03		0.35	0.05	0.88
1849	0.03	0.12	0.36	0.05	0.92
1850	0.03	0.11	0.34	0.05	1.11
1851	0.02	0.09	0.33	0.05	1.06
1852	0.02	0.09	0.32	0.05	1.04
1853	0.03	0.09	0.32	0.05	1.20
1854	0.03	0.10	0.38	0.06	1.07
1855	0.03	0.10	0.40	0.05	1.04
1856	0.03	0.10	0.46	0.06	1.09
1857	0.03	0.10	0.45	0.06	1.11
1858	0.03	0.11	0.36	0.06	0.98
1859	0.03	0.11	0.36	0.07	1.12
1860	0.03	0.12	0.40	0.08	1.32
1861	0.03	0.11	0.39	0.07	1.16
1862	0.03	0.11	0.39	0.07	1.26
1863	0.03	0.11	0.38	0.05	1.21
1864	0.03	0.11	0.38	0.06	1.13
1865	0.04	0.11	0.29	0.07	1.09
1866	0.04	0.10	0.34	0.06	1.21
1867	0.04	0.10	0.40	0.07	1.24
1868	0.04	0.10	0.40	0.08	1.15
1869	0.04	0.10	0.41	0.08	1.06
1870	0.04	0.10	0.41	0.07	1.20
1871	0.04	0.10	0.44	0.08	1.05
1872	0.04	0.11	0.42	0.08	1.12
1873	0.03	0.13	0.41	0.10	1.01
1874	0.04	0.14	0.44	0.11	1.01
1875	0.05	0.15	0.42	0.10	1.00
1876	0.04	0.14	0.41	0.08	1.18
1877	0.04	0.15	0.41	0.09	1.26

Year	Firewood	Charcoal	Bread	Straw	Olive oil	Petrol
1878	0.04	0.14	0.41	0.11	1.26	
1879	0.04	0.14	0.41	0.10	1.27	
1880	0.04	0.13	0.42	0.07	1.22	
1881	0.04	0.13	0.42	0.07	1.13	
1882	0.04	0.13	0.43	0.09	1.15	
1883	0.04	0.13	0.44	0.09	1.17	
1884	0.04	0.13	0.42	0.08	1.16	
1885	0.03	0.12	0.34	0.08	1.11	
1886	0.04	0.12	0.34	0.07	1.05	
1887	0.04	0.11	0.34	0.07	1.00	
1888	0.03	0.11	0.34	0.08	1.00	
1889	0.03	0.11	0.35	0.08	1.03	
1890	0.04	0.11	0.34	0.08	1.14	
1891	0.05	0.11	0.34	0.08	1.13	
1892	0.05	0.11	0.35	0.08	1.13	
1893	0.05	0.12	0.33	0.08	1.15	
1894	0.05	0.12	0.33	0.08	1.16	
1895	0.04	0.12	0.33	0.07	1.04	
1896	0.05	0.12	0.34	0.07	1.12	
1897	0.05	0.12	0.36	0.08	1.24	
1898	0.04	0.12	0.40	0.08	1.28	0.83
1899	0.04	0.13	0.41	0.08	1.25	0.85
1900	0.05	0.13	0.40	0.08	1.28	0.83
1901	0.03	0.13	0.40	0.06	1.29	0.83
1902	0.03	0.14	0.37	0.06	1.26	0.81
1903	0.03	0.14	0.39	0.06	1.20	0.82
1904	0.03	0.13	0.40	0.06	1.19	0.80
1905	0.04	0.14	0.40	0.09	1.21	0.82
1906	0.04	0.14	0.40	0.10	1.28	0.83
1907	0.04	0.15	0.37	0.09	1.42	0.81

Year	Firewood	Charcoal	Bread	Straw	Olive oil	Petrol
1908	0.04	0.15	0.38	0.09	1.39	0.81
1909	0.04	0.15	0.39	0.08	1.54	0.81
1910	0.04	0.15	0.40	0.08	1.49	0.82
1911	0.04	0.15	0.38	0.08	1.54	0.82
1912	0.04	0.15	0.37	0.08	1.43	0.84
1913	0.04	0.14	0.37	0.08	1.48	0.84
1914	0.04	0.14	0.39	0.08	1.44	0.85
1915	0.04	0.14	0.42	0.08	1.41	0.86
1916	0.05	0.17	0.46	0.08	1.44	0.90
1917	0.06	0.19	0.50	0.09	1.67	1.01
1918	0.09	0.28	0.56	0.12	1.88	1.31
1919	0.07	0.25	0.60	0.14	1.90	2.01
1920	0.08	0.29	0.67	0.15	2.29	1.79
1921	0.08	0.32	0.73	0.16	2.27	1.54
1922	0.07	0.32	0.71	0.15	2.16	1.40
1923	0.07	0.29	0.65	0.14	2.12	1.18
1924	0.06	0.28	0.63	0.15	2.23	0.87
1925	0.06	0.30	0.65	0.15	2.41	0.88
1926	0.06	0.30	0.69	0.13	2.37	0.84
1927	0.06	0.28	0.68	0.12	2.63	0.83
1928	0.06	0.29	0.68	0.11	2.25	0.76
1929	0.06	0.29	0.68	0.11	2.30	0.76
1930	0.07	0.29	0.69	0.10	2.04	0.77
1931	0.07	0.30	0.69	0.10	2.09	0.77
1932	0.07	0.32	0.70	0.09	2.04	0.79

B.3 BOPB. Total observations of every product by year (1848-1932).

Table B.4: BOPB: Total observations of every product by year (1848-1932).

YEAR	**FW**	**CH**	**BR**	**ST**	**OL**	**YEAR**	**FW**	**CH**	**BR**	**ST**	**OL**	**PE**
1848	3	0	3	3	3	1892	11	11	11	11	11	
1849	12	9	12	12	12	1893	10	10	11	10	10	
1850	12	12	12	12	12	1894	10	10	10	10	10	
1851	12	12	12	12	12	1895	10	10	10	10	10	
1852	12	12	12	12	12	1896	9	9	9	9	9	
1853	12	12	12	12	12	1897	8	8	8	8	8	
1854	10	10	10	10	10	1898	10	10	10	10	10	8
1855	8	8	8	8	8	1899	11	11	11	11	11	11
1856	7	7	7	7	7	1900	11	11	11	11	11	11
1857	6	6	6	6	6	1901	11	11	11	11	11	11
1858	11	11	11	11	11	1902	12	12	12	12	12	12
1859	11	11	11	11	11	1903	12	12	12	12	12	12
1860	9	9	9	9	9	1904	11	11	11	11	11	11
1861	11	11	11	11	11	1905	10	10	10	10	10	10
1862	12	12	12	12	12	1906	12	12	12	12	12	12
1863	10	10	10	10	10	1907	12	12	12	12	12	12
1864	12	12	12	12	12	1908	11	11	11	11	11	11
1865	10	10	10	10	10	1909	9	9	9	9	9	9
1866	8	8	8	8	8	1910	12	12	12	12	12	12
1867	9	9	9	9	9	1911	9	9	9	9	9	9
1868	0	0	0	0	0	1912	9	9	9	9	9	9
1869	12	12	12	12	12	1913	12	12	12	12	12	12
1870	11	11	11	11	11	1914	11	11	11	11	11	11
1871	12	12	12	12	11	1915	12	12	12	12	12	12
1872	11	11	11	11	11	1916	11	11	11	11	11	11
1873	7	7	7	7	7	1917	12	12	12	12	12	12
1874	11	11	11	11	11	1918	10	10	10	10	10	10
1875	9	9	9	9	9	1919	11	11	11	11	11	11
1876	10	10	10	10	10	1920	10	10	10	10	10	10
1877	12	12	12	12	12	1921	12	12	12	12	12	12
1878	12	12	12	12	12	1922	10	10	10	10	10	10
1879	11	11	11	11	11	1923	12	12	12	12	12	12
1880	11	11	11	11	11	1924	11	11	11	11	11	11
1881	12	12	12	12	12	1925	8	8	8	8	8	8
1882	10	10	10	10	10	1926	10	10	10	10	10	10
1883	11	11	11	11	11	1927	12	12	12	12	12	12
1884	9	9	9	9	9	1928	11	11	11	11	11	11
1885	12	12	12	12	12	1929	9	9	9	9	9	9
1886	11	11	11	11	11	1930	10	10	10	10	10	10
1887	12	12	12	12	12	1931	11	11	11	11	11	11
1888	11	11	11	11	11	1932	6	6	6	6	6	6
1889	11	11	11	11	11							
1890	10	10	10	10	10							
1891	11	11	11	11	11							

B.4 BOPB. Yearly Coefficient of Variation - Relative Standard Deviation

Table B.5: BOPB: Yearly coefficient of variation – Relative Standard Deviation.

YEAR	**FW**	**CH**	**BR**	**ST**	**OL**	**YEAR**	**FW**	**CH**	**BR**	**ST**	**OL**	**PE**
1848	0.00		0.00	0.00	0.00	1892	15.49	4.44	1.67	3.94	3.94	
1849	0.00	1.66	3.76	3.01	9.22	1893	9.11	2.61	1.74	2.84	0.96	
1850	3.57	8.66	3.50	11.84	5.30	1894	10.28	0.00	2.21	4.29	1.82	
1851	1.85	13.82	3.30	2.70	2.80	1895	7.71	4.13	0.00	5.64	30.08	
1852	1.67	5.60	3.09	1.93	3.48	1896	0.00	4.29	2.11	4.93	1.73	
1853	0.63	0.94	5.39	2.84	5.05	1897	9.75	0.00	4.19	0.00	3.49	
1854	3.47	6.96	3.52	2.43	6.63	1898	0.00	2.61	3.26	4.32	1.09	2.72
1855	3.35	1.42	2.09	2.67	1.41	1899	10.93	3.67	2.42	0.00	0.97	0.63
1856	6.41	5.65	222.50	6.04	2.46	1900	8.40	3.67	1.07	3.81	1.01	3.84
1857	6.45	4.25	4.96	7.11	0.72	1901	15.12	2.30	1.68	28.05	0.98	2.64
1858	32.15	5.82	4.70	6.26	5.65	1902	9.36	3.87	4.15	9.95	4.75	0.61
1859	8.12	3.86	4.99	12.91	8.33	1903	9.36	2.81	2.28	0.00	0.83	0.90
1860	10.82	4.45	3.08	11.43	3.82	1904	14.27	3.88	1.45	1.67	0.78	1.94
1861	5.92	4.05	4.15	13.67	6.54	1905	0.00	4.08	2.03	17.87	2.20	3.02
1862	11.49	3.37	3.33	9.98	2.27	1906	7.07	2.75	3.88	10.93	3.27	2.39
1863	63.66	2.16	1.40	79.98	2.53	1907	0.00	3.53	2.58	5.33	1.66	2.59
1864	4.72	2.83	1.68	6.17	3.77	1908	0.00	0.00	2.42	5.88	2.57	0.86
1865	58.21	7.87	72.89	60.18	9.14	1909	0.00	0.00	1.83	4.42	3.34	0.61
1866	261.49	263.46	5.55	190.38	262.44	1910	0.00	1.94	1.78	0.00	1.73	0.63
1867	7.82	3.79	5.12	4.94	4.49	1911	16.35	2.24	1.24	0.00	2.47	0.54
1868						1912	0.00	0.00	1.28	0.00	2.09	2.87
1869	10.62	4.44	15.41	11.37	9.22	1913	7.07	3.17	4.49	0.00	1.56	0.54
1870	55.53	47.58	51.90	48.43	46.59	1914	0.00	0.00	3.70	0.00	0.28	0.55
1871	7.37	0.00	4.01	11.23	1.10	1915	0.00	2.05	2.26	4.88	1.04	0.83
1872	10.59	2.76	1.60	7.37	2.44	1916	12.52	7.25	6.15	0.00	1.93	1.53
1873	15.59	5.37	1.99	5.08	1.90	1917	27.21	15.55	4.03	10.10	9.41	5.94
1874	7.37	3.83	1.31	4.47	2.55	1918	7.76	2.80	4.36	2.66	2.16	12.81
1875	6.82	3.41	3.43	13.68	2.04	1919	13.67	6.18	4.44	11.12	3.86	9.34
1876	7.71	3.38	1.82	1.67	4.42	1920	7.03	7.62	7.91	3.81	6.16	9.34
1877	11.36	3.60	2.27	2.85	0.91	1921	5.48	3.59	1.73	3.14	2.39	5.77
1878	7.07	3.29	1.72	8.53	3.06	1922	15.19	3.74	2.33	6.45	2.64	6.55
1879	0.00	3.70	1.63	16.17	3.32	1923	7.39	4.69	3.97	5.47	4.94	10.96
1880	11.56	0.00	1.70	3.58	2.05	1924	0.00	3.28	0.68	2.69	3.67	9.86
1881	11.66	2.21	1.74	4.87	2.30	1925	0.00	1.56	2.01	2.40	2.41	1.13
1882	0.00	0.00	1.70	8.22	2.52	1926	0.00	1.63	1.09	8.39	3.34	3.10
1883	0.00	2.34	0.98	6.17	1.88	1927	0.00	1.81	1.09	2.06	2.68	2.81
1884	11.67	3.45	2.95	4.40	2.50	1928	6.54	1.40	1.10	4.34	3.87	5.20
1885	14.77	0.00	4.26	8.82	1.30	1929	0.00	1.53	1.49	8.44	1.54	5.98
1886	3.96	3.81	0.53	30.48	6.52	1930	4.58	1.96	0.66	4.30	3.03	5.34
1887	1.84	0.68	0.40	2.40	1.23	1931	6.72	3.40	14.97	6.85	6.50	5.41
1888	1.96	1.04	1.36	2.51	3.29	1932	4.99	10.92	1.21	42.85	4.16	3.84
1889	5.59	0.74	1.76	1.85	1.04							
1890	13.06	2.85	0.00	1.60	18.85							
1891	10.88	4.86	1.86	4.85	2.52							

B.5 BOPB. Monthly firewood and charcoal prices (1848-1932).

Table B.6: BOPB: monthly data prices (1848-1932).

Year	**M**	**F1**	**F2**	**F3**	**C1**	**C2**	**C3**	**B1**	**B2**	**B3**	**S1**	**S2**	**S3**	**O1**	**O2**	**O3**
1848	10	1.14	0.03	0.03				0.33	0.35	0.35	2.06	0.05	0.05	44.00	0.88	0.88
1848	11	1.14	0.03	0.03				0.33	0.35	0.35	2.06	0.05	0.05	44.00	0.88	0.88
1848	12	1.14	0.03	0.03				0.33	0.35	0.35	2.06	0.05	0.05	44.00	0.88	0.88
1849	1	1.14	0.03	0.03	5.17	0.12	0.12	0.32	0.33	0.33	2.00	0.04	0.04	44.00	0.88	0.88
1849	2	1.14	0.03	0.03	5.17	0.12	0.12	0.32	0.33	0.33	2.00	0.04	0.04	44.00	0.88	0.88
1849	3	1.14	0.03	0.03	5.17	0.12	0.12	0.32	0.33	0.33	2.00	0.04	0.04	44.00	0.88	0.88
1849	4	1.14	0.03	0.03	5.17	0.12	0.12	0.35	0.37	0.37	2.14	0.05	0.05	43.00	0.86	0.86
1849	5	1.14	0.03	0.03	5.17	0.12	0.12	0.35	0.37	0.37	2.14	0.05	0.05	43.00	0.86	0.86
1849	6	1.14	0.03	0.03	5.17	0.12	0.12	0.35	0.37	0.37	2.14	0.05	0.05	43.00	0.86	0.86
1849	7	1.14	0.03	0.03			0.12	0.35	0.37	0.37	2.14	0.05	0.05	44.00	0.88	0.88
1849	8	1.14	0.03	0.03			0.11	0.35	0.37	0.37	2.14	0.05	0.05	44.00	0.88	0.88
1849	9	1.14	0.03	0.03			0.11	0.35	0.37	0.37	2.14	0.05	0.05	44.00	0.88	0.88
1849	10	1.14	0.03	0.03	5.00	0.11	0.11	0.34	0.36	0.36	2.14	0.05	0.05	53.00	1.05	1.05
1849	11	1.14	0.03	0.03	5.00	0.11	0.11	0.34	0.36	0.36	2.14	0.05	0.05	53.00	1.05	1.05
1849	12	1.14	0.03	0.03	5.00	0.11	0.11	0.34	0.36	0.36	2.14	0.05	0.05	53.00	1.05	1.05
1850	1	1.14	0.03	0.03	5.00	0.11	0.11	0.34	0.36	0.36	2.08	0.05	0.05	52.00	1.03	1.03
1850	2	1.14	0.03	0.03	5.00	0.11	0.11	0.34	0.36	0.36	2.08	0.05	0.05	52.00	1.03	1.03
1850	3	1.14	0.03	0.03	5.00	0.11	0.11	0.34	0.36	0.36	2.08	0.05	0.05	52.00	1.03	1.03
1850	4	1.15	0.03	0.03	5.00	0.11	0.11	0.35	0.37	0.37	2.17	0.05	0.05	60.00	1.19	1.19
1850	5	1.08	0.03	0.03	5.17	0.12	0.12	0.33	0.34	0.34	2.21	0.06	0.06	56.17	1.12	1.12
1850	6	1.06	0.03	0.03	5.24	0.12	0.12	0.31	0.32	0.32	2.12	0.05	0.05	54.27	1.09	1.09
1850	7	1.07	0.03	0.03	4.16	0.10	0.10	0.32	0.33	0.33	3.00	0.07	0.07	54.28	1.09	1.09
1850	8	1.08	0.03	0.03	4.18	0.10	0.10	0.33	0.34	0.34	2.12	0.05	0.05	55.28	1.11	1.11
1850	9	1.07	0.03	0.03	5.14	0.12	0.12	0.32	0.34	0.34	2.10	0.05	0.05	57.22	1.15	1.15
1850	10	1.06	0.03	0.03	4.17	0.10	0.10	0.32	0.33	0.33	2.09	0.05	0.05	58.20	1.17	1.17
1850	11	1.05	0.02	0.02	5.00	0.11	0.11	0.32	0.33	0.33	2.16	0.05	0.05	60.00	1.19	1.19
1850	12	1.06	0.03	0.03	5.17	0.12	0.12	0.33	0.35	0.35	2.06	0.05	0.05	58.00	1.15	1.15
1851	1	1.04	0.02	0.02	5.07	0.11	0.11	0.33	0.35	0.35	2.04	0.05	0.05	56.32	1.13	1.13
1851	2	1.05	0.02	0.02	4.14	0.10	0.10	0.34	0.36	0.36	2.20	0.06	0.06	55.30	1.11	1.11

Year	**M**	**F1**	**F2**	**F3**	**C1**	**C2**	**C3**	**B1**	**B2**	**B3**	**S1**	**S2**	**S3**	**O1**	**O2**	**O3**
1851	3	1.02	0.02	0.02	4.14	0.10	0.10	0.32	0.33	0.33	2.16	0.05	0.05	54.24	1.09	1.09
1851	4	1.03	0.02	0.02	4.04	0.09	0.09	0.32	0.33	0.33	2.18	0.05	0.05	52.14	1.04	1.04
1851	5	1.03	0.02	0.02	3.17	0.08	0.08	0.32	0.33	0.33	2.25	0.06	0.06	52.20	1.05	1.05
1851	6	1.03	0.02	0.02	3.17	0.08	0.08	0.32	0.33	0.33	2.20	0.06	0.06	52.20	1.05	1.05
1851	7	1.05	0.02	0.02	4.16	0.10	0.10	0.31	0.32	0.32	2.15	0.05	0.05	54.21	1.09	1.09
1851	8	1.03	0.02	0.02	3.17	0.08	0.08	0.31	0.32	0.32	2.15	0.05	0.05	53.00	1.05	1.05
1851	9	1.05	0.02	0.02	4.08	0.09	0.09	0.30	0.32	0.32	2.11	0.05	0.05	52.26	1.05	1.05
1851	10	1.06	0.03	0.03	4.10	0.09	0.09	0.32	0.33	0.33	2.12	0.05	0.05	52.00	1.03	1.03
1851	11	1.09	0.03	0.03	4.08	0.09	0.09	0.32	0.34	0.34	2.22	0.06	0.06	52.08	1.04	1.04
1851	12	1.06	0.03	0.03	4.09	0.09	0.09	0.32	0.33	0.33	2.23	0.06	0.06	52.00	1.03	1.03
1852	1	1.04	0.02	0.02	3.32	0.09	0.09	0.32	0.33	0.33	2.16	0.05	0.05	52.30	1.05	1.05
1852	2	1.04	0.02	0.02	4.11	0.09	0.09	0.32	0.33	0.33	2.09	0.05	0.05	51.13	1.02	1.02
1852	3	1.05	0.02	0.02	4.11	0.09	0.09	0.31	0.32	0.32	2.16	0.05	0.05	51.27	1.03	1.03
1852	4	1.02	0.02	0.02	4.04	0.09	0.09	0.29	0.30	0.30	2.11	0.05	0.05	50.17	1.00	1.00
1852	5	1.04	0.02	0.02	4.07	0.09	0.09	0.31	0.32	0.32	2.21	0.06	0.06	51.10	1.02	1.02
1852	6	1.05	0.02	0.02	4.11	0.09	0.09	0.31	0.32	0.32	2.19	0.06	0.06	51.07	1.02	1.02
1852	7	1.06	0.03	0.03	4.13	0.10	0.10	0.30	0.31	0.31	2.11	0.05	0.05	51.00	1.01	1.01
1852	8	1.03	0.02	0.02	4.00	0.09	0.09	0.29	0.30	0.30	2.09	0.05	0.05	50.19	1.01	1.01
1852	9	1.05	0.02	0.02	4.06	0.09	0.09	0.30	0.31	0.31	2.14	0.05	0.05	51.28	1.03	1.03
1852	10	1.09	0.03	0.03	4.13	0.10	0.10	0.30	0.31	0.31	2.17	0.05	0.05	54.00	1.07	1.07
1852	11	1.05	0.02	0.02	4.08	0.09	0.09	0.30	0.31	0.31	2.20	0.06	0.06	54.20	1.09	1.09
1852	12	1.06	0.03	0.03	4.08	0.09	0.09	0.31	0.32	0.32	2.14	0.05	0.05	56.00	1.11	1.11
1853	1	1.06	0.03	0.03	4.10	0.09	0.09	0.31	0.32	0.32	2.00	0.04	0.04	54.12	1.08	1.08
1853	2	1.06	0.03	0.03	4.12	0.09	0.09	0.30	0.31	0.31	2.24	0.06	0.06	56.02	1.12	1.12
1853	3	1.06	0.03	0.03	4.17	0.10	0.10	0.30	0.31	0.31	2.20	0.06	0.06	58.25	1.17	1.17
1853	4	1.06	0.03	0.03	4.15	0.10	0.10	0.30	0.31	0.31	2.20	0.06	0.06	60.00	1.19	1.19
1853	5	1.06	0.03	0.03	4.11	0.09	0.09	0.30	0.31	0.31	2.20	0.06	0.06	61.00	1.21	1.21
1853	6	1.04	0.02	0.02	4.13	0.10	0.10	0.30	0.31	0.31	2.22	0.06	0.06	66.16	1.32	1.32
1853	7	1.05	0.02	0.02	4.07	0.09	0.09	0.30	0.31	0.31	2.17	0.05	0.05	61.20	1.23	1.23
1853	8	1.06	0.03	0.03	4.05	0.09	0.09	0.30	0.31	0.31	2.15	0.05	0.05	61.03	1.22	1.22

Year	**M**	**F1**	**F2**	**F3**	**C1**	**C2**	**C3**	**B1**	**B2**	**B3**	**S1**	**S2**	**S3**	**O1**	**O2**	**O3**
1853	9	1.05	0.02	0.02	4.07	0.09	0.09	0.31	0.32	0.32	2.13	0.05	0.05	62.06	1.24	1.24
1853	10	1.06	0.03	0.03	4.10	0.09	0.09	0.33	0.34	0.34	2.14	0.05	0.05	61.08	1.22	1.22
1853	11	1.06	0.03	0.03	4.06	0.09	0.09	0.33	0.34	0.34	2.17	0.05	0.05	61.15	1.22	1.22
1853	12	1.05	0.02	0.02	4.06	0.09	0.09	0.35	0.37	0.37	2.17	0.05	0.05	61.10	1.22	1.22
1854	1	1.05	0.02	0.02	4.08	0.09	0.09	0.35	0.37	0.37	2.22	0.06	0.06	59.00	1.17	1.17
1854	2	1.06	0.03	0.03	4.05	0.09	0.09	0.37	0.39	0.39	2.20	0.06	0.06	54.30	1.09	1.09
1854	3	1.04	0.02	0.02	4.06	0.09	0.09	0.37	0.39	0.39	2.24	0.06	0.06	54.00	1.07	1.07
1854	4	1.11	0.03	0.03	5.00	0.11	0.11	0.37	0.39	0.39	2.25	0.06	0.06	60.09	1.20	1.20
1854	5	1.06	0.03	0.03	4.06	0.09	0.09	0.37	0.38	0.38	2.25	0.06	0.06	52.12	1.04	1.04
1854	6	1.06	0.03	0.03	4.06	0.09	0.09	0.36	0.38	0.38	2.24	0.06	0.06	51.26	1.03	1.03
1854	7	1.06	0.03	0.03	4.06	0.09	0.09	0.35	0.37	0.37	2.16	0.05	0.05	51.07	1.02	1.02
1854	8			0.03			0.10			0.37			0.06			1.02
1854	9			0.03			0.10			0.37			0.06			1.02
1854	10	1.06	0.03	0.03	4.26	0.10	0.10	0.35	0.37	0.37	2.22	0.06	0.06	51.09	1.02	1.02
1854	11	1.14	0.03	0.03	4.14	0.10	0.10	0.34	0.36	0.36	2.08	0.05	0.05	49.26	0.99	0.99
1854	12	1.14	0.03	0.03	4.30	0.11	0.11	0.38	0.40	0.40	2.17	0.05	0.05	52.14	1.04	1.04
1855	1	1.11	0.03	0.03	4.23	0.10	0.10	0.39	0.41	0.41	2.15	0.05	0.05	51.05	1.02	1.02
1855	2	1.10	0.03	0.03	4.19	0.10	0.10	0.39	0.41	0.41	2.16	0.05	0.05	52.29	1.05	1.05
1855	3	1.13	0.03	0.03	4.11	0.09	0.09	0.37	0.39	0.39	2.09	0.05	0.05	52.32	1.05	1.05
1855	4	1.08	0.03	0.03	4.22	0.10	0.10	0.38	0.40	0.40	2.20	0.06	0.06	53.10	1.06	1.06
1855	5	1.06	0.03	0.03	4.18	0.10	0.10	0.38	0.39	0.39	2.22	0.06	0.06	53.00	1.05	1.05
1855	6	1.05	0.02	0.02	4.05	0.09	0.09	0.39	0.41	0.41	2.23	0.06	0.06	52.23	1.05	1.05
1855	7	1.14	0.03	0.03	4.16	0.10	0.10	0.39	0.41	0.41	2.24	0.06	0.06	52.00	1.03	1.03
1855	8	1.15	0.03	0.03	4.16	0.10	0.10	0.38	0.40	0.40	2.10	0.05	0.05	51.23	1.03	1.03
1855	9			0.03			0.11			0.41			0.06			1.05
1855	10			0.03			0.11			0.42			0.07			1.06
1855	11			0.03			0.12			0.43			0.08			1.08
1855	12			0.03			0.13			0.44			0.09			1.10
1856	1	1.20	0.03	0.03	4.65	0.13	0.13	49.61		0.45	2.68	0.09	0.09	54.43	1.10	1.10
1856	2	1.18	0.03	0.03	4.61	0.10	0.10	1.26	0.45	0.45	2.64	0.06	0.06	54.00	1.07	1.07

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1856	3	1.34	0.03	0.03	4.80	0.10	0.10	1.21	0.43	0.43	2.62	0.06	0.06	54.80	1.09	1.09
1856	4			0.03			0.10			0.44			0.06			1.08
1856	5	1.17	0.03	0.03	4.55	0.10	0.10	1.26	0.45	0.45	2.60	0.06	0.06	54.10	1.08	1.08
1856	6			0.03			0.10			0.47			0.05			1.07
1856	7	1.20	0.03	0.03	4.25	0.09	0.09	1.36	0.48	0.48	2.32	0.05	0.05	53.54	1.07	1.07
1856	8	1.19	0.03	0.03	4.35	0.09	0.09	1.37	0.49	0.49	2.42	0.05	0.05	54.74	1.09	1.09
1856	9	1.08	0.02	0.02	4.08	0.09	0.09	1.37	0.49	0.49	2.34	0.05	0.05	57.63	1.15	1.15
1856	10			0.02			0.09			0.49			0.05			1.14
1856	11			0.03			0.09			0.49			0.05			1.13
1856	12			0.03			0.10			0.49			0.05			1.13
1857	1			0.03			0.10			0.49			0.05			1.12
1857	2			0.03			0.10			0.49			0.06			1.12
1857	3			0.03			0.10			0.49			0.06			1.11
1857	4			0.03			0.11			0.49			0.06			1.10
1857	5			0.03			0.11			0.49			0.06			1.10
1857	6	1.40	0.03	0.03	5.00	0.11	0.11	1.38	0.49	0.49	2.62	0.06	0.06	55.50	1.10	1.10
1857	7	1.25	0.03	0.03	4.75	0.10	0.10	1.30	0.46	0.46	2.80	0.06	0.06	55.70	1.11	1.11
1857	8	1.25	0.03	0.03	4.65	0.10	0.10	1.26	0.45	0.45	2.38	0.05	0.05	55.00	1.09	1.09
1857	9	1.15	0.02	0.02	4.45	0.10	0.10	1.23	0.44	0.44	2.30	0.05	0.05	56.00	1.11	1.11
1857	10	1.25	0.03	0.03	4.50	0.10	0.10	1.30	0.46	0.46	2.60	0.06	0.06	56.00	1.11	1.11
1857	11	1.30	0.03	0.03	4.75	0.10	0.10	1.20	0.43	0.43	2.50	0.05	0.05	56.00	1.11	1.11
1857	12			0.03			0.11			0.40			0.05			1.08
1858	1	1.38	0.03	0.03	5.00	0.11	0.11	1.07	0.38	0.38	2.52	0.05	0.05	52.20	1.04	1.04
1858	2	1.10	0.02	0.02	4.40	0.10	0.10	0.92	0.33	0.33	2.25	0.05	0.05	45.00	0.90	0.90
1858	3			0.02			0.10			0.35			0.05			0.92
1858	4	1.20	0.03	0.03	4.50	0.10	0.10	1.04	0.37	0.37	2.76	0.06	0.06	47.00	0.94	0.94
1858	5	1.58	0.03	0.03	5.50	0.12	0.12	1.00	0.36	0.36	2.50	0.05	0.05	52.00	1.03	1.03
1858	6	1.30	0.03	0.03	5.00	0.11	0.11	1.03	0.37	0.37	2.74	0.06	0.06	48.40	0.96	0.96
1858	7	1.50	0.03	0.03	5.00	0.11	0.11	0.96	0.34	0.34	2.50	0.05	0.05	48.00	0.96	0.96
1858	8	1.25	0.03	0.03	5.00	0.11	0.11	1.08	0.38	0.38	2.74	0.06	0.06	46.00	0.92	0.92

Year	**M**	**F1**	**F2**	**F3**	**C1**	**C2**	**C3**	**B1**	**B2**	**B3**	**S1**	**S2**	**S3**	**O1**	**O2**	**O3**
1858	9	1.35	0.03	0.03	5.00	0.11	0.11	1.04	0.37	0.37	2.74	0.06	0.06	50.00	0.99	0.99
1858	10	1.30	0.03	0.03	4.90	0.11	0.11	1.06	0.38	0.38	2.75	0.06	0.06	48.72	0.97	0.97
1858	11	2.85	0.06	0.06	5.00	0.11	0.11	1.02	0.36	0.36	2.70	0.06	0.06	52.75	1.05	1.05
1858	12	1.44	0.03	0.03	5.00	0.11	0.11	1.00	0.36	0.36	2.72	0.06	0.06	52.80	1.05	1.05
1859	1	1.45	0.03	0.03	5.40	0.12	0.12	0.92	0.33	0.33	2.92	0.06	0.06	52.00	1.03	1.03
1859	2	1.40	0.03	0.03	5.00	0.11	0.11	1.00	0.36	0.36	3.08	0.07	0.07	51.80	1.03	1.03
1859	3	1.40	0.03	0.03	5.00	0.11	0.11	0.99	0.35	0.35	2.96	0.06	0.06	52.00	1.03	1.03
1859	4	1.50	0.03	0.03	5.40	0.12	0.12	1.04	0.37	0.37	3.30	0.07	0.07	48.98	0.97	0.97
1859	5	1.42	0.03	0.03	5.20	0.11	0.11	1.07	0.38	0.38	3.70	0.08	0.08	57.00	1.13	1.13
1859	6	1.26	0.03	0.03	4.92	0.11	0.11	0.95	0.34	0.34	4.39	0.10	0.10	56.33	1.12	1.12
1859	7	1.20	0.03	0.03	5.00	0.11	0.11	0.95	0.34	0.34	3.58	0.08	0.08	59.20	1.18	1.18
1859	8	1.55	0.03	0.03	5.44	0.12	0.12	1.06	0.38	0.38	3.25	0.07	0.07	57.80	1.15	1.15
1859	9	1.45	0.03	0.03	5.00	0.11	0.11	1.00	0.36	0.36	3.48	0.08	0.08	61.00	1.21	1.21
1859	10	1.25	0.03	0.03	5.00	0.11	0.11	1.00	0.36	0.36	3.08	0.07	0.07	60.50	1.20	1.20
1859	11	1.30	0.03	0.03	5.00	0.11	0.11	1.06	0.38	0.38	3.82	0.08	0.08	64.00	1.27	1.27
1859	12			0.03			0.12			0.39			0.08			1.28
1860	1			0.04			0.13			0.40			0.08			1.29
1860	2	1.74	0.04	0.04	5.76	0.13	0.13	1.13	0.40	0.40	3.74	0.08	0.08	65.00	1.29	1.29
1860	3	1.35	0.03	0.03	5.10	0.11	0.11	1.13	0.40	0.40	3.90	0.08	0.08	66.15	1.32	1.32
1860	4			0.03			0.11			0.41			0.09			1.33
1860	5			0.03			0.11			0.41			0.09			1.35
1860	6	1.20	0.03	0.03	5.00	0.11	0.11	1.16	0.41	0.41	4.00	0.09	0.09	67.60	1.35	1.35
1860	7	1.40	0.03	0.03	5.15	0.11	0.11	1.06	0.38	0.38	4.06	0.09	0.09	68.00	1.35	1.35
1860	8	1.54	0.03	0.03	5.45	0.12	0.12	1.11	0.39	0.39	3.42	0.07	0.07	66.00	1.31	1.31
1860	9	1.60	0.03	0.03	5.25	0.11	0.11	1.08	0.38	0.38	3.16	0.07	0.07	69.20	1.38	1.38
1860	10	1.38	0.03	0.03	5.40	0.12	0.12	1.12	0.40	0.40	2.80	0.06	0.06	66.50	1.32	1.32
1860	11	1.45	0.03	0.03	5.50	0.12	0.12	1.15	0.41	0.41	3.66	0.08	0.08	60.50	1.20	1.20
1860	12	1.40	0.03	0.03	5.20	0.11	0.11	1.16	0.41	0.41	3.68	0.08	0.08	68.00	1.35	1.35
1861	1			0.03			0.11			0.41			0.08			1.32
1861	2	1.25	0.03	0.03	5.30	0.12	0.12	1.15	0.41	0.41	4.12	0.09	0.09	65.00	1.29	1.29

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1861	3	1.40	0.03	0.03	5.00	0.11	0.11	1.10	0.39	0.39	3.66	0.08	0.08	57.60	1.15	1.15
1861	4	1.40	0.03	0.03	5.50	0.12	0.12	1.10	0.39	0.39	3.66	0.08	0.08	57.50	1.14	1.14
1861	5	1.34	0.03	0.03	5.00	0.11	0.11	1.06	0.38	0.38	3.54	0.08	0.08	55.75	1.11	1.11
1861	6	1.40	0.03	0.03	5.00	0.11	0.11	1.00	0.36	0.36	3.08	0.07	0.07	55.00	1.09	1.09
1861	7	1.20	0.03	0.03	5.50	0.12	0.12	1.12	0.40	0.40	3.20	0.07	0.07	54.00	1.07	1.07
1861	8	1.25	0.03	0.03	5.00	0.11	0.11	1.15	0.41	0.41	3.00	0.07	0.07	55.00	1.09	1.09
1861	9	1.25	0.03	0.03	5.15	0.11	0.11	1.10	0.39	0.39	2.50	0.05	0.05	54.44	1.08	1.08
1861	10	1.40	0.03	0.03	5.25	0.11	0.11	1.16	0.41	0.41	2.92	0.06	0.06	61.40	1.22	1.22
1861	11	1.25	0.03	0.03	5.15	0.11	0.11	1.13	0.40	0.40	3.08	0.07	0.07	62.00	1.23	1.23
1861	12	1.35	0.03	0.03	5.50	0.12	0.12	1.12	0.40	0.40	3.12	0.07	0.07	62.00	1.23	1.23
1862	1	1.25	0.03	0.03	5.00	0.11	0.11	1.19	0.42	0.42	3.50	0.08	0.08	62.00	1.23	1.23
1862	2	1.30	0.03	0.03	5.00	0.11	0.11	1.09	0.39	0.39	2.75	0.06	0.06	62.00	1.23	1.23
1862	3	1.25	0.03	0.03	5.00	0.11	0.11	1.06	0.38	0.38	3.35	0.07	0.07	62.00	1.23	1.23
1862	4	1.25	0.03	0.03	5.00	0.11	0.11	1.12	0.40	0.40	3.10	0.07	0.07	64.00	1.27	1.27
1862	5	1.25	0.03	0.03	5.00	0.11	0.11	1.10	0.39	0.39	3.00	0.07	0.07	62.00	1.23	1.23
1862	6	1.25	0.03	0.03	5.15	0.11	0.11	1.10	0.39	0.39	2.84	0.06	0.06	64.00	1.27	1.27
1862	7	1.20	0.03	0.03	5.20	0.11	0.11	1.16	0.41	0.41	3.42	0.07	0.07	64.00	1.27	1.27
1862	8	1.25	0.03	0.03	5.00	0.11	0.11	1.14	0.41	0.41	3.00	0.07	0.07	64.00	1.27	1.27
1862	9	1.75	0.04	0.04	4.50	0.10	0.10	1.08	0.38	0.38	3.80	0.08	0.08	65.50	1.30	1.30
1862	10	1.20	0.03	0.03	5.00	0.11	0.11	1.08	0.38	0.38	3.00	0.07	0.07	64.00	1.27	1.27
1862	11	1.25	0.03	0.03	5.00	0.11	0.11	1.10	0.39	0.39	2.88	0.06	0.06	66.00	1.31	1.31
1862	12	1.25	0.03	0.03	5.00	0.11	0.11	1.10	0.39	0.39	3.00	0.07	0.07	62.00	1.23	1.23
1863	1	1.25	0.03	0.03	5.00	0.11	0.11	1.05	0.37	0.37	3.00	0.07	0.07	64.00	1.27	1.27
1863	2	1.25	0.03	0.03	5.00	0.11	0.11	1.09	0.39	0.39	2.50	0.05	0.05	62.00	1.23	1.23
1863	3	1.25	0.03	0.03	5.00	0.11	0.11	1.06	0.38	0.38	2.38	0.05	0.05	62.00	1.23	1.23
1863	4	1.25	0.03	0.03	5.00	0.11	0.11	1.08	0.38	0.38	2.42	0.05	0.05	61.00	1.21	1.21
1863	5	1.25	0.03	0.03	5.00	0.11	0.11	1.08	0.38	0.38	2.50	0.05	0.05	62.00	1.23	1.23
1863	6	4.35	0.02	0.02	5.00	0.11	0.11	1.07	0.38	0.38	2.32	0.05	0.05	59.40	1.18	1.18
1863	7	4.35	0.02	0.02	5.00	0.11	0.11	1.06	0.38	0.38	2.50	0.05	0.05	59.52	1.18	1.18
1863	8	4.25	0.02	0.02	5.00	0.11	0.11	1.05	0.37	0.37	2.00	0.04	0.04	59.75	1.19	1.19

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1863	9	5.66	0.03	0.03	4.98	0.11	0.11	1.05	0.37	0.37	9.43	0.05	0.05	60.45	1.20	1.20
1863	10			0.03			0.10			0.38			0.05			1.19
1863	11	5.42	0.03	0.03	4.66	0.10	0.10	1.08	0.38	0.38	10.34	0.06	0.06	59.34	1.18	1.18
1863	12			0.03			0.10			0.38			0.06			1.14
1864	1	5.69	0.03	0.03	4.89	0.11	0.11	1.06	0.38	0.38	10.90	0.06	0.06	55.32	1.10	1.10
1864	2	5.80	0.03	0.03	4.92	0.11	0.11	1.05	0.38	0.38	11.15	0.06	0.06	57.00	1.13	1.13
1864	3	5.82	0.03	0.03	4.84	0.11	0.11	1.05	0.38	0.38	11.58	0.06	0.06	56.16	1.12	1.12
1864	4	6.08	0.03	0.03	4.94	0.11	0.11	1.05	0.38	0.38	11.38	0.06	0.06	56.54	1.13	1.13
1864	5	5.86	0.03	0.03	4.90	0.11	0.11	1.05	0.38	0.38	11.64	0.06	0.06	56.60	1.13	1.13
1864	6	6.56	0.04	0.04	5.39	0.12	0.12	1.06	0.38	0.38	13.04	0.07	0.07	62.21	1.24	1.24
1864	7	5.64	0.03	0.03	4.94	0.11	0.11	1.08	0.39	0.39	11.30	0.06	0.06	57.20	1.14	1.14
1864	8	5.60	0.03	0.03	4.90	0.11	0.11	1.09	0.39	0.39	11.51	0.06	0.06	56.74	1.13	1.13
1864	9	5.50	0.03	0.03	4.96	0.11	0.11	1.08	0.39	0.39	11.12	0.06	0.06	52.82	1.05	1.05
1864	10	5.87	0.03	0.03	4.91	0.11	0.11	1.08	0.39	0.39	10.21	0.06	0.06	56.12	1.12	1.12
1864	11	5.97	0.03	0.03	4.93	0.11	0.11	1.05	0.38	0.38	11.96	0.06	0.06	56.36	1.12	1.12
1864	12	5.97	0.03	0.03	4.95	0.11	0.11	1.03	0.37	0.37	12.27	0.07	0.07	55.34	1.10	1.10
1865	1	5.69	0.03	0.03	4.97	0.11	0.11	1.05	0.38	0.38	12.72	0.07	0.07	54.36	1.08	1.08
1865	2	6.89	0.04	0.04	5.07	0.11	0.11	1.05	0.38	0.38	12.66	0.07	0.07	53.28	1.06	1.06
1865	3	7.01	0.04	0.04	5.08	0.11	0.11	1.05	0.38	0.38	13.03	0.07	0.07	53.01	1.05	1.05
1865	4	6.63	0.04	0.04	5.04	0.11	0.11	1.03	0.37	0.37	13.00	0.07	0.07	53.62	1.07	1.07
1865	5	6.77	0.04	0.04	5.03	0.11	0.11	1.03	0.37	0.37	13.18	0.07	0.07	53.58	1.07	1.07
1865	6	5.82	0.03	0.03	4.94	0.11	0.11	1.02	0.37	0.37	12.17	0.07	0.07	52.99	1.05	1.05
1865	7			0.03			0.11			0.26			0.07			1.06
1865	8	1.47	0.04	0.04	4.74	0.12	0.12	0.10	0.15	0.15	2.58	0.06	0.06	42.76	1.07	1.07
1865	9	1.49	0.04	0.04	4.24	0.11	0.11	0.10	0.15	0.15	2.66	0.07	0.07	43.27	1.08	1.08
1865	10	1.51	0.04	0.04	4.22	0.11	0.11	0.10	0.15	0.15	2.68	0.07	0.07	47.17	1.18	1.18
1865	11	1.49	0.04	0.04	4.24	0.11	0.11	0.10	0.15	0.15	2.63	0.07	0.07	46.93	1.17	1.17
1865	12			0.04			0.11			0.25			0.07			1.20
1866	1			0.04			0.11			0.35			0.07			1.22
1866	2	0.02	0.04	0.04	0.04	0.11	0.11	0.10	0.35	0.35	0.16	0.07	0.07	0.49	1.22	1.22

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1866	3	0.02	0.04	0.04	0.04	0.11	0.11	0.09	0.33	0.33	0.15	0.06	0.06	0.48	1.21	1.21
1866	4			0.04			0.11			0.32			0.07			1.23
1866	5	1.40	0.04	0.04	4.50	0.11	0.11	0.09	0.31	0.31	2.70	0.07	0.07	50.00	1.25	1.25
1866	6			0.03			0.11			0.32			0.07			1.25
1866	7	0.01	0.03	0.03	0.04	0.11	0.11	0.09	0.33	0.33	0.16	0.07	0.07	0.50	1.25	1.25
1866	8	0.01	0.03	0.03	0.04	0.11	0.11	0.09	0.33	0.33	0.16	0.07	0.07	0.44	1.09	1.09
1866	9	0.02	0.04	0.04	0.04	0.11	0.11	0.09	0.32	0.32	0.16	0.07	0.07	0.49	1.23	1.23
1866	10	0.01	0.03	0.03	0.04	0.10	0.10	0.10	0.37	0.37	0.16	0.07	0.07	0.50	1.25	1.25
1866	11			0.04			0.10			0.36			0.06			1.21
1866	12	0.02	0.04	0.04	0.04	0.09	0.09	0.10	0.35	0.35	0.13	0.06	0.06	0.47	1.18	1.18
1867	1	0.02	0.04	0.04	0.04	0.11	0.11	0.10	0.36	0.36	0.16	0.07	0.07	0.49	1.23	1.23
1867	2			0.04			0.11			0.37			0.07			1.22
1867	3	0.02	0.04	0.04	0.04	0.10	0.10	0.11	0.38	0.38	0.19	0.08	0.08	0.48	1.21	1.21
1867	4			0.04			0.10			0.39			0.07			1.20
1867	5	0.01	0.04	0.04	0.04	0.10	0.10	0.11	0.40	0.40	0.17	0.07	0.07	0.48	1.20	1.20
1867	6	0.02	0.04	0.04	0.04	0.11	0.11	0.11	0.41	0.41	0.17	0.07	0.07	0.48	1.21	1.21
1867	7	0.02	0.04	0.04	0.04	0.10	0.10	0.11	0.39	0.39	0.16	0.07	0.07	0.49	1.21	1.21
1867	8	0.02	0.04	0.04	0.04	0.10	0.10	0.11	0.39	0.39	0.17	0.07	0.07	0.50	1.26	1.26
1867	9	0.02	0.05	0.05	0.04	0.10	0.10	0.12	0.41	0.41	0.17	0.07	0.07	0.49	1.22	1.22
1867	10	0.02	0.04	0.04	0.04	0.10	0.10	0.11	0.40	0.40	0.17	0.07	0.07	0.53	1.33	1.33
1867	11	0.02	0.04	0.04	0.04	0.11	0.11	0.12	0.43	0.43	0.17	0.07	0.07	0.54	1.35	1.35
1867	12			0.04			0.11			0.43			0.07			1.32
1868	1			0.04			0.11			0.42			0.07			1.29
1868	2			0.04			0.11			0.42			0.08			1.26
1868	3			0.04			0.11			0.42			0.08			1.24
1868	4			0.04			0.11			0.41			0.08			1.21
1868	5			0.04			0.11			0.41			0.08			1.18
1868	6			0.04			0.11			0.41			0.08			1.15
1868	7			0.04			0.11			0.41			0.08			1.13
1868	8			0.04			0.11			0.40			0.08			1.10

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1868	9			0.04			0.11			0.40			0.08			1.07
1868	10			0.04			0.11			0.40			0.09			1.04
1868	11			0.04			0.11			0.40			0.09			1.02
1868	12			0.04			0.11			0.39			0.09			0.99
1869	1	0.02	0.04	0.04	0.04	0.11	0.11	0.11	0.39	0.39	0.21	0.09	0.09	0.40	0.99	0.99
1869	2	0.02	0.04	0.04	0.04	0.11	0.11	0.11	0.39	0.39	0.22	0.09	0.09	0.38	0.96	0.96
1869	3	0.02	0.04	0.04	0.04	0.10	0.10	0.11	0.38	0.38	0.20	0.09	0.09	0.38	0.94	0.94
1869	4	0.02	0.04	0.04	0.04	0.10	0.10	0.17	0.61	0.61	0.21	0.09	0.09	0.40	1.00	1.00
1869	5	0.02	0.04	0.04	0.04	0.10	0.10	0.11	0.40	0.40	0.21	0.09	0.09	0.41	1.02	1.02
1869	6	0.01	0.03	0.03	0.04	0.10	0.10	0.11	0.41	0.41	0.22	0.09	0.09	0.41	1.02	1.02
1869	7	0.02	0.04	0.04	0.04	0.09	0.09	0.11	0.39	0.39	0.22	0.09	0.09	0.42	1.05	1.05
1869	8	0.01	0.03	0.03	0.04	0.10	0.10	0.11	0.38	0.38	0.15	0.06	0.06	0.40	1.01	1.01
1869	9	0.02	0.04	0.04	0.04	0.10	0.10	0.11	0.40	0.40	0.19	0.08	0.08	0.44	1.10	1.10
1869	10	0.01	0.03	0.03	0.04	0.10	0.10	0.11	0.41	0.41	0.19	0.08	0.08	0.48	1.19	1.19
1869	11	0.02	0.04	0.04	0.04	0.10	0.10	0.11	0.40	0.40	0.17	0.07	0.07	0.48	1.21	1.21
1869	12	0.02	0.04	0.04	0.04	0.10	0.10	0.11	0.38	0.38	0.17	0.07	0.07	0.49	1.22	1.22
1870	1	0.02	0.04	0.04	0.04	0.10	0.10	0.11	0.38	0.38	0.17	0.07	0.07	0.50	1.24	1.24
1870	2	0.02	0.04	0.04	0.04	0.10	0.10	0.11	0.39	0.39	0.18	0.08	0.08	0.48	1.20	1.20
1870	3	0.02	0.04	0.04	0.04	0.11	0.11	0.11	0.38	0.38	0.17	0.07	0.07	0.49	1.22	1.22
1870	4	0.02	0.04	0.04	0.04	0.11	0.11	0.11	0.39	0.39	0.17	0.07	0.07	0.48	1.20	1.20
1870	5	0.02	0.04	0.04	0.04	0.11	0.11	0.11	0.39	0.39	0.18	0.08	0.08	0.47	1.18	1.18
1870	6	0.02	0.04	0.04	0.04	0.10	0.10	0.11	0.38	0.38	0.18	0.08	0.08	0.47	1.18	1.18
1870	7	0.04	0.04	0.04	0.10	0.10	0.10	0.29	0.41	0.41	0.44	0.07	0.07	1.20	1.20	1.20
1870	8	0.04	0.04	0.04	0.10	0.10	0.10	0.30	0.43	0.43	0.44	0.07	0.07	1.20	1.20	1.20
1870	9	0.06	0.06	0.06	0.10	0.10	0.10	0.30	0.43	0.43	0.42	0.07	0.07	1.19	1.19	1.19
1870	10	0.04	0.04	0.04	0.10	0.10	0.10	0.30	0.43	0.43	0.45	0.08	0.08	1.18	1.18	1.18
1870	11			0.04			0.11			0.44			0.08			1.21
1870	12	0.04	0.04	0.04	0.12	0.12	0.12	0.32	0.46	0.46	0.52	0.09	0.09	1.24	1.24	1.24
1871	1	0.04	0.04	0.04	0.10	0.10	0.10	0.30	0.43	0.43	0.42	0.07	0.07	1.13	1.13	1.13
1871	2	0.04	0.04	0.04	0.10	0.10	0.10	0.31	0.44	0.44	0.42	0.07	0.07	1.17	1.17	1.17

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1871	3	0.04	0.04	0.04	0.10	0.10	0.10	0.31	0.44	0.44	0.48	0.08	0.08	1.14	1.14	1.14
1871	4	0.04	0.04	0.04	0.10	0.10	0.10	0.32	0.46	0.46	0.48	0.08	0.08	1.15	1.15	1.15
1871	5	0.04	0.04	0.04	0.10	0.10	0.10	0.32	0.46	0.46	0.45	0.08	0.08	1.16	1.16	1.16
1871	6	0.03	0.03	0.03	0.10	0.10	0.10	0.33	0.47	0.47	0.44	0.07	0.07	1.16	1.16	1.16
1871	7	0.04	0.04	0.04	0.10	0.10	0.10	0.31	0.44	0.44	0.45	0.08	0.08	1.13	1.13	1.13
1871	8	0.04	0.04	0.04	0.10	0.10	0.10	0.30	0.43	0.43	0.48	0.08	0.08	1.16	1.16	1.16
1871	9	0.04	0.04	0.04	0.10	0.10	0.10	0.30	0.43	0.43	0.48	0.08	0.08	1.15	1.15	1.15
1871	10	0.04	0.04	0.04	0.10	0.10	0.10	0.30	0.43	0.43	0.54	0.09	0.09	1.15	1.15	1.15
1871	11	0.04	0.04	0.04	0.10	0.10	0.10	0.29	0.41	0.41	0.60	0.10	0.10		0.00	0.00
1871	12	0.04	0.04	0.04	0.10	0.10	0.10	0.29	0.41	0.41	0.54	0.09	0.09	1.15	1.15	1.15
1872	1	0.03	0.03	0.03	0.10	0.10	0.10	0.29	0.41	0.41	0.48	0.08	0.08	1.13	1.13	1.13
1872	2	0.03	0.03	0.03	0.11	0.11	0.11	0.29	0.41	0.41	0.54	0.09	0.09	1.20	1.20	1.20
1872	3	0.04	0.04	0.04	0.11	0.11	0.11	0.29	0.41	0.41	0.48	0.08	0.08	1.11	1.11	1.11
1872	4	0.04	0.04	0.04	0.11	0.11	0.11	0.30	0.43	0.43	0.48	0.08	0.08	1.11	1.11	1.11
1872	5	0.04	0.04	0.04	0.11	0.11	0.11	0.30	0.43	0.43	0.54	0.09	0.09	1.12	1.12	1.12
1872	6	0.04	0.04	0.04	0.11	0.11	0.11	0.29	0.41	0.41	0.54	0.09	0.09	1.11	1.11	1.11
1872	7	0.04	0.04	0.04	0.11	0.11	0.11	0.30	0.43	0.43	0.48	0.08	0.08	1.12	1.12	1.12
1872	8	0.04	0.04	0.04	0.11	0.11	0.11	0.29	0.41	0.41	0.42	0.07	0.07	1.11	1.11	1.11
1872	9	0.04	0.04	0.04	0.11	0.11	0.11	0.29	0.41	0.41	0.48	0.08	0.08	1.11	1.11	1.11
1872	10	0.04	0.04	0.04	0.11	0.11	0.11	0.29	0.41	0.41	0.48	0.08	0.08	1.11	1.11	1.11
1872	11	0.04	0.04	0.04	0.11	0.11	0.11	0.29	0.41	0.41	0.48	0.08	0.08	1.10	1.10	1.10
1872	12			0.04			0.12			0.41			0.08			1.07
1873	1			0.04			0.13			0.41			0.09			1.05
1873	2			0.04			0.14			0.41			0.09			1.02
1873	3	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.55	0.09	0.09	1.02	1.02	1.02
1873	4	0.03	0.03	0.03	0.13	0.13	0.13	0.29	0.41	0.41	0.55	0.09	0.09	1.05	1.05	1.05
1873	5	0.03	0.03	0.03	0.12	0.12	0.12	0.29	0.41	0.41	0.59	0.10	0.10	1.00	1.00	1.00
1873	6	0.03	0.03	0.03	0.13	0.13	0.13	0.28	0.40	0.40	0.58	0.10	0.10	1.00	1.00	1.00
1873	7	0.04	0.04	0.04	0.13	0.13	0.13	0.29	0.41	0.41	0.61	0.10	0.10	1.00	1.00	1.00
1873	8	0.04	0.04	0.04	0.12	0.12	0.12	0.29	0.41	0.41	0.60	0.10	0.10	1.00	1.00	1.00

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1873	9			0.04			0.12			0.42			0.10			1.00
1873	10			0.03			0.13			0.42			0.10			1.00
1873	11			0.03			0.13			0.43			0.11			1.00
1873	12	0.03	0.03	0.03	0.13	0.13	0.13	0.30	0.43	0.43	0.63	0.11	0.11	1.00	1.00	1.00
1874	1	0.04	0.04	0.04	0.14	0.14	0.14	0.30	0.43	0.43	0.60	0.10	0.10	0.97	0.97	0.97
1874	2	0.04	0.04	0.04	0.14	0.14	0.14	0.30	0.43	0.43	0.62	0.10	0.10	1.00	1.00	1.00
1874	3	0.04	0.04	0.04	0.14	0.14	0.14	0.31	0.44	0.44	0.66	0.11	0.11	1.03	1.03	1.03
1874	4	0.04	0.04	0.04	0.14	0.14	0.14	0.31	0.44	0.44	0.68	0.11	0.11	1.06	1.06	1.06
1874	5	0.04	0.04	0.04	0.13	0.13	0.13	0.31	0.44	0.44	0.66	0.11	0.11	1.00	1.00	1.00
1874	6	0.04	0.04	0.04	0.14	0.14	0.14	0.31	0.44	0.44	0.70	0.12	0.12	1.00	1.00	1.00
1874	7	0.04	0.04	0.04	0.14	0.14	0.14	0.31	0.44	0.44	0.68	0.11	0.11	1.00	1.00	1.00
1874	8	0.04	0.04	0.04	0.15	0.15	0.15	0.31	0.44	0.44	0.66	0.11	0.11	1.02	1.02	1.02
1874	9			0.04			0.15			0.44			0.11			1.02
1874	10	0.04	0.04	0.04	0.14	0.14	0.14	0.31	0.44	0.44	0.65	0.11	0.11	1.01	1.01	1.01
1874	11	0.04	0.04	0.04	0.14	0.14	0.14	0.31	0.44	0.44	0.69	0.12	0.12	1.02	1.02	1.02
1874	12	0.05	0.05	0.05	0.15	0.15	0.15	0.31	0.44	0.44	0.65	0.11	0.11	0.97	0.97	0.97
1875	1	0.05	0.05	0.05	0.15	0.15	0.15	0.31	0.44	0.44	0.68	0.11	0.11	1.03	1.03	1.03
1875	2			0.05			0.15			0.44			0.12			1.00
1875	3	0.05	0.05	0.05	0.14	0.14	0.14	0.31	0.44	0.44	0.71	0.12	0.12	0.96	0.96	0.96
1875	4	0.05	0.05	0.05	0.14	0.14	0.14	0.30	0.43	0.43	0.64	0.11	0.11	1.00	1.00	1.00
1875	5	0.05	0.05	0.05	0.15	0.15	0.15	0.30	0.43	0.43	0.65	0.11	0.11	1.00	1.00	1.00
1875	6	0.05	0.05	0.05	0.15	0.15	0.15	0.29	0.41	0.41	0.55	0.09	0.09	1.02	1.02	1.02
1875	7	0.05	0.05	0.05	0.15	0.15	0.15	0.29	0.41	0.41	0.54	0.09	0.09	1.02	1.02	1.02
1875	8	0.05	0.05	0.05	0.15	0.15	0.15	0.29	0.41	0.41	0.51	0.09	0.09	1.00	1.00	1.00
1875	9	0.05	0.05	0.05	0.15	0.15	0.15	0.29	0.41	0.41	0.51	0.09	0.09	1.00	1.00	1.00
1875	10			0.05			0.15			0.41			0.09			1.00
1875	11			0.04			0.14			0.40			0.09			0.99
1875	12	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.51	0.09	0.09	0.99	0.99	0.99
1876	1			0.04			0.14			0.40			0.08			1.05
1876	2			0.04			0.14			0.40			0.08			1.10

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1876	3	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.50	0.08	0.08	1.10	1.10	1.10
1876	4	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.50	0.08	0.08	1.12	1.12	1.12
1876	5	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.52	0.09	0.09	1.14	1.14	1.14
1876	6	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.50	0.08	0.08	1.16	1.16	1.16
1876	7	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.50	0.08	0.08	1.18	1.18	1.18
1876	8	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.50	0.08	0.08	1.21	1.21	1.21
1876	9	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.51	0.09	0.09	1.21	1.21	1.21
1876	10	0.04	0.04	0.04	0.15	0.15	0.15	0.29	0.41	0.41	0.49	0.08	0.08	1.21	1.21	1.21
1876	11	0.05	0.05	0.05	0.15	0.15	0.15	0.28	0.40	0.40	0.51	0.09	0.09	1.24	1.24	1.24
1876	12	0.04	0.04	0.04	0.15	0.15	0.15	0.28	0.40	0.40	0.51	0.09	0.09	1.26	1.26	1.26
1877	1	0.04	0.04	0.04	0.15	0.15	0.15	0.28	0.40	0.40	0.52	0.09	0.09	1.26	1.26	1.26
1877	2	0.05	0.05	0.05	0.15	0.15	0.15	0.28	0.40	0.40	0.53	0.09	0.09	1.27	1.27	1.27
1877	3	0.05	0.05	0.05	0.15	0.15	0.15	0.28	0.40	0.40	0.54	0.09	0.09	1.26	1.26	1.26
1877	4	0.05	0.05	0.05	0.15	0.15	0.15	0.28	0.40	0.40	0.54	0.09	0.09	1.26	1.26	1.26
1877	5	0.04	0.04	0.04	0.15	0.15	0.15	0.29	0.41	0.41	0.55	0.09	0.09	1.25	1.25	1.25
1877	6	0.05	0.05	0.05	0.15	0.15	0.15	0.30	0.43	0.43	0.55	0.09	0.09	1.24	1.24	1.24
1877	7	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.55	0.09	0.09	1.27	1.27	1.27
1877	8	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.55	0.09	0.09	1.27	1.27	1.27
1877	9	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.55	0.09	0.09	1.27	1.27	1.27
1877	10	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.57	0.10	0.10	1.24	1.24	1.24
1877	11	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.57	0.10	0.10	1.25	1.25	1.25
1877	12	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.57	0.10	0.10	1.25	1.25	1.25
1878	1	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.58	0.10	0.10	1.23	1.23	1.23
1878	2	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.56	0.09	0.09	1.20	1.20	1.20
1878	3	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.58	0.10	0.10	1.22	1.22	1.22
1878	4	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.57	0.10	0.10	1.23	1.23	1.23
1878	5	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.61	0.10	0.10	1.25	1.25	1.25
1878	6	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.64	0.11	0.11	1.25	1.25	1.25
1878	7	0.04	0.04	0.04	0.13	0.13	0.13	0.29	0.41	0.41	0.66	0.11	0.11	1.27	1.27	1.27
1878	8	0.05	0.05	0.05	0.13	0.13	0.13	0.29	0.41	0.41	0.67	0.11	0.11	1.25	1.25	1.25

Year	**M**	**F1**	**F2**	**F3**	**C1**	**C2**	**C3**	**B1**	**B2**	**B3**	**S1**	**S2**	**S3**	**O1**	**O2**	**O3**
1878	9	0.04	0.04	0.04	0.13	0.13	0.13	0.29	0.41	0.41	0.67	0.11	0.11	1.30	1.30	1.30
1878	10	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.69	0.12	0.12	1.33	1.33	1.33
1878	11	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.70	0.12	0.12	1.29	1.29	1.29
1878	12	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.71	0.12	0.12	1.30	1.30	1.30
1879	1	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.72	0.12	0.12	1.32	1.32	1.32
1879	2	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.70	0.12	0.12	1.30	1.30	1.30
1879	3	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.70	0.12	0.12	1.30	1.30	1.30
1879	4	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.70	0.12	0.12	1.27	1.27	1.27
1879	5	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.67	0.11	0.11	1.29	1.29	1.29
1879	6	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.65	0.11	0.11	1.28	1.28	1.28
1879	7	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.64	0.11	0.11	1.29	1.29	1.29
1879	8	0.04	0.04	0.04	0.13	0.13	0.13	0.29	0.41	0.41	0.51	0.09	0.09	1.25	1.25	1.25
1879	9	0.04	0.04	0.04	0.13	0.13	0.13	0.29	0.41	0.41	0.49	0.08	0.08	1.23	1.23	1.23
1879	10	0.04	0.04	0.04	0.13	0.13	0.13	0.29	0.41	0.41	0.47	0.08	0.08	1.22	1.22	1.22
1879	11			0.04			0.13			0.41			0.08			1.20
1879	12	0.04	0.04	0.04	0.13	0.13	0.13	0.29	0.41	0.41	0.50	0.08	0.08	1.18	1.18	1.18
1880	1	0.04	0.04	0.04	0.13	0.13	0.13	0.29	0.41	0.41	0.46	0.08	0.08	1.23	1.23	1.23
1880	2	0.04	0.04	0.04	0.13	0.13	0.13	0.29	0.41	0.41	0.44	0.07	0.07	1.24	1.24	1.24
1880	3	0.04	0.04	0.04	0.13	0.13	0.13	0.29	0.41	0.41	0.45	0.08	0.08	1.22	1.22	1.22
1880	4			0.04			0.13			0.42			0.08			1.23
1880	5	0.04	0.04	0.04	0.13	0.13	0.13	0.30	0.43	0.43	0.46	0.08	0.08	1.23	1.23	1.23
1880	6	0.04	0.04	0.04	0.13	0.13	0.13	0.30	0.43	0.43	0.45	0.08	0.08	1.24	1.24	1.24
1880	7	0.04	0.04	0.04	0.13	0.13	0.13	0.30	0.43	0.43	0.44	0.07	0.07	1.21	1.21	1.21
1880	8	0.05	0.05	0.05	0.13	0.13	0.13	0.30	0.43	0.43	0.45	0.08	0.08	1.15	1.15	1.15
1880	9	0.05	0.05	0.05	0.13	0.13	0.13	0.30	0.43	0.43	0.44	0.07	0.07	1.22	1.22	1.22
1880	10	0.05	0.05	0.05	0.13	0.13	0.13	0.30	0.43	0.43	0.41	0.07	0.07	1.23	1.23	1.23
1880	11	0.04	0.04	0.04	0.13	0.13	0.13	0.29	0.41	0.41	0.43	0.07	0.07	1.23	1.23	1.23
1880	12	0.05	0.05	0.05	0.13	0.13	0.13	0.30	0.43	0.43	0.42	0.07	0.07	1.23	1.23	1.23
1881	1	0.05	0.05	0.05	0.13	0.13	0.13	0.29	0.41	0.41	0.42	0.07	0.07	1.18	1.18	1.18
1881	2	0.04	0.04	0.04	0.13	0.13	0.13	0.29	0.41	0.41	0.41	0.07	0.07	1.16	1.16	1.16

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1881	3	0.05	0.05	0.05	0.13	0.13	0.13	0.30	0.43	0.43	0.42	0.07	0.07	1.14	1.14	1.14
1881	4	0.05	0.05	0.05	0.13	0.13	0.13	0.30	0.43	0.43	0.43	0.07	0.07	1.15	1.15	1.15
1881	5	0.04	0.04	0.04	0.13	0.13	0.13	0.29	0.41	0.41	0.42	0.07	0.07	1.11	1.11	1.11
1881	6	0.05	0.05	0.05	0.13	0.13	0.13	0.29	0.41	0.41	0.43	0.07	0.07	1.10	1.10	1.10
1881	7	0.04	0.04	0.04	0.13	0.13	0.13	0.30	0.43	0.43	0.40	0.07	0.07	1.12	1.12	1.12
1881	8	0.04	0.04	0.04	0.13	0.13	0.13	0.30	0.43	0.43	0.38	0.06	0.06	1.09	1.09	1.09
1881	9	0.05	0.05	0.05	0.13	0.13	0.13	0.30	0.43	0.43	0.41	0.07	0.07	1.15	1.15	1.15
1881	10	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.38	0.06	0.06	1.13	1.13	1.13
1881	11	0.04	0.04	0.04	0.13	0.13	0.13	0.30	0.43	0.43	0.44	0.07	0.07	1.13	1.13	1.13
1881	12	0.04	0.04	0.04	0.13	0.13	0.13	0.30	0.43	0.43	0.44	0.07	0.07	1.15	1.15	1.15
1882	1	0.04	0.04	0.04	0.13	0.13	0.13	0.30	0.43	0.43	0.46	0.08	0.08	1.14	1.14	1.14
1882	2	0.04	0.04	0.04	0.13	0.13	0.13	0.30	0.43	0.43	0.46	0.08	0.08	1.12	1.12	1.12
1882	3	0.04	0.04	0.04	0.13	0.13	0.13	0.30	0.43	0.43	0.48	0.08	0.08	1.13	1.13	1.13
1882	4	0.04	0.04	0.04	0.13	0.13	0.13	0.30	0.43	0.43	0.48	0.08	0.08	1.14	1.14	1.14
1882	5	0.04	0.04	0.04	0.13	0.13	0.13	0.30	0.43	0.43	0.50	0.08	0.08	1.17	1.17	1.17
1882	6	0.04	0.04	0.04	0.13	0.13	0.13	0.30	0.43	0.43	0.56	0.09	0.09	1.15	1.15	1.15
1882	7			0.04			0.13			0.44			0.09			1.14
1882	8	0.04	0.04	0.04	0.13	0.13	0.13	0.31	0.44	0.44	0.51	0.09	0.09	1.12	1.12	1.12
1882	9			0.04			0.13			0.44			0.09			1.16
1882	10	0.04	0.04	0.04	0.13	0.13	0.13	0.31	0.44	0.44	0.57	0.10	0.10	1.20	1.20	1.20
1882	11	0.04	0.04	0.04	0.13	0.13	0.13	0.31	0.44	0.44	0.53	0.09	0.09	1.19	1.19	1.19
1882	12	0.04	0.04	0.04	0.13	0.13	0.13	0.31	0.44	0.44	0.56	0.09	0.09	1.18	1.18	1.18
1883	1	0.04	0.04	0.04	0.13	0.13	0.13	0.31	0.44	0.44	0.53	0.09	0.09	1.15	1.15	1.15
1883	2	0.04	0.04	0.04	0.13	0.13	0.13	0.31	0.44	0.44	0.56	0.09	0.09	1.19	1.19	1.19
1883	3	0.04	0.04	0.04	0.13	0.13	0.13	0.31	0.44	0.44	0.59	0.10	0.10	1.20	1.20	1.20
1883	4	0.04	0.04	0.04	0.13	0.13	0.13	0.31	0.44	0.44	0.58	0.10	0.10	1.19	1.19	1.19
1883	5	0.04	0.04	0.04	0.12	0.12	0.12	0.31	0.44	0.44	0.58	0.10	0.10	1.19	1.19	1.19
1883	6	0.04	0.04	0.04	0.13	0.13	0.13	0.31	0.44	0.44	0.56	0.09	0.09	1.17	1.17	1.17
1883	7	0.04	0.04	0.04	0.13	0.13	0.13	0.31	0.44	0.44	0.58	0.10	0.10	1.15	1.15	1.15
1883	8	0.04	0.04	0.04	0.13	0.13	0.13	0.31	0.44	0.44	0.51	0.09	0.09	1.16	1.16	1.16

Year	**M**	**F1**	**F2**	**F3**	**C1**	**C2**	**C3**	**B1**	**B2**	**B3**	**S1**	**S2**	**S3**	**O1**	**O2**	**O3**
1883	9			0.04			0.13			0.44			0.08			1.16
1883	10	0.04	0.04	0.04	0.13	0.13	0.13	0.31	0.44	0.44	0.50	0.08	0.08	1.16	1.16	1.16
1883	11	0.04	0.04	0.04	0.13	0.13	0.13	0.31	0.44	0.44	0.52	0.09	0.09	1.14	1.14	1.14
1883	12	0.04	0.04	0.04	0.13	0.13	0.13	0.30	0.43	0.43	0.51	0.09	0.09	1.14	1.14	1.14
1884	1	0.04	0.04	0.04	0.13	0.13	0.13	0.30	0.43	0.43	0.52	0.09	0.09	1.13	1.13	1.13
1884	2			0.04			0.13			0.43			0.09			1.15
1884	3	0.04	0.04	0.04	0.13	0.13	0.13	0.30	0.43	0.43	0.52	0.09	0.09	1.17	1.17	1.17
1884	4	0.04	0.04	0.04	0.13	0.13	0.13	0.30	0.43	0.43	0.52	0.09	0.09	1.17	1.17	1.17
1884	5	0.04	0.04	0.04	0.13	0.13	0.13	0.30	0.43	0.43	0.51	0.09	0.09	1.17	1.17	1.17
1884	6	0.04	0.04	0.04	0.13	0.13	0.13	0.30	0.43	0.43	0.51	0.09	0.09	1.16	1.16	1.16
1884	7	0.04	0.04	0.04	0.13	0.13	0.13	0.29	0.41	0.41	0.51	0.09	0.09	1.15	1.15	1.15
1884	8			0.04			0.13			0.41			0.08			1.14
1884	9			0.04			0.13			0.41			0.08			1.13
1884	10	0.04	0.04	0.04	0.13	0.13	0.13	0.29	0.41	0.41	0.46	0.08	0.08	1.13	1.13	1.13
1884	11	0.03	0.03	0.03	0.12	0.12	0.12	0.28	0.40	0.40	0.48	0.08	0.08	1.13	1.13	1.13
1884	12	0.03	0.03	0.03	0.12	0.12	0.12	0.28	0.40	0.40	0.48	0.08	0.08	1.22	1.22	1.22
1885	1	0.04	0.04	0.04	0.12	0.12	0.12	0.25	0.36	0.36	0.48	0.08	0.08	1.13	1.13	1.13
1885	2	0.03	0.03	0.03	0.12	0.12	0.12	0.24	0.34	0.34	0.54	0.09	0.09	1.11	1.11	1.11
1885	3	0.04	0.04	0.04	0.12	0.12	0.12	0.24	0.34	0.34	0.48	0.08	0.08	1.12	1.12	1.12
1885	4	0.03	0.03	0.03	0.12	0.12	0.12	0.24	0.34	0.34	0.42	0.07	0.07	1.12	1.12	1.12
1885	5	0.04	0.04	0.04	0.12	0.12	0.12	0.24	0.34	0.34	0.48	0.08	0.08	1.13	1.13	1.13
1885	6	0.03	0.03	0.03	0.12	0.12	0.12	0.24	0.34	0.34	0.42	0.07	0.07	1.13	1.13	1.13
1885	7	0.03	0.03	0.03	0.12	0.12	0.12	0.24	0.34	0.34	0.42	0.07	0.07	1.11	1.11	1.11
1885	8	0.03	0.03	0.03	0.12	0.12	0.12	0.24	0.34	0.34	0.42	0.07	0.07	1.12	1.12	1.12
1885	9	0.03	0.03	0.03	0.12	0.12	0.12	0.22	0.31	0.31	0.42	0.07	0.07	1.10	1.10	1.10
1885	10	0.03	0.03	0.03	0.12	0.12	0.12	0.22	0.31	0.31	0.42	0.07	0.07	1.11	1.11	1.11
1885	11	0.03	0.03	0.03	0.12	0.12	0.12	0.22	0.31	0.31	0.48	0.08	0.08	1.11	1.11	1.11
1885	12	0.04	0.04	0.04	0.12	0.12	0.12	0.23	0.33	0.33	0.48	0.08	0.08	1.08	1.08	1.08
1886	1	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.42	0.07	0.07	1.06	1.06	1.06
1886	2	0.04	0.04	0.04	0.12	0.12	0.12	0.24	0.34	0.34	0.48	0.08	0.08	1.05	1.05	1.05

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1886	3	0.04	0.04	0.04	0.12	0.12	0.12	0.24	0.34	0.34	0.42	0.07	0.07	1.04	1.04	1.04
1886	4	0.04	0.04	0.04	0.12	0.12	0.12	0.24	0.34	0.34	0.48	0.08	0.08	1.04	1.04	1.04
1886	5	0.04	0.04	0.04	0.12	0.12	0.12	0.24	0.34	0.34	0.48	0.08	0.08	1.04	1.04	1.04
1886	6	0.04	0.04	0.04	0.12	0.12	0.12	0.24	0.34	0.34	0.42	0.07	0.07	1.04	1.04	1.04
1886	7			0.04			0.12			0.34			0.07			1.14
1886	8	0.04	0.04	0.04	0.12	0.12	0.12	0.24	0.34	0.34	0.42	0.07	0.07	1.24	1.24	1.24
1886	9	0.04	0.04	0.04	0.12	0.12	0.12	0.24	0.34	0.34	0.42	0.07	0.07	0.99	0.99	0.99
1886	10	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.04	0.01	0.01	0.98	0.98	0.98
1886	11	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.42	0.07	0.07	1.02	1.02	1.02
1886	12	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.42	0.07	0.07	1.01	1.01	1.01
1887	1	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.42	0.07	0.07	1.01	1.01	1.01
1887	2	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.44	0.07	0.07	1.01	1.01	1.01
1887	3	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.44	0.07	0.07	1.01	1.01	1.01
1887	4	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.44	0.07	0.07	1.01	1.01	1.01
1887	5	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.44	0.07	0.07	1.02	1.02	1.02
1887	6	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.44	0.07	0.07	1.02	1.02	1.02
1887	7	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.44	0.07	0.07	1.00	1.00	1.00
1887	8	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.43	0.07	0.07	1.00	1.00	1.00
1887	9	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.41	0.07	0.07	1.00	1.00	1.00
1887	10	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.42	0.07	0.07	0.99	0.99	0.99
1887	11	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.43	0.07	0.07	0.98	0.98	0.98
1887	12	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.44	0.07	0.07	0.99	0.99	0.99
1888	1	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.44	0.07	0.07	0.98	0.98	0.98
1888	2	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.44	0.07	0.07	0.98	0.98	0.98
1888	3	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.45	0.08	0.08	0.99	0.99	0.99
1888	4	0.03	0.03	0.03	0.11	0.11	0.11	0.24	0.34	0.34	0.45	0.08	0.08	0.99	0.99	0.99
1888	5	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.45	0.08	0.08	0.99	0.99	0.99
1888	6	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.44	0.07	0.07	0.99	0.99	0.99
1888	7	0.03	0.03	0.03	0.11	0.11	0.11	0.24	0.34	0.34	0.44	0.07	0.07	0.98	0.98	0.98
1888	8	0.03	0.03	0.03	0.11	0.11	0.11	0.24	0.34	0.34	0.44	0.07	0.07	0.99	0.99	0.99

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1888	9	0.03	0.03	0.03	0.11	0.11	0.11	0.24	0.35	0.35	0.48	0.08	0.08	1.06	1.06	1.06
1888	10	0.03	0.03	0.03	0.11	0.11	0.11	0.25	0.35	0.35	0.46	0.08	0.08	1.06	1.06	1.06
1888	11	0.03	0.03	0.03	0.11	0.11	0.11	0.24	0.35	0.35	0.46	0.08	0.08	1.05	1.05	1.05
1888	12			0.03			0.11			0.35			0.08			1.05
1889	1	0.03	0.03	0.03	0.11	0.11	0.11	0.25	0.35	0.35	0.47	0.08	0.08	1.05	1.05	1.05
1889	2	0.03	0.03	0.03	0.11	0.11	0.11	0.25	0.35	0.35	0.48	0.08	0.08	1.04	1.04	1.04
1889	3	0.03	0.03	0.03	0.11	0.11	0.11	0.25	0.35	0.35	0.47	0.08	0.08	1.02	1.02	1.02
1889	4	0.03	0.03	0.03	0.11	0.11	0.11	0.25	0.36	0.36	0.47	0.08	0.08	1.03	1.03	1.03
1889	5	0.03	0.03	0.03	0.11	0.11	0.11	0.25	0.36	0.36	0.48	0.08	0.08	1.02	1.02	1.02
1889	6	0.03	0.03	0.03	0.11	0.11	0.11	0.25	0.36	0.36	0.49	0.08	0.08	1.04	1.04	1.04
1889	7	0.03	0.03	0.03	0.11	0.11	0.11	0.25	0.36	0.36	0.49	0.08	0.08	1.03	1.03	1.03
1889	8			0.03			0.11			0.36			0.08			1.04
1889	9	0.03	0.03	0.03	0.11	0.11	0.11	0.25	0.36	0.36	0.49	0.08	0.08	1.04	1.04	1.04
1889	10	0.03	0.03	0.03	0.11	0.11	0.11	0.24	0.34	0.34	0.48	0.08	0.08	1.04	1.04	1.04
1889	11	0.03	0.03	0.03	0.11	0.11	0.11	0.24	0.34	0.34	0.47	0.08	0.08	1.02	1.02	1.02
1889	12	0.03	0.03	0.03	0.11	0.11	0.11	0.24	0.34	0.34	0.47	0.08	0.08	1.02	1.02	1.02
1890	1	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.47	0.08	0.08	1.03	1.03	1.03
1890	2	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.45	0.08	0.08	1.04	1.04	1.04
1890	3	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.46	0.08	0.08	1.08	1.08	1.08
1890	4			0.04			0.11			0.34			0.08			1.42
1890	5	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.47	0.08	0.08	1.75	1.75	1.75
1890	6	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.47	0.08	0.08	1.07	1.07	1.07
1890	7	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.46	0.08	0.08	1.13	1.13	1.13
1890	8	0.03	0.03	0.03	0.11	0.11	0.11	0.24	0.34	0.34	0.46	0.08	0.08	1.08	1.08	1.08
1890	9			0.03			0.11			0.34			0.08			1.08
1890	10	0.03	0.03	0.03	0.11	0.11	0.11	0.24	0.34	0.34	0.46	0.08	0.08	1.08	1.08	1.08
1890	11	0.03	0.03	0.03	0.11	0.11	0.11	0.24	0.34	0.34	0.46	0.08	0.08	1.08	1.08	1.08
1890	12	0.04	0.04	0.04	0.12	0.12	0.12	0.24	0.34	0.34	0.45	0.08	0.08	1.08	1.08	1.08
1891	1	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.45	0.08	0.08	1.09	1.09	1.09
1891	2	0.04	0.04	0.04	0.10	0.10	0.10	0.25	0.36	0.36	0.45	0.08	0.08	1.08	1.08	1.08

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1891	3	0.05	0.05	0.05	0.11	0.11	0.11	0.23	0.33	0.33	0.45	0.08	0.08	1.11	1.11	1.11
1891	4	0.05	0.05	0.05	0.11	0.11	0.11	0.24	0.34	0.34	0.45	0.08	0.08	1.12	1.12	1.12
1891	5	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.47	0.08	0.08	1.12	1.12	1.12
1891	6	0.05	0.05	0.05	0.11	0.11	0.11	0.24	0.34	0.34	0.46	0.08	0.08	1.15	1.15	1.15
1891	7	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.47	0.08	0.08	1.15	1.15	1.15
1891	8			0.05			0.11			0.34			0.07			1.16
1891	9	0.05	0.05	0.05	0.11	0.11	0.11	0.24	0.34	0.34	0.42	0.07	0.07	1.16	1.16	1.16
1891	10	0.05	0.05	0.05	0.12	0.12	0.12	0.24	0.34	0.34	0.49	0.08	0.08	1.15	1.15	1.15
1891	11	0.05	0.05	0.05	0.12	0.12	0.12	0.24	0.34	0.34	0.42	0.07	0.07	1.15	1.15	1.15
1891	12	0.05	0.05	0.05	0.11	0.11	0.11	0.24	0.34	0.34	0.48	0.08	0.08	1.16	1.16	1.16
1892	1	0.04	0.04	0.04	0.12	0.12	0.12	0.24	0.34	0.34	0.42	0.07	0.07	1.18	1.18	1.18
1892	2	0.05	0.05	0.05	0.11	0.11	0.11	0.24	0.34	0.34	0.48	0.08	0.08	1.18	1.18	1.18
1892	3	0.05	0.05	0.05	0.11	0.11	0.11	0.24	0.34	0.34	0.47	0.08	0.08	1.15	1.15	1.15
1892	4	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.47	0.08	0.08	1.06	1.06	1.06
1892	5	0.05	0.05	0.05	0.11	0.11	0.11	0.24	0.34	0.34	0.45	0.08	0.08	1.13	1.13	1.13
1892	6	0.05	0.05	0.05	0.11	0.11	0.11	0.25	0.36	0.36	0.47	0.08	0.08	1.15	1.15	1.15
1892	7	0.04	0.04	0.04	0.11	0.11	0.11	0.24	0.34	0.34	0.44	0.07	0.07	1.04	1.04	1.04
1892	8	0.05	0.05	0.05	0.12	0.12	0.12	0.24	0.34	0.34	0.48	0.08	0.08	1.10	1.10	1.10
1892	9	0.06	0.06	0.06	0.11	0.11	0.11	0.24	0.34	0.34	0.47	0.08	0.08	1.12	1.12	1.12
1892	10	0.06	0.06	0.06	0.12	0.12	0.12	0.25	0.36	0.36	0.46	0.08	0.08	1.14	1.14	1.14
1892	11	0.06	0.06	0.06	0.12	0.12	0.12	0.24	0.34	0.34	0.46	0.08	0.08	1.13	1.13	1.13
1892	12			0.06			0.12			0.34			0.08			1.13
1893	1	0.05	0.05	0.05	0.12	0.12	0.12	0.24	0.34	0.34	0.48	0.08	0.08	1.13	1.13	1.13
1893	2	0.05	0.05	0.05	0.12	0.12	0.12	0.24	0.34	0.34	0.46	0.08	0.08	1.14	1.14	1.14
1893	3	0.06	0.06	0.06	0.12	0.12	0.12	0.23	0.33	0.33	0.45	0.08	0.08	1.16	1.16	1.16
1893	4			0.06			0.13	0.23	0.33	0.33			0.08			1.16
1893	5	0.06	0.06	0.06	0.13	0.13	0.13	0.23	0.33	0.33	0.48	0.08	0.08	1.16	1.16	1.16
1893	6	0.06	0.06	0.06	0.12	0.12	0.12	0.23	0.33	0.33	0.46	0.08	0.08	1.14	1.14	1.14
1893	7	0.05	0.05	0.05	0.12	0.12	0.12	0.23	0.33	0.33	0.45	0.08	0.08	1.14	1.14	1.14
1893	8			0.05			0.12			0.33			0.08			1.15

Year	**M**	**F1**	**F2**	**F3**	**C1**	**C2**	**C3**	**B1**	**B2**	**B3**	**S1**	**S2**	**S3**	**O1**	**O2**	**O3**
1893	9	0.05	0.05	0.05	0.12	0.12	0.12	0.23	0.33	0.33	0.48	0.08	0.08	1.15	1.15	1.15
1893	10	0.05	0.05	0.05	0.12	0.12	0.12	0.23	0.33	0.33	0.48	0.08	0.08	1.15	1.15	1.15
1893	11	0.05	0.05	0.05	0.12	0.12	0.12	0.23	0.33	0.33	0.48	0.08	0.08	1.16	1.16	1.16
1893	12	0.05	0.05	0.05	0.12	0.12	0.12	0.23	0.33	0.33	0.48	0.08	0.08	1.16	1.16	1.16
1894	1	0.05	0.05	0.05	0.12	0.12	0.12	0.23	0.33	0.33	0.48	0.08	0.08	1.17	1.17	1.17
1894	2	0.05	0.05	0.05	0.12	0.12	0.12	0.24	0.34	0.34	0.48	0.08	0.08	1.18	1.18	1.18
1894	3	0.05	0.05	0.05	0.12	0.12	0.12	0.24	0.34	0.34	0.48	0.08	0.08	1.17	1.17	1.17
1894	4	0.05	0.05	0.05	0.12	0.12	0.12	0.24	0.34	0.34	0.48	0.08	0.08	1.19	1.19	1.19
1894	5			0.05			0.12			0.34			0.08			1.18
1894	6	0.05	0.05	0.05	0.12	0.12	0.12	0.23	0.33	0.33	0.48	0.08	0.08	1.16	1.16	1.16
1894	7	0.05	0.05	0.05	0.12	0.12	0.12	0.23	0.33	0.33	0.48	0.08	0.08	1.16	1.16	1.16
1894	8			0.05			0.12			0.34			0.08			1.15
1894	9	0.05	0.05	0.05	0.12	0.12	0.12	0.24	0.34	0.34	0.45	0.08	0.08	1.14	1.14	1.14
1894	10	0.04	0.04	0.04	0.12	0.12	0.12	0.23	0.33	0.33	0.42	0.07	0.07	1.13	1.13	1.13
1894	11	0.04	0.04	0.04	0.12	0.12	0.12	0.23	0.33	0.33	0.46	0.08	0.08	1.13	1.13	1.13
1894	12	0.04	0.04	0.04	0.12	0.12	0.12	0.23	0.33	0.33	0.46	0.08	0.08	1.14	1.14	1.14
1895	1	0.04	0.04	0.04	0.12	0.12	0.12	0.23	0.33	0.33	0.46	0.08	0.08	1.14	1.14	1.14
1895	2	0.04	0.04	0.04	0.12	0.12	0.12	0.23	0.33	0.33	0.47	0.08	0.08	1.15	1.15	1.15
1895	3	0.04	0.04	0.04	0.12	0.12	0.12	0.23	0.33	0.33	0.46	0.08	0.08	1.15	1.15	1.15
1895	4	0.04	0.04	0.04	0.12	0.12	0.12	0.23	0.33	0.33	0.46	0.08	0.08	0.15	0.15	0.15
1895	5			0.04			0.12			0.33			0.08			0.65
1895	6	0.04	0.04	0.04	0.11	0.11	0.11	0.23	0.33	0.33	0.48	0.08	0.08	1.14	1.14	1.14
1895	7	0.04	0.04	0.04	0.11	0.11	0.11	0.23	0.33	0.33	0.42	0.07	0.07	1.13	1.13	1.13
1895	8	0.04	0.04	0.04	0.12	0.12	0.12	0.23	0.33	0.33	0.42	0.07	0.07	1.13	1.13	1.13
1895	9			0.05			0.12			0.33			0.07			1.13
1895	10	0.05	0.05	0.05	0.12	0.12	0.12	0.23	0.33	0.33	0.42	0.07	0.07	1.13	1.13	1.13
1895	11	0.04	0.04	0.04	0.11	0.11	0.11	0.23	0.33	0.33	0.42	0.07	0.07	1.15	1.15	1.15
1895	12	0.04	0.04	0.04	0.12	0.12	0.12	0.23	0.33	0.33	0.42	0.07	0.07	1.14	1.14	1.14
1896	1	0.05	0.05	0.05	0.12	0.12	0.12	0.23	0.33	0.33	0.42	0.07	0.07	1.12	1.12	1.12
1896	2	0.05	0.05	0.05	0.12	0.12	0.12	0.23	0.33	0.33	0.42	0.07	0.07	1.14	1.14	1.14

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1896	3			0.05			0.12			0.33			0.07			1.14
1896	4	0.05	0.05	0.05	0.12	0.12	0.12	0.23	0.33	0.33	0.42	0.07	0.07	1.13	1.13	1.13
1896	5	0.05	0.05	0.05	0.12	0.12	0.12	0.24	0.34	0.34	0.42	0.07	0.07	1.13	1.13	1.13
1896	6	0.05	0.05	0.05	0.12	0.12	0.12	0.24	0.34	0.34	0.42	0.07	0.07	1.13	1.13	1.13
1896	7			0.05			0.12			0.34			0.07			1.12
1896	8	0.05	0.05	0.05	0.11	0.11	0.11	0.24	0.34	0.34	0.42	0.07	0.07	1.10	1.10	1.10
1896	9	0.05	0.05	0.05	0.11	0.11	0.11	0.24	0.34	0.34	0.42	0.07	0.07	1.10	1.10	1.10
1896	10			0.05			0.11			0.34			0.07			1.11
1896	11	0.05	0.05	0.05	0.11	0.11	0.11	0.24	0.34	0.34	0.45	0.08	0.08	1.11	1.11	1.11
1896	12	0.05	0.05	0.05	0.12	0.12	0.12	0.24	0.34	0.34	0.48	0.08	0.08	1.16	1.16	1.16
1897	1	0.05	0.05	0.05	0.12	0.12	0.12	0.24	0.34	0.34	0.48	0.08	0.08	1.17	1.17	1.17
1897	2	0.05	0.05	0.05	0.12	0.12	0.12	0.25	0.36	0.36	0.48	0.08	0.08	1.20	1.20	1.20
1897	3			0.05			0.12			0.36			0.08			1.21
1897	4	0.05	0.05	0.05	0.12	0.12	0.12	0.25	0.36	0.36	0.48	0.08	0.08	1.22	1.22	1.22
1897	5			0.05			0.12			0.36			0.08			1.23
1897	6	0.05	0.05	0.05	0.12	0.12	0.12	0.26	0.37	0.37	0.48	0.08	0.08	1.24	1.24	1.24
1897	7	0.05	0.05	0.05	0.12	0.12	0.12	0.25	0.36	0.36	0.48	0.08	0.08	1.24	1.24	1.24
1897	8	0.05	0.05	0.05	0.12	0.12	0.12	0.25	0.36	0.36	0.48	0.08	0.08	1.25	1.25	1.25
1897	9			0.05			0.12			0.37			0.08			1.28
1897	10	0.04	0.04	0.04	0.12	0.12	0.12	0.27	0.39	0.39	0.48	0.08	0.08	1.30	1.30	1.30
1897	11	0.04	0.04	0.04	0.12	0.12	0.12	0.27	0.39	0.39	0.48	0.08	0.08	1.29	1.29	1.29
1897	12			0.04			0.12			0.39			0.08			1.28
1898	1	0.04	0.04	0.04	0.12	0.12	0.12	0.27	0.39	0.39	0.48	0.08	0.08	1.27	1.27	1.27
1898	2	0.04	0.04	0.04	0.12	0.12	0.12	0.27	0.39	0.39	0.48	0.08	0.08	1.26	1.26	1.26
1898	3			0.04			0.12			0.39			0.08			1.27
1898	4	0.04	0.04	0.04	0.12	0.12	0.12	0.27	0.39	0.39	0.48	0.08	0.08	1.27	1.27	1.27
1898	5	0.04	0.04	0.04	0.12	0.12	0.12	0.28	0.40	0.40	0.48	0.08	0.08	1.28	1.28	1.28
1898	6	0.04	0.04	0.04	0.12	0.12	0.12	0.29	0.41	0.41	0.48	0.08	0.08	1.29	1.29	1.29
1898	7	0.04	0.04	0.04	0.12	0.12	0.12	0.29	0.41	0.41	0.48	0.08	0.08	1.30	1.30	1.30
1898	8	0.04	0.04	0.04	0.12	0.12	0.12	0.29	0.41	0.41	0.48	0.08	0.08	1.30	1.30	1.30

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1898	9			0.04			0.13			0.41			0.08			1.29
1898	10	0.04	0.04	0.04	0.13	0.13	0.13	0.29	0.41	0.41	0.46	0.08	0.08	1.27	1.27	1.27
1898	11	0.04	0.04	0.04	0.12	0.12	0.12	0.29	0.41	0.41	0.45	0.08	0.08	1.27	1.27	1.27
1898	12	0.04	0.04	0.04	0.12	0.12	0.12	0.28	0.40	0.40	0.42	0.07	0.07	1.27	1.27	1.27
1899	1	0.04	0.04	0.04	0.12	0.12	0.12	0.29	0.41	0.41	0.48	0.08	0.08	1.27	1.27	1.27
1899	2	0.04	0.04	0.04	0.13	0.13	0.13	0.29	0.41	0.41	0.48	0.08	0.08	1.25	1.25	1.25
1899	3	0.04	0.04	0.04	0.13	0.13	0.13	0.29	0.41	0.41	0.48	0.08	0.08	1.24	1.24	1.24
1899	4	0.04	0.04	0.04	0.13	0.13	0.13	0.29	0.41	0.41	0.48	0.08	0.08	1.24	1.24	1.24
1899	5	0.05	0.05	0.05	0.13	0.13	0.13	0.29	0.41	0.41	0.48	0.08	0.08	1.24	1.24	1.24
1899	6	0.04	0.04	0.04	0.13	0.13	0.13	0.29	0.41	0.41	0.48	0.08	0.08	1.22	1.22	1.22
1899	7	0.04	0.04	0.04	0.13	0.13	0.13	0.28	0.40	0.40	0.48	0.08	0.08	1.25	1.25	1.25
1899	8			0.04			0.13			0.39			0.08			1.25
1899	9	0.04	0.04	0.04	0.12	0.12	0.12	0.27	0.39	0.39	0.48	0.08	0.08	1.24	1.24	1.24
1899	10	0.04	0.04	0.04	0.12	0.12	0.12	0.28	0.40	0.40	0.48	0.08	0.08	1.25	1.25	1.25
1899	11	0.05	0.05	0.05	0.13	0.13	0.13	0.28	0.40	0.40	0.48	0.08	0.08	1.25	1.25	1.25
1899	12	0.05	0.05	0.05	0.13	0.13	0.13	0.28	0.40	0.40	0.48	0.08	0.08	1.25	1.25	1.25
1900	1	0.05	0.05	0.05	0.13	0.13	0.13	0.28	0.40	0.40	0.48	0.08	0.08	1.25	1.25	1.25
1900	2	0.05	0.05	0.05	0.13	0.13	0.13	0.28	0.40	0.40	0.48	0.08	0.08	1.27	1.27	1.27
1900	3			0.05			0.13			0.40			0.08			1.28
1900	4	0.05	0.05	0.05	0.13	0.13	0.13	0.28	0.40	0.40	0.48	0.08	0.08	1.28	1.28	1.28
1900	5	0.05	0.05	0.05	0.12	0.12	0.12	0.28	0.40	0.40	0.48	0.08	0.08	1.29	1.29	1.29
1900	6	0.05	0.05	0.05	0.12	0.12	0.12	0.28	0.40	0.40	0.48	0.08	0.08	1.29	1.29	1.29
1900	7	0.05	0.05	0.05	0.12	0.12	0.12	0.28	0.40	0.40	0.48	0.08	0.08	1.28	1.28	1.28
1900	8	0.05	0.05	0.05	0.13	0.13	0.13	0.28	0.40	0.40	0.48	0.08	0.08	1.28	1.28	1.28
1900	9	0.05	0.05	0.05	0.13	0.13	0.13	0.28	0.40	0.40	0.42	0.07	0.07	1.26	1.26	1.26
1900	10	0.05	0.05	0.05	0.13	0.13	0.13	0.28	0.40	0.40	0.48	0.08	0.08	1.28	1.28	1.28
1900	11	0.04	0.04	0.04	0.13	0.13	0.13	0.28	0.40	0.40	0.48	0.08	0.08	1.27	1.27	1.27
1900	12	0.04	0.04	0.04	0.13	0.13	0.13	0.29	0.41	0.41	0.48	0.08	0.08	1.29	1.29	1.29
1901	1	0.03	0.03	0.03	0.13	0.13	0.13	0.28	0.40	0.40	0.42	0.07	0.07	1.28	1.28	1.28
1901	2			0.04			0.13			0.40			0.07			1.29

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1901	3	0.04	0.04	0.04	0.13	0.13	0.13	0.28	0.40	0.40	0.42	0.07	0.07	1.30	1.30	1.30
1901	4	0.04	0.04	0.04	0.13	0.13	0.13	0.28	0.40	0.40	0.48	0.08	0.08	1.31	1.31	1.31
1901	5	0.03	0.03	0.03	0.13	0.13	0.13	0.28	0.40	0.40	0.07	0.01	0.01	1.31	1.31	1.31
1901	6	0.03	0.03	0.03	0.13	0.13	0.13	0.28	0.40	0.40	0.42	0.07	0.07	1.28	1.28	1.28
1901	7	0.03	0.03	0.03	0.13	0.13	0.13	0.27	0.39	0.39	0.42	0.07	0.07	1.27	1.27	1.27
1901	8	0.03	0.03	0.03	0.13	0.13	0.13	0.28	0.40	0.40	0.42	0.07	0.07	1.28	1.28	1.28
1901	9	0.03	0.03	0.03	0.13	0.13	0.13	0.27	0.39	0.39	0.42	0.07	0.07	1.29	1.29	1.29
1901	10	0.04	0.04	0.04	0.13	0.13	0.13	0.27	0.39	0.39	0.42	0.07	0.07	1.29	1.29	1.29
1901	11	0.04	0.04	0.04	0.13	0.13	0.13	0.28	0.40	0.40	0.42	0.07	0.07	1.29	1.29	1.29
1901	12	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.36	0.06	0.06	1.29	1.29	1.29
1902	1	0.04	0.04	0.04	0.13	0.13	0.13	0.28	0.40	0.40	0.42	0.07	0.07	1.29	1.29	1.29
1902	2	0.03	0.03	0.03	0.13	0.13	0.13	0.27	0.39	0.39	0.48	0.08	0.08	1.39	1.39	1.39
1902	3	0.03	0.03	0.03	0.13	0.13	0.13	0.27	0.39	0.39	0.36	0.06	0.06	1.32	1.32	1.32
1902	4	0.03	0.03	0.03	0.13	0.13	0.13	0.27	0.39	0.39	0.36	0.06	0.06	1.31	1.31	1.31
1902	5	0.03	0.03	0.03	0.13	0.13	0.13	0.27	0.39	0.39	0.36	0.06	0.06	1.30	1.30	1.30
1902	6	0.03	0.03	0.03	0.13	0.13	0.13	0.26	0.37	0.37	0.36	0.06	0.06	1.28	1.28	1.28
1902	7	0.03	0.03	0.03	0.14	0.14	0.14	0.26	0.37	0.37	0.36	0.06	0.06	1.24	1.24	1.24
1902	8	0.03	0.03	0.03	0.14	0.14	0.14	0.25	0.36	0.36	0.36	0.06	0.06	1.21	1.21	1.21
1902	9	0.03	0.03	0.03	0.14	0.14	0.14	0.25	0.36	0.36	0.36	0.06	0.06	1.21	1.21	1.21
1902	10	0.03	0.03	0.03	0.14	0.14	0.14	0.25	0.36	0.36	0.36	0.06	0.06	1.21	1.21	1.21
1902	11	0.03	0.03	0.03	0.14	0.14	0.14	0.25	0.36	0.36	0.36	0.06	0.06	1.20	1.20	1.20
1902	12	0.03	0.03	0.03	0.14	0.14	0.14	0.25	0.36	0.36	0.36	0.06	0.06	1.21	1.21	1.21
1903	1	0.03	0.03	0.03	0.13	0.13	0.13	0.28	0.40	0.40	0.36	0.06	0.06	1.20	1.20	1.20
1903	2	0.03	0.03	0.03	0.13	0.13	0.13	0.26	0.37	0.37	0.36	0.06	0.06	1.21	1.21	1.21
1903	3	0.03	0.03	0.03	0.14	0.14	0.14	0.28	0.40	0.40	0.36	0.06	0.06	1.21	1.21	1.21
1903	4	0.03	0.03	0.03	0.14	0.14	0.14	0.27	0.39	0.39	0.36	0.06	0.06	1.21	1.21	1.21
1903	5	0.03	0.03	0.03	0.14	0.14	0.14	0.27	0.39	0.39	0.36	0.06	0.06	1.21	1.21	1.21
1903	6	0.03	0.03	0.03	0.14	0.14	0.14	0.28	0.40	0.40	0.36	0.06	0.06	1.21	1.21	1.21
1903	7	0.03	0.03	0.03	0.14	0.14	0.14	0.27	0.39	0.39	0.36	0.06	0.06	1.21	1.21	1.21
1903	8	0.03	0.03	0.03	0.14	0.14	0.14	0.27	0.39	0.39	0.36	0.06	0.06	1.19	1.19	1.19

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1903	9	0.03	0.03	0.03	0.14	0.14	0.14	0.27	0.39	0.39	0.36	0.06	0.06	1.19	1.19	1.19
1903	10	0.03	0.03	0.03	0.14	0.14	0.14	0.27	0.39	0.39	0.36	0.06	0.06	1.19	1.19	1.19
1903	11	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.36	0.06	0.06	1.19	1.19	1.19
1903	12	0.03	0.03	0.03	0.14	0.14	0.14	0.27	0.39	0.39	0.36	0.06	0.06	1.19	1.19	1.19
1904	1	0.03	0.03	0.03	0.14	0.14	0.14	0.27	0.39	0.39	0.36	0.06	0.06	1.20	1.20	1.20
1904	2	0.03	0.03	0.03	0.14	0.14	0.14	0.27	0.39	0.39	0.38	0.06	0.06	1.19	1.19	1.19
1904	3	0.03	0.03	0.03	0.14	0.14	0.14	0.28	0.40	0.40	0.36	0.06	0.06	1.19	1.19	1.19
1904	4	0.03	0.03	0.03	0.14	0.14	0.14	0.28	0.40	0.40	0.36	0.06	0.06	1.20	1.20	1.20
1904	5	0.03	0.03	0.03	0.13	0.13	0.13	0.28	0.40	0.40	0.36	0.06	0.06	1.20	1.20	1.20
1904	6			0.03			0.13			0.40			0.06			1.20
1904	7	0.03	0.03	0.03	0.13	0.13	0.13	0.28	0.40	0.40	0.36	0.06	0.06	1.20	1.20	1.20
1904	8	0.03	0.03	0.03	0.13	0.13	0.13	0.28	0.40	0.40	0.36	0.06	0.06	1.17	1.17	1.17
1904	9	0.03	0.03	0.03	0.13	0.13	0.13	0.28	0.40	0.40	0.36	0.06	0.06	1.19	1.19	1.19
1904	10	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.36	0.06	0.06	1.20	1.20	1.20
1904	11	0.04	0.04	0.04	0.13	0.13	0.13	0.28	0.40	0.40	0.36	0.06	0.06	1.20	1.20	1.20
1904	12	0.04	0.04	0.04	0.13	0.13	0.13	0.28	0.40	0.40	0.36	0.06	0.06	1.20	1.20	1.20
1905	1	0.04	0.04	0.04	0.13	0.13	0.13	0.28	0.40	0.40	0.36	0.06	0.06	1.20	1.20	1.20
1905	2	0.04	0.04	0.04	0.13	0.13	0.13	0.28	0.40	0.40	0.36	0.06	0.06	1.20	1.20	1.20
1905	3	0.04	0.04	0.04	0.14	0.14	0.14	0.27	0.39	0.39	0.48	0.08	0.08	1.20	1.20	1.20
1905	4	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.54	0.09	0.09	1.21	1.21	1.21
1905	5	0.04	0.04	0.04	0.14	0.14	0.14	0.27	0.39	0.39	0.54	0.09	0.09	1.20	1.20	1.20
1905	6			0.04			0.14			0.39			0.09			1.20
1905	7	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.54	0.09	0.09	1.19	1.19	1.19
1905	8	0.04	0.04	0.04	0.15	0.15	0.15	0.28	0.40	0.40	0.54	0.09	0.09	1.19	1.19	1.19
1905	9			0.04			0.15			0.40			0.10			1.21
1905	10	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.60	0.10	0.10	1.23	1.23	1.23
1905	11	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.60	0.10	0.10	1.26	1.26	1.26
1905	12	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.62	0.10	0.10	1.26	1.26	1.26
1906	1	0.04	0.04	0.04	0.15	0.15	0.15	0.28	0.40	0.40	0.66	0.11	0.11	1.26	1.26	1.26
1906	2	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.60	0.10	0.10	1.25	1.25	1.25

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1906	3	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.66	0.11	0.11	1.25	1.25	1.25
1906	4	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.66	0.11	0.11	1.26	1.26	1.26
1906	5	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.66	0.11	0.11	1.26	1.26	1.26
1906	6	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.66	0.11	0.11	1.26	1.26	1.26
1906	7	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.60	0.10	0.10	1.26	1.26	1.26
1906	8	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.54	0.09	0.09	1.26	1.26	1.26
1906	9	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.54	0.09	0.09	1.27	1.27	1.27
1906	10	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.54	0.09	0.09	1.27	1.27	1.27
1906	11	0.04	0.04	0.04	0.15	0.15	0.15	0.26	0.37	0.37	0.54	0.09	0.09	1.35	1.35	1.35
1906	12	0.05	0.05	0.05	0.14	0.14	0.14	0.25	0.36	0.36	0.48	0.08	0.08	1.38	1.38	1.38
1907	1	0.04	0.04	0.04	0.14	0.14	0.14	0.25	0.36	0.36	0.48	0.08	0.08	1.38	1.38	1.38
1907	2	0.04	0.04	0.04	0.14	0.14	0.14	0.25	0.36	0.36	0.48	0.08	0.08	1.39	1.39	1.39
1907	3	0.04	0.04	0.04	0.14	0.14	0.14	0.25	0.36	0.36	0.48	0.08	0.08	1.40	1.40	1.40
1907	4	0.04	0.04	0.04	0.14	0.14	0.14	0.27	0.39	0.39	0.48	0.08	0.08	1.40	1.40	1.40
1907	5	0.04	0.04	0.04	0.14	0.14	0.14	0.27	0.39	0.39	0.54	0.09	0.09	1.41	1.41	1.41
1907	6	0.04	0.04	0.04	0.15	0.15	0.15	0.26	0.37	0.37	0.54	0.09	0.09	1.44	1.44	1.44
1907	7	0.04	0.04	0.04	0.15	0.15	0.15	0.26	0.37	0.37	0.54	0.09	0.09	1.43	1.43	1.43
1907	8	0.04	0.04	0.04	0.15	0.15	0.15	0.26	0.37	0.37	0.54	0.09	0.09	1.44	1.44	1.44
1907	9	0.04	0.04	0.04	0.15	0.15	0.15	0.26	0.37	0.37	0.50	0.08	0.08	1.44	1.44	1.44
1907	10	0.04	0.04	0.04	0.15	0.15	0.15	0.26	0.37	0.37	0.51	0.09	0.09	1.41	1.41	1.41
1907	11	0.04	0.04	0.04	0.15	0.15	0.15	0.26	0.37	0.37	0.54	0.09	0.09	1.44	1.44	1.44
1907	12	0.04	0.04	0.04	0.15	0.15	0.15	0.26	0.37	0.37	0.51	0.09	0.09	1.45	1.45	1.45
1908	1	0.04	0.04	0.04	0.15	0.15	0.15	0.26	0.37	0.37	0.51	0.09	0.09	1.45	1.45	1.45
1908	2			0.04			0.15			0.37			0.09			1.45
1908	3	0.04	0.04	0.04	0.15	0.15	0.15	0.26	0.37	0.37	0.54	0.09	0.09	1.45	1.45	1.45
1908	4	0.04	0.04	0.04	0.15	0.15	0.15	0.26	0.37	0.37	0.54	0.09	0.09	1.41	1.41	1.41
1908	5	0.04	0.04	0.04	0.15	0.15	0.15	0.26	0.37	0.37	0.54	0.09	0.09	1.39	1.39	1.39
1908	6	0.04	0.04	0.04	0.15	0.15	0.15	0.27	0.39	0.39	0.54	0.09	0.09	1.40	1.40	1.40
1908	7	0.04	0.04	0.04	0.15	0.15	0.15	0.27	0.39	0.39	0.54	0.09	0.09	1.37	1.37	1.37
1908	8	0.04	0.04	0.04	0.15	0.15	0.15	0.27	0.39	0.39	0.48	0.08	0.08	1.35	1.35	1.35

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1908	9	0.04	0.04	0.04	0.15	0.15	0.15	0.27	0.39	0.39	0.48	0.08	0.08	1.34	1.34	1.34
1908	10	0.04	0.04	0.04	0.15	0.15	0.15	0.27	0.39	0.39	0.48	0.08	0.08	1.37	1.37	1.37
1908	11	0.04	0.04	0.04	0.15	0.15	0.15	0.28	0.40	0.40	0.48	0.08	0.08	1.40	1.40	1.40
1908	12	0.04	0.04	0.04	0.15	0.15	0.15	0.27	0.39	0.39	0.48	0.08	0.08	1.41	1.41	1.41
1909	1	0.04	0.04	0.04	0.15	0.15	0.15	0.27	0.39	0.39	0.48	0.08	0.08	1.41	1.41	1.41
1909	2	0.04	0.04	0.04	0.15	0.15	0.15	0.27	0.39	0.39	0.48	0.08	0.08	1.51	1.51	1.51
1909	3	0.04	0.04	0.04	0.15	0.15	0.15	0.27	0.39	0.39	0.48	0.08	0.08	1.57	1.57	1.57
1909	4			0.04			0.15			0.39			0.09			1.57
1909	5	0.04	0.04	0.04	0.15	0.15	0.15	0.28	0.40	0.40	0.54	0.09	0.09	1.57	1.57	1.57
1909	6	0.04	0.04	0.04	0.15	0.15	0.15	0.28	0.40	0.40	0.51	0.09	0.09	1.57	1.57	1.57
1909	7			0.04			0.15			0.39			0.09			1.56
1909	8	0.04	0.04	0.04	0.15	0.15	0.15	0.27	0.39	0.39	0.51	0.09	0.09	1.55	1.55	1.55
1909	9			0.04			0.15			0.39			0.08			1.55
1909	10	0.04	0.04	0.04	0.15	0.15	0.15	0.27	0.39	0.39	0.48	0.08	0.08	1.55	1.55	1.55
1909	11	0.04	0.04	0.04	0.15	0.15	0.15	0.27	0.39	0.39	0.48	0.08	0.08	1.55	1.55	1.55
1909	12	0.04	0.04	0.04	0.15	0.15	0.15	0.28	0.40	0.40	0.48	0.08	0.08	1.56	1.56	1.56
1910	1	0.04	0.04	0.04	0.15	0.15	0.15	0.27	0.39	0.39	0.48	0.08	0.08	1.53	1.53	1.53
1910	2	0.04	0.04	0.04	0.15	0.15	0.15	0.28	0.40	0.40	0.48	0.08	0.08	1.50	1.50	1.50
1910	3	0.04	0.04	0.04	0.15	0.15	0.15	0.27	0.39	0.39	0.48	0.08	0.08	1.52	1.52	1.52
1910	4	0.04	0.04	0.04	0.15	0.15	0.15	0.28	0.40	0.40	0.48	0.08	0.08	1.50	1.50	1.50
1910	5	0.04	0.04	0.04	0.15	0.15	0.15	0.28	0.40	0.40	0.48	0.08	0.08	1.48	1.48	1.48
1910	6	0.04	0.04	0.04	0.15	0.15	0.15	0.28	0.40	0.40	0.48	0.08	0.08	1.46	1.46	1.46
1910	7	0.04	0.04	0.04	0.15	0.15	0.15	0.28	0.40	0.40	0.48	0.08	0.08	1.45	1.45	1.45
1910	8	0.04	0.04	0.04	0.15	0.15	0.15	0.28	0.40	0.40	0.48	0.08	0.08	1.48	1.48	1.48
1910	9	0.04	0.04	0.04	0.15	0.15	0.15	0.28	0.40	0.40	0.48	0.08	0.08	1.47	1.47	1.47
1910	10	0.04	0.04	0.04	0.15	0.15	0.15	0.28	0.40	0.40	0.48	0.08	0.08	1.45	1.45	1.45
1910	11	0.04	0.04	0.04	0.15	0.15	0.15	0.27	0.39	0.39	0.48	0.08	0.08	1.48	1.48	1.48
1910	12	0.04	0.04	0.04	0.14	0.14	0.14	0.27	0.39	0.39	0.48	0.08	0.08	1.50	1.50	1.50
1911	1	0.05	0.05	0.05	0.14	0.14	0.14	0.27	0.39	0.39	0.48	0.08	0.08	1.55	1.55	1.55
1911	2			0.06			0.15			0.39			0.08			1.56

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1911	3	0.06	0.06	0.06	0.15	0.15	0.15	0.27	0.39	0.39	0.48	0.08	0.08	1.57	1.57	1.57
1911	4	0.05	0.05	0.05	0.15	0.15	0.15	0.27	0.39	0.39	0.48	0.08	0.08	1.58	1.58	1.58
1911	5	0.04	0.04	0.04	0.15	0.15	0.15	0.27	0.39	0.39	0.48	0.08	0.08	1.60	1.60	1.60
1911	6	0.04	0.04	0.04	0.15	0.15	0.15	0.27	0.39	0.39	0.48	0.08	0.08	1.55	1.55	1.55
1911	7			0.04			0.15			0.39			0.08			1.54
1911	8	0.04	0.04	0.04	0.15	0.15	0.15	0.27	0.39	0.39	0.48	0.08	0.08	1.53	1.53	1.53
1911	9	0.04	0.04	0.04	0.15	0.15	0.15	0.27	0.39	0.39	0.48	0.08	0.08	1.53	1.53	1.53
1911	10	0.04	0.04	0.04	0.15	0.15	0.15	0.27	0.39	0.39	0.48	0.08	0.08	1.50	1.50	1.50
1911	11			0.04			0.15			0.38			0.08			1.49
1911	12	0.04	0.04	0.04	0.15	0.15	0.15	0.26	0.37	0.37	0.48	0.08	0.08	1.48	1.48	1.48
1912	1	0.04	0.04	0.04	0.15	0.15	0.15	0.26	0.37	0.37	0.48	0.08	0.08	1.50	1.50	1.50
1912	2	0.04	0.04	0.04	0.15	0.15	0.15	0.26	0.37	0.37	0.48	0.08	0.08	1.45	1.45	1.45
1912	3			0.04			0.15			0.37			0.08			1.44
1912	4	0.04	0.04	0.04	0.15	0.15	0.15	0.26	0.37	0.37	0.48	0.08	0.08	1.43	1.43	1.43
1912	5			0.04			0.15			0.37			0.08			1.43
1912	6	0.04	0.04	0.04	0.15	0.15	0.15	0.26	0.37	0.37	0.48	0.08	0.08	1.42	1.42	1.42
1912	7	0.04	0.04	0.04	0.15	0.15	0.15	0.26	0.37	0.37	0.48	0.08	0.08	1.40	1.40	1.40
1912	8	0.04	0.04	0.04	0.15	0.15	0.15	0.26	0.37	0.37	0.48	0.08	0.08	1.40	1.40	1.40
1912	9			0.04			0.15			0.37			0.08			1.42
1912	10	0.04	0.04	0.04	0.15	0.15	0.15	0.26	0.37	0.37	0.48	0.08	0.08	1.43	1.43	1.43
1912	11	0.04	0.04	0.04	0.15	0.15	0.15	0.26	0.37	0.37	0.48	0.08	0.08	1.43	1.43	1.43
1912	12	0.04	0.04	0.04	0.15	0.15	0.15	0.27	0.39	0.39	0.48	0.08	0.08	1.44	1.44	1.44
1913	1	0.04	0.04	0.04	0.15	0.15	0.15	0.27	0.39	0.39	0.48	0.08	0.08	1.47	1.47	1.47
1913	2	0.04	0.04	0.04	0.15	0.15	0.15	0.27	0.39	0.39	0.48	0.08	0.08	1.50	1.50	1.50
1913	3	0.05	0.05	0.05	0.15	0.15	0.15	0.27	0.39	0.39	0.48	0.08	0.08	1.45	1.45	1.45
1913	4	0.04	0.04	0.04	0.14	0.14	0.14	0.27	0.39	0.39	0.48	0.08	0.08	1.50	1.50	1.50
1913	5	0.04	0.04	0.04	0.14	0.14	0.14	0.27	0.39	0.39	0.48	0.08	0.08	1.47	1.47	1.47
1913	6	0.04	0.04	0.04	0.14	0.14	0.14	0.25	0.36	0.36	0.48	0.08	0.08	1.45	1.45	1.45
1913	7	0.04	0.04	0.04	0.14	0.14	0.14	0.24	0.34	0.34	0.48	0.08	0.08	1.47	1.47	1.47
1913	8	0.04	0.04	0.04	0.14	0.14	0.14	0.24	0.34	0.34	0.48	0.08	0.08	1.50	1.50	1.50

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1913	9	0.04	0.04	0.04	0.14	0.14	0.14	0.25	0.36	0.36	0.48	0.08	0.08	1.48	1.48	1.48
1913	10	0.04	0.04	0.04	0.14	0.14	0.14	0.26	0.37	0.37	0.48	0.08	0.08	1.47	1.47	1.47
1913	11	0.04	0.04	0.04	0.14	0.14	0.14	0.26	0.37	0.37	0.48	0.08	0.08	1.52	1.52	1.52
1913	12	0.04	0.04	0.04	0.14	0.14	0.14	0.26	0.37	0.37	0.48	0.08	0.08	1.45	1.45	1.45
1914	1	0.04	0.04	0.04	0.14	0.14	0.14	0.26	0.37	0.37	0.48	0.08	0.08	1.44	1.44	1.44
1914	2	0.04	0.04	0.04	0.14	0.14	0.14	0.25	0.36	0.36	0.48	0.08	0.08	1.43	1.43	1.43
1914	3	0.04	0.04	0.04	0.14	0.14	0.14	0.27	0.39	0.39	0.48	0.08	0.08	1.43	1.43	1.43
1914	4	0.04	0.04	0.04	0.14	0.14	0.14	0.27	0.39	0.39	0.48	0.08	0.08	1.44	1.44	1.44
1914	5	0.04	0.04	0.04	0.14	0.14	0.14	0.27	0.39	0.39	0.48	0.08	0.08	1.44	1.44	1.44
1914	6	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.48	0.08	0.08	1.44	1.44	1.44
1914	7	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.48	0.08	0.08	1.44	1.44	1.44
1914	8	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.48	0.08	0.08	1.44	1.44	1.44
1914	9	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.48	0.08	0.08	1.44	1.44	1.44
1914	10	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.48	0.08	0.08	1.44	1.44	1.44
1914	11	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.48	0.08	0.08	1.44	1.44	1.44
1914	12			0.04			0.14			0.40			0.08			1.44
1915	1	0.04	0.04	0.04	0.14	0.14	0.14	0.28	0.40	0.40	0.48	0.08	0.08	1.44	1.44	1.44
1915	2	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.48	0.08	0.08	1.41	1.41	1.41
1915	3	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.48	0.08	0.08	1.41	1.41	1.41
1915	4	0.04	0.04	0.04	0.14	0.14	0.14	0.29	0.41	0.41	0.40	0.07	0.07	1.42	1.42	1.42
1915	5	0.04	0.04	0.04	0.14	0.14	0.14	0.30	0.43	0.43	0.48	0.08	0.08	1.41	1.41	1.41
1915	6	0.04	0.04	0.04	0.14	0.14	0.14	0.30	0.43	0.43	0.48	0.08	0.08	1.41	1.41	1.41
1915	7	0.04	0.04	0.04	0.14	0.14	0.14	0.30	0.43	0.43	0.48	0.08	0.08	1.42	1.42	1.42
1915	8	0.04	0.04	0.04	0.14	0.14	0.14	0.30	0.43	0.43	0.48	0.08	0.08	1.41	1.41	1.41
1915	9	0.04	0.04	0.04	0.14	0.14	0.14	0.30	0.43	0.43	0.48	0.08	0.08	1.39	1.39	1.39
1915	10	0.04	0.04	0.04	0.14	0.14	0.14	0.30	0.43	0.43	0.48	0.08	0.08	1.40	1.40	1.40
1915	11	0.04	0.04	0.04	0.14	0.14	0.14	0.30	0.43	0.43	0.48	0.08	0.08	1.39	1.39	1.39
1915	12	0.04	0.04	0.04	0.15	0.15	0.15	0.30	0.43	0.43	0.48	0.08	0.08	1.39	1.39	1.39
1916	1	0.04	0.04	0.04	0.15	0.15	0.15	0.30	0.43	0.43	0.48	0.08	0.08	1.40	1.40	1.40
1916	2	0.04	0.04	0.04	0.15	0.15	0.15	0.30	0.43	0.43	0.48	0.08	0.08	1.40	1.40	1.40

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1916	3	0.05	0.05	0.05	0.16	0.16	0.16	0.31	0.44	0.44	0.48	0.08	0.08	1.47	1.47	1.47
1916	4	0.05	0.05	0.05	0.19	0.19	0.19	0.31	0.44	0.44	0.48	0.08	0.08	1.46	1.46	1.46
1916	5			0.05			0.19			0.46			0.08			1.45
1916	6	0.05	0.05	0.05	0.18	0.18	0.18	0.33	0.47	0.47	0.48	0.08	0.08	1.44	1.44	1.44
1916	7	0.05	0.05	0.05	0.17	0.17	0.17	0.33	0.47	0.47	0.48	0.08	0.08	1.42	1.42	1.42
1916	8	0.06	0.06	0.06	0.17	0.17	0.17	0.33	0.47	0.47	0.48	0.08	0.08	1.45	1.45	1.45
1916	9	0.05	0.05	0.05	0.16	0.16	0.16	0.31	0.44	0.44	0.48	0.08	0.08	1.45	1.45	1.45
1916	10	0.05	0.05	0.05	0.17	0.17	0.17	0.32	0.46	0.46	0.48	0.08	0.08	1.49	1.49	1.49
1916	11	0.04	0.04	0.04	0.16	0.16	0.16	0.32	0.46	0.46	0.48	0.08	0.08	1.45	1.45	1.45
1916	12	0.05	0.05	0.05	0.17	0.17	0.17	0.37	0.53	0.53	0.48	0.08	0.08	1.43	1.43	1.43
1917	1	0.06	0.06	0.06	0.16	0.16	0.16	0.34	0.49	0.49	0.48	0.08	0.08	1.43	1.43	1.43
1917	2	0.05	0.05	0.05	0.18	0.18	0.18	0.34	0.49	0.49	0.48	0.08	0.08	1.51	1.51	1.51
1917	3	0.05	0.05	0.05	0.17	0.17	0.17	0.35	0.50	0.50	0.48	0.08	0.08	1.57	1.57	1.57
1917	4	0.05	0.05	0.05	0.18	0.18	0.18	0.35	0.50	0.50	0.54	0.09	0.09	1.56	1.56	1.56
1917	5	0.05	0.05	0.05	0.17	0.17	0.17	0.35	0.50	0.50	0.60	0.10	0.10	1.51	1.51	1.51
1917	6	0.05	0.05	0.05	0.18	0.18	0.18	0.35	0.50	0.50	0.54	0.09	0.09	1.63	1.63	1.63
1917	7	0.07	0.07	0.07	0.18	0.18	0.18	0.35	0.50	0.50	0.54	0.09	0.09	1.67	1.67	1.67
1917	8	0.07	0.07	0.07	0.18	0.18	0.18	0.35	0.50	0.50	0.54	0.09	0.09	1.70	1.70	1.70
1917	9	0.07	0.07	0.07	0.19	0.19	0.19	0.34	0.49	0.49	0.54	0.09	0.09	1.80	1.80	1.80
1917	10	0.06	0.06	0.06	0.21	0.21	0.21	0.35	0.50	0.50	0.48	0.08	0.08	1.87	1.87	1.87
1917	11	0.07	0.07	0.07	0.25	0.25	0.25	0.37	0.53	0.53	0.54	0.09	0.09	1.87	1.87	1.87
1917	12	0.11	0.11	0.11	0.25	0.25	0.25	0.39	0.56	0.56	0.66	0.11	0.11	1.87	1.87	1.87
1918	1			0.10			0.26			0.55			0.12			1.85
1918	2	0.08	0.08	0.08	0.27	0.27	0.27	0.38	0.54	0.54	0.72	0.12	0.12	1.82	1.82	1.82
1918	3	0.08	0.08	0.08	0.27	0.27	0.27	0.38	0.54	0.54	0.72	0.12	0.12	1.81	1.81	1.81
1918	4	0.08	0.08	0.08	0.28	0.28	0.28	0.37	0.53	0.53	0.72	0.12	0.12	1.85	1.85	1.85
1918	5	0.09	0.09	0.09	0.28	0.28	0.28	0.38	0.54	0.54	0.72	0.12	0.12	1.88	1.88	1.88
1918	6	0.09	0.09	0.09	0.29	0.29	0.29	0.38	0.54	0.54	0.72	0.12	0.12	1.91	1.91	1.91
1918	7			0.09			0.29			0.54			0.12			1.92
1918	8	0.08	0.08	0.08	0.28	0.28	0.28	0.38	0.54	0.54	0.66	0.11	0.11	1.93	1.93	1.93

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1918	9	0.09	0.09	0.09	0.28	0.28	0.28	0.39	0.56	0.56	0.72	0.12	0.12	1.90	1.90	1.90
1918	10	0.09	0.09	0.09	0.29	0.29	0.29	0.42	0.60	0.60	0.72	0.12	0.12	1.90	1.90	1.90
1918	11	0.10	0.10	0.10	0.29	0.29	0.29	0.41	0.59	0.59	0.72	0.12	0.12	1.90	1.90	1.90
1918	12	0.09	0.09	0.09	0.29	0.29	0.29	0.41	0.59	0.59	0.72	0.12	0.12	1.91	1.91	1.91
1919	1	0.07	0.07	0.07	0.26	0.26	0.26	0.41	0.59	0.59	0.78	0.13	0.13	1.80	1.80	1.80
1919	2			0.08			0.28			0.59			0.14			1.85
1919	3	0.09	0.09	0.09	0.29	0.29	0.29	0.41	0.59	0.59	0.90	0.15	0.15	1.90	1.90	1.90
1919	4	0.09	0.09	0.09	0.26	0.26	0.26	0.40	0.57	0.57	0.90	0.15	0.15	1.92	1.92	1.92
1919	5	0.07	0.07	0.07	0.25	0.25	0.25	0.40	0.57	0.57	0.91	0.15	0.15	2.03	2.03	2.03
1919	6	0.07	0.07	0.07	0.23	0.23	0.23	0.41	0.59	0.59	0.78	0.13	0.13	1.85	1.85	1.85
1919	7	0.06	0.06	0.06	0.25	0.25	0.25	0.45	0.64	0.64	0.84	0.14	0.14	1.82	1.82	1.82
1919	8	0.07	0.07	0.07	0.24	0.24	0.24	0.41	0.59	0.59	0.66	0.11	0.11	1.85	1.85	1.85
1919	9	0.07	0.07	0.07	0.25	0.25	0.25	0.42	0.60	0.60	0.72	0.12	0.12	1.85	1.85	1.85
1919	10	0.06	0.06	0.06	0.25	0.25	0.25	0.45	0.64	0.64	0.78	0.13	0.13	1.90	1.90	1.90
1919	11	0.07	0.07	0.07	0.25	0.25	0.25	0.43	0.61	0.61	0.78	0.13	0.13	1.95	1.95	1.95
1919	12	0.07	0.07	0.07	0.27	0.27	0.27	0.44	0.63	0.63	0.96	0.16	0.16	2.00	2.00	2.00
1920	1			0.07			0.27			0.62			0.15			2.07
1920	2	0.07	0.07	0.07	0.26	0.26	0.26	0.43	0.61	0.61	0.84	0.14	0.14	2.13	2.13	2.13
1920	3	0.07	0.07	0.07	0.27	0.27	0.27	0.44	0.63	0.63	0.84	0.14	0.14	2.14	2.14	2.14
1920	4	0.07	0.07	0.07	0.27	0.27	0.27	0.44	0.63	0.63	0.90	0.15	0.15	2.19	2.19	2.19
1920	5	0.07	0.07	0.07	0.28	0.28	0.28	0.44	0.63	0.63	0.90	0.15	0.15	2.09	2.09	2.09
1920	6	0.07	0.07	0.07	0.26	0.26	0.26	0.44	0.63	0.63	0.90	0.15	0.15	2.30	2.30	2.30
1920	7			0.08			0.28			0.65			0.15			2.35
1920	8	0.08	0.08	0.08	0.29	0.29	0.29	0.47	0.67	0.67	0.90	0.15	0.15	2.40	2.40	2.40
1920	9	0.08	0.08	0.08	0.29	0.29	0.29	0.51	0.73	0.73	0.96	0.16	0.16	2.48	2.48	2.48
1920	10	0.08	0.08	0.08	0.30	0.30	0.30	0.51	0.73	0.73	0.90	0.15	0.15	2.38	2.38	2.38
1920	11	0.08	0.08	0.08	0.30	0.30	0.30	0.51	0.73	0.73	0.90	0.15	0.15	2.38	2.38	2.38
1920	12	0.08	0.08	0.08	0.33	0.33	0.33	0.52	0.74	0.74	0.90	0.15	0.15	2.42	2.42	2.42
1921	1	0.08	0.08	0.08	0.34	0.34	0.34	0.50	0.71	0.71	0.96	0.16	0.16	2.30	2.30	2.30
1921	2	0.08	0.08	0.08	0.32	0.32	0.32	0.51	0.73	0.73	0.96	0.16	0.16	2.33	2.33	2.33

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1921	3	0.08	0.08	0.08	0.32	0.32	0.32	0.51	0.73	0.73	0.90	0.15	0.15	2.23	2.23	2.23
1921	4	0.08	0.08	0.08	0.33	0.33	0.33	0.51	0.73	0.73	0.96	0.16	0.16	2.31	2.31	2.31
1921	5	0.09	0.09	0.09	0.32	0.32	0.32	0.53	0.76	0.76	0.96	0.16	0.16	2.30	2.30	2.30
1921	6	0.09	0.09	0.09	0.32	0.32	0.32	0.51	0.73	0.73	0.96	0.16	0.16	2.19	2.19	2.19
1921	7	0.08	0.08	0.08	0.31	0.31	0.31	0.52	0.74	0.74	0.90	0.15	0.15	2.16	2.16	2.16
1921	8	0.09	0.09	0.09	0.33	0.33	0.33	0.53	0.76	0.76	0.96	0.16	0.16	2.32	2.32	2.32
1921	9	0.08	0.08	0.08	0.33	0.33	0.33	0.51	0.73	0.73	0.90	0.15	0.15	2.29	2.29	2.29
1921	10	0.08	0.08	0.08	0.33	0.33	0.33	0.51	0.73	0.73	0.96	0.16	0.16	2.31	2.31	2.31
1921	11	0.08	0.08	0.08	0.30	0.30	0.30	0.51	0.73	0.73	0.96	0.16	0.16	2.25	2.25	2.25
1921	12	0.08	0.08	0.08	0.34	0.34	0.34	0.51	0.73	0.73	0.90	0.15	0.15	2.25	2.25	2.25
1922	1	0.08	0.08	0.08	0.32	0.32	0.32	0.51	0.73	0.73	0.90	0.15	0.15	2.25	2.25	2.25
1922	2	0.08	0.08	0.08	0.33	0.33	0.33	0.51	0.73	0.73	0.96	0.16	0.16	2.23	2.23	2.23
1922	3	0.08	0.08	0.08	0.33	0.33	0.33	0.51	0.73	0.73	0.96	0.16	0.16	2.22	2.22	2.22
1922	4	0.08	0.08	0.08	0.33	0.33	0.33	0.51	0.73	0.73	0.84	0.14	0.14	2.19	2.19	2.19
1922	5			0.07			0.32			0.71			0.15			2.15
1922	6	0.06	0.06	0.06	0.31	0.31	0.31	0.49	0.70	0.70	0.90	0.15	0.15	2.11	2.11	2.11
1922	7	0.06	0.06	0.06	0.31	0.31	0.31	0.49	0.70	0.70	0.90	0.15	0.15	2.11	2.11	2.11
1922	8	0.06	0.06	0.06	0.31	0.31	0.31	0.49	0.70	0.70	0.84	0.14	0.14	2.15	2.15	2.15
1922	9			0.06			0.31			0.70			0.14			2.12
1922	10	0.06	0.06	0.06	0.30	0.30	0.30	0.49	0.70	0.70	0.78	0.13	0.13	2.09	2.09	2.09
1922	11	0.06	0.06	0.06	0.30	0.30	0.30	0.49	0.70	0.70	0.90	0.15	0.15	2.13	2.13	2.13
1922	12	0.06	0.06	0.06	0.31	0.31	0.31	0.48	0.69	0.69	0.84	0.14	0.14	2.13	2.13	2.13
1923	1	0.06	0.06	0.06	0.30	0.30	0.30	0.47	0.67	0.67	0.83	0.14	0.14	2.16	2.16	2.16
1923	2	0.07	0.07	0.07	0.28	0.28	0.28	0.47	0.67	0.67	0.82	0.14	0.14	2.06	2.06	2.06
1923	3	0.07	0.07	0.07	0.30	0.30	0.30	0.47	0.67	0.67	0.82	0.14	0.14	2.19	2.19	2.19
1923	4	0.07	0.07	0.07	0.30	0.30	0.30	0.47	0.67	0.67	0.81	0.14	0.14	2.17	2.17	2.17
1923	5	0.07	0.07	0.07	0.31	0.31	0.31	0.43	0.61	0.61	0.78	0.13	0.13	2.27	2.27	2.27
1923	6	0.07	0.07	0.07	0.31	0.31	0.31	0.45	0.64	0.64	0.78	0.13	0.13	2.06	2.06	2.06
1923	7	0.07	0.07	0.07	0.30	0.30	0.30	0.47	0.67	0.67	0.84	0.14	0.14	2.01	2.01	2.01
1923	8	0.07	0.07	0.07	0.29	0.29	0.29	0.47	0.67	0.67	0.84	0.14	0.14	2.20	2.20	2.20

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1923	9	0.07	0.07	0.07	0.31	0.31	0.31	0.48	0.69	0.69	0.78	0.13	0.13	2.25	2.25	2.25
1923	10	0.06	0.06	0.06	0.28	0.28	0.28	0.44	0.63	0.63	0.90	0.15	0.15	1.99	1.99	1.99
1923	11	0.06	0.06	0.06	0.27	0.27	0.27	0.43	0.61	0.61	0.90	0.15	0.15	1.96	1.96	1.96
1923	12	0.06	0.06	0.06	0.28	0.28	0.28	0.44	0.63	0.63	0.90	0.15	0.15	2.06	2.06	2.06
1924	1	0.06	0.06	0.06	0.28	0.28	0.28	0.44	0.63	0.63	0.84	0.14	0.14	2.11	2.11	2.11
1924	2	0.06	0.06	0.06	0.27	0.27	0.27	0.44	0.63	0.63	0.90	0.15	0.15	2.12	2.12	2.12
1924	3	0.06	0.06	0.06	0.28	0.28	0.28	0.44	0.63	0.63	0.88	0.15	0.15	2.36	2.36	2.36
1924	4			0.06			0.28			0.63			0.14			2.31
1924	5	0.06	0.06	0.06	0.28	0.28	0.28	0.44	0.63	0.63	0.84	0.14	0.14	2.26	2.26	2.26
1924	6	0.06	0.06	0.06	0.28	0.28	0.28	0.44	0.63	0.63	0.90	0.15	0.15	2.15	2.15	2.15
1924	7	0.06	0.06	0.06	0.28	0.28	0.28	0.44	0.63	0.63	0.90	0.15	0.15	2.21	2.21	2.21
1924	8	0.06	0.06	0.06	0.28	0.28	0.28	0.44	0.63	0.63	0.88	0.15	0.15	2.23	2.23	2.23
1924	9	0.06	0.06	0.06	0.29	0.29	0.29	0.44	0.63	0.63	0.90	0.15	0.15	2.24	2.24	2.24
1924	10	0.06	0.06	0.06	0.29	0.29	0.29	0.44	0.63	0.63	0.90	0.15	0.15	2.29	2.29	2.29
1924	11	0.06	0.06	0.06	0.30	0.30	0.30	0.44	0.63	0.63	0.90	0.15	0.15	2.28	2.28	2.28
1924	12	0.06	0.06	0.06	0.30	0.30	0.30	0.45	0.64	0.64	0.90	0.15	0.15	2.33	2.33	2.33
1925	1	0.06	0.06	0.06	0.29	0.29	0.29	0.45	0.64	0.64	0.90	0.15	0.15	2.37	2.37	2.37
1925	2	0.06	0.06	0.06	0.29	0.29	0.29	0.45	0.64	0.64	0.90	0.15	0.15	2.38	2.38	2.38
1925	3			0.06			0.30			0.66			0.15			2.44
1925	4			0.06			0.30			0.67			0.16			2.50
1925	5	0.06	0.06	0.06	0.30	0.30	0.30	0.47	0.67	0.67	0.95	0.16	0.16	2.50	2.50	2.50
1925	6			0.06			0.30			0.66			0.15			2.47
1925	7			0.06			0.30			0.66			0.15			2.43
1925	8	0.06	0.06	0.06	0.30	0.30	0.30	0.46	0.66	0.66	0.90	0.15	0.15	2.43	2.43	2.43
1925	9	0.06	0.06	0.06	0.30	0.30	0.30	0.45	0.64	0.64	0.90	0.15	0.15	2.46	2.46	2.46
1925	10	0.06	0.06	0.06	0.30	0.30	0.30	0.45	0.64	0.64	0.88	0.15	0.15	2.43	2.43	2.43
1925	11	0.06	0.06	0.06	0.30	0.30	0.30	0.45	0.64	0.64	0.88	0.15	0.15	2.34	2.34	2.34
1925	12	0.06	0.06	0.06	0.30	0.30	0.30	0.47	0.67	0.67	0.90	0.15	0.15	2.34	2.34	2.34
1926	1	0.06	0.06	0.06	0.30	0.30	0.30	0.48	0.69	0.69	0.84	0.14	0.14	2.29	2.29	2.29
1926	2	0.06	0.06	0.06	0.30	0.30	0.30	0.48	0.69	0.69	0.84	0.14	0.14	2.36	2.36	2.36

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1926	3	0.06	0.06	0.06	0.30	0.30	0.30	0.49	0.70	0.70	0.84	0.14	0.14	2.35	2.35	2.35
1926	4	0.06	0.06	0.06	0.30	0.30	0.30	0.49	0.70	0.70	0.84	0.14	0.14	2.34	2.34	2.34
1926	5			0.06			0.30			0.70			0.14			2.35
1926	6	0.06	0.06	0.06	0.30	0.30	0.30	0.49	0.70	0.70	0.81	0.14	0.14	2.35	2.35	2.35
1926	7	0.06	0.06	0.06	0.30	0.30	0.30	0.49	0.70	0.70	0.78	0.13	0.13	2.29	2.29	2.29
1926	8	0.06	0.06	0.06	0.30	0.30	0.30	0.49	0.70	0.70	0.72	0.12	0.12	2.30	2.30	2.30
1926	9	0.06	0.06	0.06	0.29	0.29	0.29	0.48	0.69	0.69	0.70	0.12	0.12	2.47	2.47	2.47
1926	10	0.06	0.06	0.06	0.29	0.29	0.29	0.48	0.69	0.69	0.69	0.12	0.12	2.47	2.47	2.47
1926	11			0.06			0.29			0.69			0.12			2.49
1926	12	0.06	0.06	0.06	0.29	0.29	0.29	0.48	0.69	0.69	0.71	0.12	0.12	2.50	2.50	2.50
1927	1	0.06	0.06	0.06	0.29	0.29	0.29	0.48	0.69	0.69	0.72	0.12	0.12	2.52	2.52	2.52
1927	2	0.06	0.06	0.06	0.29	0.29	0.29	0.48	0.69	0.69	0.72	0.12	0.12	2.57	2.57	2.57
1927	3	0.06	0.06	0.06	0.29	0.29	0.29	0.48	0.69	0.69	0.70	0.12	0.12	2.58	2.58	2.58
1927	4	0.06	0.06	0.06	0.29	0.29	0.29	0.47	0.67	0.67	0.70	0.12	0.12	2.60	2.60	2.60
1927	5	0.06	0.06	0.06	0.28	0.28	0.28	0.47	0.67	0.67	0.69	0.12	0.12	2.58	2.58	2.58
1927	6	0.06	0.06	0.06	0.28	0.28	0.28	0.47	0.67	0.67	0.70	0.12	0.12	2.61	2.61	2.61
1927	7	0.06	0.06	0.06	0.28	0.28	0.28	0.47	0.67	0.67	0.69	0.12	0.12	2.70	2.70	2.70
1927	8	0.06	0.06	0.06	0.28	0.28	0.28	0.47	0.67	0.67	0.68	0.11	0.11	2.73	2.73	2.73
1927	9	0.06	0.06	0.06	0.28	0.28	0.28	0.48	0.69	0.69	0.70	0.12	0.12	2.75	2.75	2.75
1927	10	0.06	0.06	0.06	0.28	0.28	0.28	0.48	0.69	0.69	0.72	0.12	0.12	2.67	2.67	2.67
1927	11	0.06	0.06	0.06	0.28	0.28	0.28	0.47	0.67	0.67	0.68	0.11	0.11	2.60	2.60	2.60
1927	12	0.06	0.06	0.06	0.29	0.29	0.29	0.47	0.67	0.67	0.69	0.12	0.12	2.60	2.60	2.60
1928	1	0.06	0.06	0.06	0.29	0.29	0.29	0.48	0.69	0.69	0.69	0.12	0.12	2.41	2.41	2.41
1928	2	0.07	0.07	0.07	0.29	0.29	0.29	0.48	0.69	0.69	0.69	0.12	0.12	2.31	2.31	2.31
1928	3	0.06	0.06	0.06	0.29	0.29	0.29	0.48	0.69	0.69	0.69	0.12	0.12	2.25	2.25	2.25
1928	4	0.06	0.06	0.06	0.29	0.29	0.29	0.48	0.69	0.69	0.65	0.11	0.11	2.19	2.19	2.19
1928	5	0.06	0.06	0.06	0.28	0.28	0.28	0.48	0.69	0.69	0.65	0.11	0.11	2.19	2.19	2.19
1928	6	0.06	0.06	0.06	0.28	0.28	0.28	0.48	0.69	0.69	0.64	0.11	0.11	2.12	2.12	2.12
1928	7	0.06	0.06	0.06	0.29	0.29	0.29	0.47	0.67	0.67	0.61	0.10	0.10	2.20	2.20	2.20
1928	8	0.06	0.06	0.06	0.29	0.29	0.29	0.47	0.67	0.67	0.65	0.11	0.11	2.16	2.16	2.16

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1928	9			0.06			0.29			0.67			0.11			2.24
1928	10	0.06	0.06	0.06	0.29	0.29	0.29	0.47	0.67	0.67	0.61	0.10	0.10	2.31	2.31	2.31
1928	11	0.06	0.06	0.06	0.29	0.29	0.29	0.47	0.67	0.67	0.66	0.11	0.11	2.31	2.31	2.31
1928	12	0.07	0.07	0.07	0.29	0.29	0.29	0.47	0.67	0.67	0.66	0.11	0.11	2.32	2.32	2.32
1929	1			0.07			0.29			0.67			0.11			2.34
1929	2	0.06	0.06	0.06	0.29	0.29	0.29	0.47	0.67	0.67	0.69	0.12	0.12	2.35	2.35	2.35
1929	3	0.06	0.06	0.06	0.29	0.29	0.29	0.47	0.67	0.67	0.72	0.12	0.12	2.31	2.31	2.31
1929	4	0.06	0.06	0.06	0.29	0.29	0.29	0.47	0.67	0.67	0.66	0.11	0.11	2.32	2.32	2.32
1929	5	0.06	0.06	0.06	0.29	0.29	0.29	0.49	0.70	0.70	0.72	0.12	0.12	2.32	2.32	2.32
1929	6	0.06	0.06	0.06	0.29	0.29	0.29	0.48	0.69	0.69	0.60	0.10	0.10	2.32	2.32	2.32
1929	7	0.06	0.06	0.06	0.29	0.29	0.29	0.47	0.67	0.67	0.60	0.10	0.10	2.32	2.32	2.32
1929	8			0.06			0.29			0.67			0.10			2.30
1929	9	0.06	0.06	0.06	0.28	0.28	0.28	0.47	0.67	0.67	0.60	0.10	0.10	2.27	2.27	2.27
1929	10	0.06	0.06	0.06	0.28	0.28	0.28	0.47	0.67	0.67	0.60	0.10	0.10	2.25	2.25	2.25
1929	11	0.06	0.06	0.06	0.29	0.29	0.29	0.47	0.67	0.67	0.60	0.10	0.10	2.25	2.25	2.25
1929	12			0.07			0.29			0.69			0.10			2.19
1930	1	0.07	0.07	0.07	0.29	0.29	0.29	0.49	0.70	0.70	0.60	0.10	0.10	2.12	2.12	2.12
1930	2	0.07	0.07	0.07	0.29	0.29	0.29	0.48	0.69	0.69	0.54	0.09	0.09	2.12	2.12	2.12
1930	3	0.07	0.07	0.07	0.29	0.29	0.29	0.48	0.69	0.69	0.54	0.09	0.09	2.10	2.10	2.10
1930	4			0.07			0.29			0.69			0.10			2.05
1930	5	0.07	0.07	0.07	0.29	0.29	0.29	0.48	0.69	0.69	0.60	0.10	0.10	2.00	2.00	2.00
1930	6	0.07	0.07	0.07	0.28	0.28	0.28	0.48	0.69	0.69	0.60	0.10	0.10	2.03	2.03	2.03
1930	7	0.07	0.07	0.07	0.28	0.28	0.28	0.48	0.69	0.69	0.60	0.10	0.10	1.97	1.97	1.97
1930	8	0.06	0.06	0.06	0.29	0.29	0.29	0.48	0.69	0.69	0.60	0.10	0.10	1.95	1.95	1.95
1930	9			0.07			0.29			0.69			0.10			1.98
1930	10	0.07	0.07	0.07	0.29	0.29	0.29	0.48	0.69	0.69	0.60	0.10	0.10	2.00	2.00	2.00
1930	11	0.07	0.07	0.07	0.29	0.29	0.29	0.48	0.69	0.69	0.60	0.10	0.10	2.05	2.05	2.05
1930	12	0.07	0.07	0.07	0.30	0.30	0.30	0.48	0.69	0.69	0.60	0.10	0.10	2.08	2.08	2.08
1931	1	0.07	0.07	0.07	0.29	0.29	0.29	0.48	0.69	0.69	0.60	0.10	0.10	2.09	2.09	2.09
1931	2	0.07	0.07	0.07	0.30	0.30	0.30	0.48	0.69	0.69	0.66	0.11	0.11	2.09	2.09	2.09

Year	M	F1	F2	F3	C1	C2	C3	B1	B2	B3	S1	S2	S3	O1	O2	O3
1931	3			0.07			0.30			0.69			0.11			2.08
1931	4	0.07	0.07	0.07	0.30	0.30	0.30	0.48	0.69	0.69	0.66	0.11	0.11	2.07	2.07	2.07
1931	5	0.07	0.07	0.07	0.27	0.27	0.27	0.42	0.60	0.60	0.54	0.09	0.09	1.82	1.82	1.82
1931	6	0.07	0.07	0.07	0.31	0.31	0.31	0.50	0.71	0.71	0.56	0.09	0.09	2.02	2.02	2.02
1931	7	0.06	0.06	0.06	0.30	0.30	0.30	0.47	0.67	0.67	0.66	0.11	0.11	2.08	2.08	2.08
1931	8	0.07	0.07	0.07	0.30	0.30	0.30	0.48	0.69	0.69	0.63	0.11	0.11	2.09	2.09	2.09
1931	9	0.07	0.07	0.07	0.30	0.30	0.30	0.43	0.61	0.61	0.66	0.11	0.11	2.09	2.09	2.09
1931	10	0.06	0.06	0.06	0.30	0.30	0.30	0.43	0.61	0.61	0.64	0.11	0.11	2.41	2.41	2.41
1931	11	0.06	0.06	0.06	0.30	0.30	0.30	0.69	0.99	0.99	0.60	0.10	0.10	2.15	2.15	2.15
1931	12	0.06	0.06	0.06	0.30	0.30	0.30	0.48	0.69	0.69	0.65	0.11	0.11	2.08	2.08	2.08
1932	1	0.07	0.07	0.07	0.30	0.30	0.30	0.49	0.69	0.69	0.65	0.11	0.11	2.03	2.03	2.03
1932	2			0.07			0.35			0.69			0.11			2.04
1932	3	0.07	0.07	0.07	0.39	0.39	0.39	0.49	0.69	0.69	0.64	0.11	0.11	2.06	2.06	2.06
1932	4	0.07	0.07	0.07	0.31	0.31	0.31	0.49	0.70	0.70	0.07	0.01	0.01	2.11	2.11	2.11
1932	5			0.07			0.31			0.71			0.06			2.10
1932	6	0.07	0.07	0.07	0.30	0.30	0.30	0.50	0.71	0.71	0.63	0.10	0.10	2.09	2.09	2.09
1932	7	0.06	0.06	0.06	0.30	0.30	0.30	0.50	0.71	0.71	0.62	0.10	0.10	2.09	2.09	2.09
1932	8	0.06	0.06	0.06	0.30	0.30	0.30	0.48	0.69	0.69	0.59	0.10	0.10	1.88	1.88	1.88

B.6 BOPB. Monthly petrol prices (1898-1932).

Table B.7: BOPB: monthly prices of petrol (1898-1932).

Year	**M**	**P1**	**P2**	**P3**	**Year**	**M**	**P1**	**P2**	**P3**	**Year**	**M**	**P1**	**P2**	**P3**
1898	4	0.79	0.79	0.79	1900	10	0.84	0.84	0.84	1903	4	0.81	0.81	0.81
1898	5	0.81	0.81	0.81	1900	11	0.77	0.77	0.77	1903	5	0.82	0.82	0.82
1898	6	0.82	0.82	0.82	1900	12	0.77	0.77	0.77	1903	6	0.81	0.81	0.81
1898	7	0.82	0.82	0.82	1901	1	0.84	0.84	0.84	1903	7	0.82	0.82	0.82
1898	8	0.83	0.83	0.83	1901	2			0.85	1903	8	0.81	0.81	0.81
1898	9			0.84	1901	3	0.85	0.85	0.85	1903	9	0.82	0.82	0.82
1898	10	0.84	0.84	0.84	1901	4	0.84	0.84	0.84	1903	10	0.83	0.83	0.83
1898	11	0.85	0.85	0.85	1901	5	0.84	0.84	0.84	1903	11	0.83	0.83	0.83
1898	12	0.86	0.86	0.86	1901	6	0.84	0.84	0.84	1903	12	0.82	0.82	0.82
1899	1	0.86	0.86	0.86	1901	7	0.85	0.85	0.85	1904	1	0.82	0.82	0.82
1899	2	0.86	0.86	0.86	1901	8	0.77	0.77	0.77	1904	2	0.83	0.83	0.83
1899	3	0.85	0.85	0.85	1901	9	0.83	0.83	0.83	1904	3	0.82	0.82	0.82
1899	4	0.85	0.85	0.85	1901	10	0.84	0.84	0.84	1904	4	0.81	0.81	0.81
1899	5	0.85	0.85	0.85	1901	11	0.83	0.83	0.83	1904	5	0.80	0.80	0.80
1899	6	0.85	0.85	0.85	1901	12	0.83	0.83	0.83	1904	6			0.79
1899	7	0.85	0.85	0.85	1902	1	0.82	0.82	0.82	1904	7	0.78	0.78	0.78
1899	8			0.85	1902	2	0.81	0.81	0.81	1904	8	0.80	0.80	0.80
1899	9	0.85	0.85	0.85	1902	3	0.81	0.81	0.81	1904	9	0.79	0.79	0.79
1899	10	0.84	0.84	0.84	1902	4	0.81	0.81	0.81	1904	10	0.80	0.80	0.80
1899	11	0.85	0.85	0.85	1902	5	0.81	0.81	0.81	1904	11	0.79	0.79	0.79
1899	12	0.85	0.85	0.85	1902	6	0.81	0.81	0.81	1904	12	0.79	0.79	0.79
1900	1	0.85	0.85	0.85	1902	7	0.81	0.81	0.81	1905	1	0.78	0.78	0.78
1900	2	0.85	0.85	0.85	1902	8	0.82	0.82	0.82	1905	2	0.78	0.78	0.78
1900	3			0.85	1902	9	0.82	0.82	0.82	1905	3	0.80	0.80	0.80
1900	4	0.85	0.85	0.85	1902	10	0.81	0.81	0.81	1905	4	0.83	0.83	0.83
1900	5	0.86	0.86	0.86	1902	11	0.81	0.81	0.81	1905	5	0.84	0.84	0.84
1900	6	0.85	0.85	0.85	1902	12	0.82	0.82	0.82	1905	6			0.84
1900	7	0.85	0.85	0.85	1903	1	0.82	0.82	0.82	1905	7	0.83	0.83	0.83
1900	8	0.84	0.84	0.84	1903	2	0.82	0.82	0.82	1905	8	0.81	0.81	0.81
1900	9	0.84	0.84	0.84	1903	3	0.83	0.83	0.83	1905	9			0.83

Year	M	P1	P2	P3	Year	M	P1	P2	P3	Year	M	P1	P2	P3
1905	10	0.84	0.84	0.84	1908	4	0.82	0.82	0.82	1910	10	0.81	0.81	0.81
1905	11	0.84	0.84	0.84	1908	5	0.82	0.82	0.82	1910	11	0.81	0.81	0.81
1905	12	0.84	0.84	0.84	1908	6	0.82	0.82	0.82	1910	12	0.81	0.81	0.81
1906	1	0.84	0.84	0.84	1908	7	0.81	0.81	0.81	1911	1	0.82	0.82	0.82
1906	2	0.84	0.84	0.84	1908	8	0.80	0.80	0.80	1911	2			0.82
1906	3	0.83	0.83	0.83	1908	9	0.80	0.80	0.80	1911	3	0.82	0.82	0.82
1906	4	0.83	0.83	0.83	1908	10	0.81	0.81	0.81	1911	4	0.82	0.82	0.82
1906	5	0.83	0.83	0.83	1908	11	0.81	0.81	0.81	1911	5	0.82	0.82	0.82
1906	6	0.79	0.79	0.79	1908	12	0.81	0.81	0.81	1911	6	0.81	0.81	0.81
1906	7	0.78	0.78	0.78	1909	1	0.81	0.81	0.81	1911	7			0.82
1906	8	0.83	0.83	0.83	1909	2	0.81	0.81	0.81	1911	8	0.82	0.82	0.82
1906	9	0.83	0.83	0.83	1909	3	0.81	0.81	0.81	1911	9	0.82	0.82	0.82
1906	10	0.83	0.83	0.83	1909	4			0.81	1911	10	0.82	0.82	0.82
1906	11	0.84	0.84	0.84	1909	5	0.81	0.81	0.81	1911	11			0.82
1906	12	0.84	0.84	0.84	1909	6	0.82	0.82	0.82	1911	12	0.81	0.81	0.81
1907	1	0.84	0.84	0.84	1909	7			0.82	1912	1	0.82	0.82	0.82
1907	2	0.84	0.84	0.84	1909	8	0.82	0.82	0.82	1912	2	0.81	0.81	0.81
1907	3	0.83	0.83	0.83	1909	9			0.82	1912	3			0.81
1907	4	0.81	0.81	0.81	1909	10	0.81	0.81	0.81	1912	4	0.81	0.81	0.81
1907	5	0.81	0.81	0.81	1909	11	0.82	0.82	0.82	1912	5			0.85
1907	6	0.76	0.76	0.76	1909	12	0.81	0.81	0.81	1912	6	0.89	0.89	0.89
1907	7	0.80	0.80	0.80	1910	1	0.81	0.81	0.81	1912	7	0.84	0.84	0.84
1907	8	0.81	0.81	0.81	1910	2	0.82	0.82	0.82	1912	8	0.84	0.84	0.84
1907	9	0.81	0.81	0.81	1910	3	0.82	0.82	0.82	1912	9			0.84
1907	10	0.82	0.82	0.82	1910	4	0.82	0.82	0.82	1912	10	0.84	0.84	0.84
1907	11	0.82	0.82	0.82	1910	5	0.81	0.81	0.81	1912	11	0.84	0.84	0.84
1907	12	0.81	0.81	0.81	1910	6	0.82	0.82	0.82	1912	12	0.84	0.84	0.84
1908	1	0.81	0.81	0.81	1910	7	0.82	0.82	0.82	1913	1	0.84	0.84	0.84
1908	2			0.81	1910	8	0.82	0.82	0.82	1913	2	0.84	0.84	0.84
1908	3	0.81	0.81	0.81	1910	9	0.82	0.82	0.82	1913	3	0.84	0.84	0.84

Year	M	P1	P2	P3	Year	M	P1	P2	P3	Year	M	P1	P2	P3
1913	4	0.83	0.83	0.83	1915	10	0.86	0.86	0.86	1918	4	1.16	1.16	1.16
1913	5	0.83	0.83	0.83	1915	11	0.87	0.87	0.87	1918	5	1.20	1.20	1.20
1913	6	0.83	0.83	0.83	1915	12	0.87	0.87	0.87	1918	6	1.23	1.23	1.23
1913	7	0.84	0.84	0.84	1916	1	0.87	0.87	0.87	1918	7			1.23
1913	8	0.84	0.84	0.84	1916	2	0.89	0.89	0.89	1918	8	1.23	1.23	1.23
1913	9	0.84	0.84	0.84	1916	3	0.88	0.88	0.88	1918	9	1.40	1.40	1.40
1913	10	0.84	0.84	0.84	1916	4	0.90	0.90	0.90	1918	10	1.40	1.40	1.40
1913	11	0.84	0.84	0.84	1916	5			0.91	1918	11	1.57	1.57	1.57
1913	12	0.84	0.84	0.84	1916	6	0.91	0.91	0.91	1918	12	1.60	1.60	1.60
1914	1	0.85	0.85	0.85	1916	7	0.91	0.91	0.91	1919	1	1.93	1.93	1.93
1914	2	0.85	0.85	0.85	1916	8	0.90	0.90	0.90	1919	2			1.87
1914	3	0.85	0.85	0.85	1916	9	0.90	0.90	0.90	1919	3	1.80	1.80	1.80
1914	4	0.85	0.85	0.85	1916	10	0.91	0.91	0.91	1919	4	2.53	2.53	2.53
1914	5	0.85	0.85	0.85	1916	11	0.91	0.91	0.91	1919	5	2.04	2.04	2.04
1914	6	0.85	0.85	0.85	1916	12	0.91	0.91	0.91	1919	6	2.05	2.05	2.05
1914	7	0.86	0.86	0.86	1917	1	0.95	0.95	0.95	1919	7	2.06	2.06	2.06
1914	8	0.85	0.85	0.85	1917	2	0.95	0.95	0.95	1919	8	1.99	1.99	1.99
1914	9	0.85	0.85	0.85	1917	3	0.96	0.96	0.96	1919	9	1.97	1.97	1.97
1914	10	0.86	0.86	0.86	1917	4	0.96	0.96	0.96	1919	10	1.91	1.91	1.91
1914	11	0.86	0.86	0.86	1917	5	0.95	0.95	0.95	1919	11	1.91	1.91	1.91
1914	12			0.87	1917	6	0.97	0.97	0.97	1919	12	1.94	1.94	1.94
1915	1	0.87	0.87	0.87	1917	7	1.01	1.01	1.01	1920	1			1.98
1915	2	0.85	0.85	0.85	1917	8	1.04	1.04	1.04	1920	2	2.02	2.02	2.02
1915	3	0.85	0.85	0.85	1917	9	1.00	1.00	1.00	1920	3	1.98	1.98	1.98
1915	4	0.86	0.86	0.86	1917	10	1.08	1.08	1.08	1920	4	1.97	1.97	1.97
1915	5	0.86	0.86	0.86	1917	11	1.10	1.10	1.10	1920	5	1.79	1.79	1.79
1915	6	0.86	0.86	0.86	1917	12	1.10	1.10	1.10	1920	6	1.71	1.71	1.71
1915	7	0.86	0.86	0.86	1918	1			1.14	1920	7			1.80
1915	8	0.86	0.86	0.86	1918	2	1.17	1.17	1.17	1920	8	1.88	1.88	1.88
1915	9	0.87	0.87	0.87	1918	3	1.17	1.17	1.17	1920	9	1.78	1.78	1.78

Year	M	P1	P2	P3	Year	M	P1	P2	P3	Year	M	P1	P2	P3
1920	10	1.55	1.55	1.55	1923	4	1.25	1.25	1.25	1925	10	0.89	0.89	0.89
1920	11	1.64	1.64	1.64	1923	5	1.12	1.12	1.12	1925	11	0.88	0.88	0.88
1920	12	1.60	1.60	1.60	1923	6	1.23	1.23	1.23	1925	12	0.88	0.88	0.88
1921	1	1.67	1.67	1.67	1923	7	1.22	1.22	1.22	1926	1	0.86	0.86	0.86
1921	2	1.49	1.49	1.49	1923	8	1.19	1.19	1.19	1926	2	0.82	0.82	0.82
1921	3	1.55	1.55	1.55	1923	9	1.05	1.05	1.05	1926	3	0.86	0.86	0.86
1921	4	1.58	1.58	1.58	1923	10	1.05	1.05	1.05	1926	4	0.85	0.85	0.85
1921	5	1.61	1.61	1.61	1923	11	0.93	0.93	0.93	1926	5			0.86
1921	6	1.62	1.62	1.62	1923	12	1.10	1.10	1.10	1926	6	0.86	0.86	0.86
1921	7	1.45	1.45	1.45	1924	1	0.86	0.86	0.86	1926	7	0.88	0.88	0.88
1921	8	1.60	1.60	1.60	1924	2	1.12	1.12	1.12	1926	8	0.80	0.80	0.80
1921	9	1.47	1.47	1.47	1924	3	0.83	0.83	0.83	1926	9	0.82	0.82	0.82
1921	10	1.54	1.54	1.54	1924	4			0.83	1926	10	0.82	0.82	0.82
1921	11	1.50	1.50	1.50	1924	5	0.83	0.83	0.83	1926	11			0.82
1921	12	1.35	1.35	1.35	1924	6	0.87	0.87	0.87	1926	12	0.82	0.82	0.82
1922	1	1.45	1.45	1.45	1924	7	0.83	0.83	0.83	1927	1	0.83	0.83	0.83
1922	2	1.45	1.45	1.45	1924	8	0.85	0.85	0.85	1927	2	0.81	0.81	0.81
1922	3	1.43	1.43	1.43	1924	9	0.79	0.79	0.79	1927	3	0.81	0.81	0.81
1922	4	1.27	1.27	1.27	1924	10	0.87	0.87	0.87	1927	4	0.80	0.80	0.80
1922	5			1.37	1924	11	0.88	0.88	0.88	1927	5	0.80	0.80	0.80
1922	6	1.46	1.46	1.46	1924	12	0.88	0.88	0.88	1927	6	0.83	0.83	0.83
1922	7	1.46	1.46	1.46	1925	1	0.88	0.88	0.88	1927	7	0.83	0.83	0.83
1922	8	1.36	1.36	1.36	1925	2	0.88	0.88	0.88	1927	8	0.83	0.83	0.83
1922	9			1.41	1925	3			0.87	1927	9	0.85	0.85	0.85
1922	10	1.46	1.46	1.46	1925	4			0.86	1927	10	0.88	0.88	0.88
1922	11	1.41	1.41	1.41	1925	5	0.86	0.86	0.86	1927	11	0.85	0.85	0.85
1922	12	1.20	1.20	1.20	1925	6			0.88	1927	12	0.82	0.82	0.82
1923	1	1.29	1.29	1.29	1925	7			0.89	1928	1	0.82	0.82	0.82
1923	2	1.32	1.32	1.32	1925	8	0.89	0.89	0.89	1928	2	0.76	0.76	0.76
1923	3	1.37	1.37	1.37	1925	9	0.87	0.87	0.87	1928	3	0.84	0.84	0.84

Year	**M**	**P1**	**P2**	**P3**	**Year**	**M**	**P1**	**P2**	**P3**
1928	4	0.76	0.76	0.76	1930	10	0.77	0.77	0.77
1928	5	0.74	0.74	0.74	1930	11	0.77	0.77	0.77
1928	6	0.75	0.75	0.75	1930	12	0.77	0.77	0.77
1928	7	0.71	0.71	0.71	1931	1	0.77	0.77	0.77
1928	8	0.75	0.75	0.75	1931	2	0.78	0.78	0.78
1928	9			0.74	1931	3			0.79
1928	10	0.73	0.73	0.73	1931	4	0.79	0.79	0.79
1928	11	0.72	0.72	0.72	1931	5	0.67	0.67	0.67
1928	12	0.76	0.76	0.76	1931	6	0.76	0.76	0.76
1929	1			0.76	1931	7	0.81	0.81	0.81
1929	2	0.76	0.76	0.76	1931	8	0.80	0.80	0.80
1929	3	0.76	0.76	0.76	1931	9	0.79	0.79	0.79
1929	4	0.80	0.80	0.80	1931	10	0.80	0.80	0.80
1929	5	0.81	0.81	0.81	1931	11	0.72	0.72	0.72
1929	6	0.76	0.76	0.76	1931	12	0.80	0.80	0.80
1929	7	0.80	0.80	0.80	1932	1	0.81	0.81	0.81
1929	8			0.73	1932	2			0.79
1929	9	0.66	0.66	0.66	1932	3	0.77	0.77	0.77
1929	10	0.74	0.74	0.74	1932	4	0.82	0.82	0.82
1929	11	0.74	0.74	0.74	1932	5			0.82
1929	12			0.74	1932	6	0.82	0.82	0.82
1930	1	0.74	0.74	0.74	1932	7	0.79	0.79	0.79
1930	2	0.75	0.75	0.75	1932	8	0.75	0.75	0.75
1930	3	0.88	0.88	0.88					
1930	4			0.82					
1930	5	0.75	0.75	0.75					
1930	6	0.76	0.76	0.76					
1930	7	0.74	0.74	0.74					
1930	8	0.75	0.75	0.75					
1930	9			0.76					