Discussing Chevalier’s Data on the Efficiency of Tariffs for American and French Canals in the 1830s

Paulo Reis Mourao

Abstract

This article revisits Michel Chevalier’s work and discussions of tariffs. Chevalier shifted from Saint-Simonism to economic liberalism during his life in the 19th century. His influence was soon perceived in the political world and economic debates, mainly because of his discussion of tariffs as instruments of efficient transport policies. This work discusses Chevalier’s thoughts on tariffs by revisiting his masterpiece, *Le Cours d’Économie Politique*. Data Envelopment Analysis (DEA) was conducted to test Chevalier’s hypothesis on the inefficiency of French tariffs. This work showed that Chevalier’s claims on French tariffs are not validated by DEA.

Keywords

comparative history, history, humanities, schools of economic thought and methodology, economic science, social sciences, political economy, industry sector management, management, international economics

Introduction

Michel Chevalier was one of the most emblematic Frenchmen of the 19th century. He was not only an economist who modified Saint-Simonian positions to liberal ones but also a special world traveler and an influential advisor to Napoleon III.

This work will analyze Chevalier’s arguments on the role of canal tariffs in economic growth. Although Chevalier also studied import duties, this article will focus on Chevalier’s thoughts concerning transport tariffs. As we shall see, Chevalier was a common reference in the French debates on the definition of tariffs in the transportation sector.

For Chevalier, this topic became of the utmost importance after his journey to the United States in the 1830s. Henceforth, Chevalier’s discussion of tariffs became one of the most relevant discussions of European canal tariffs produced by a 19th-century economist. The relevance of Chevalier’s discussion of tariffs culminated in a free trade treaty between England and France, notably named the Cobden–Chevalier Treaty.

This work will examine Chevalier’s discussion of canal tariffs. We will do so considering his life and his main economic work, *Le Cours d’Économie Politique*. There are several aspects that emphasize the importance of the early 19th-century discussions about tariffs or tolls. First, tolls were realized to be elements that negatively impacted economic growth. Second, they were key elements in the debate pitting individual freedom against public financing. Third, reinforced by Saint-Simon and his disciples (including Chevalier), tolls were perceived as decelerating the rhythm of industrialization. Finally, the French debates on canal tariffs produced the basis for the economic thought of the next generation of European thinkers, such as Léon Walras and the Lausanne School.

We tested a crucial element of Chevalier’s discussion: the inefficiency of 1830s French tariffs. This testing was conducted using Chevalier’s data and a modern instrument of efficiency evaluation: Data Envelopment Analysis (DEA). It is important to perform this exercise (revise Chevalier’s claims) because using current statistical techniques, we can enlighten the field as to whether the analysis of Chevalier was robustly founded by a proper statistical discussion.

The remainder of the article is organized as follows. In section “A Note on Chevalier’s Life and Bibliography,” we review Chevalier’s biography and published works. We also use references not only to historians but also to contemporaries to show Chevalier’s impact on academics and politics. In section “Chevalier’s *Cours d’Économie Politique* and His Discussions of Tariffs,” we focus on his thoughts regarding tariffs, referring to his masterpiece *Le Cours d’Économie Politique* and to his letters. In section “Toward a Discussion on Chevalier’s Claims Using DEA Analysis,” we discuss

1University Minho, Braga, Portugal

Corresponding Author:
Paulo Reis Mourao, University Minho, Gualtar, Braga 4700, Portugal.
Email: paulom@eeg.uminho.pt
Chevalier’s claims about the inefficiency of French tariffs using DEA techniques. The final section concludes.

A Note on Chevalier's Life and Bibliography

Michel Chevalier (1806-1879) was a French economist living in a very interesting period of the 19th century. The France known by Chevalier was a country characterized by a proindustrialization movement.

Michel Chevalier’s social, economic, and political thoughts changed over the course of his life. Many authors consider the young Michel Chevalier to be a disciple of Saint-Simon, primarily concerned about improving the quality of life for his contemporary French industrial workers (Takashi, 1980). As he aged, however, Chevalier increased his distance from the orthodox Saint-Simonians, although he retained the idea that social and economic development should be shared among all. As Drolet (2008) noted, “Chevalier moved from being one of the fiercest critics of France’s political establishment to one of its most ardent defenders” (p. 1229). Campagnolo (2009) stated that during his life, Chevalier always believed that both productive entrepreneurship and state intervention were necessary for a competitive environment. Of course, this universality was not well received by the most orthodox thinkers, like Carl Grun (1845), who wrote the following about Michel Chevalier:

M. Chevalier still refers with great sympathy to the industrialists . . . But to the disciple, the industrialists are no longer, as they were for his master, the proletarians; he includes capitalists, entrepreneurs and workers in one concept, that is to say, he includes the idlers in a category which should only embrace the poorest and most numerous class. (Grun,1845, p. 102)

The reasons for this distance from the orthodoxy are both physical and ideological. In other words, this distancing from orthodoxy is due to his journey across the Atlantic Ocean, where he had the opportunity to experience different people, different economic organizations, and, especially, a new inspiration for his ideas to develop the French economy (Adamson, 2005).

Before this journey to America (1833-1834), Chevalier was focused on the European reality and wrote in favor of pan-Mediterranean free trade, which he argued was also important for peace between the East and West:

The Mediterranean was an arena, a closed field, where for thirty centuries, the East and the West fought battles. Henceforth the Mediterranean must be like a vast forum where all the previously divided nations will unite together. The Mediterranean will become the wedding-bed of the East and the West. (Chevalier, 1832²)

His journey to the United States from 1833 to 1834 (essential to understanding his future critiques of French tolls) was described in his book Society, Manners, and Politics in the United States.³ This book is a composition concerning the American economy (or society) observed as “a model of industry.” According to Chevalier, it should be highlighted how poor Irish men thrived after so little time in America. The reasons for success point not just to some particularly American institutions (such as a business culture and proemployment education) but mainly to efficient American means of transport and internal tariffs; namely, it was the tariffs on the Erie Canal that exerted a special effect on Chevalier’s observations, as is documented in detail in the following section. The transport and tariffs that Chevalier observed were the result of intense federal and state debates that had begun in the 1820s (initially with the strong opposition to protectionist tariffs from Southern congressmen; DiLorenzo, 2004; Temin, 1999).

After visiting the United States, a trip that is well documented by Jennings (2006), Chevalier also traveled to Mexico and Cuba (1835), where he strengthened the idea of a Panama Canal linking the Atlantic to the Pacific and developed his principles of a Pan-American alliance of countries. According to Monteiro (2008), after this tour, Chevalier became one of the first authors to explore the concept of a “Latin American country.” This was mainly due to his support of Latin American countries being freed from the administrations of Portugal and Spain.

These ideas were influential in South American countries, developing, for instance, the basis of Poucel’s thoughts regarding the need for reinforcing French support to the young South American countries that were reaching independence.⁴

After returning to Europe, Chevalier visited Great Britain in 1851, recognizing that England’s prosperity was due to industrialization. This industrialization was symbolized by the Crystal Palace in Sydenham, which was built for the London Great Exhibition of 1851. The construction of this palace impressed him deeply, especially its rapidity and the building’s design and transparency to light. However, he was mainly impressed by British tariffs, which could be noted as the first signal of his favor of the future Cobden–Chevalier Treaty⁵ (although Nye, 1991, confirmed that British tariffs were consistently lower than those of France).

As Maddison (1995) recognized,

In 1820-70, these mercantilist barriers were largely eliminated. The UK removed all tariff barriers and trade restrictions between 1846 and 1860. Free trade policy was enforced in British colonies, and in quasi-colonies such as China, Thailand and Turkey. In Germany, the customs union (Zollverein) of 1834 ended barriers between the German states and the external Zollverein tariff was lowered after 1850. In 1860 the Cobden-Chevalier Treaty removed French quantitative restrictions and reduced tariff barriers to a modest level. This was followed by French commercial treaties with Belgium, the Zollverein, Italy, Switzerland, Spain and other countries. These treaties had
most-favoured-nation clauses which meant that bilateral liberalism applied equally to all countries. (Chapter 3, p. 3)

Although recognized mostly for his later political influence in the Second Empire and as one of Napoleon III’s closest advisors, Chevalier’s academic role as a professor at Collège de France was not limited to his influential books. For instance, Chevalier, along with Villermé and Hyppolite Passy, was also one of the founders of the Société Statistique de Paris (Statistical Society of Paris; Martin, 2001).

By this time, his influence was already being recognized not only by economists but also in the political world. For instance, Chevalier’s bibliography led to fevered debates and significant replicas, such as Gottfried Duden’s critique of Chevalier’s (1837) Letters on North America, as noted by Rowan (2009), or Carl Grun’s critique of Chevalier’s Saint-Simonism, which Marx and Engels (1845) severely reproved. Other remarkable influences were assumed by Carl Menger. According to Campagnolo (2009), Menger cited Chevalier 56 times in his leading Grundsätze.

Chevalier's Cours d’Économie Politique and His Discussions of Tariffs

Returning to the original edition (published by Capelle, Libraire-Editeur, in Paris5), we confirm that the book was written for both the academic year of 1841 to 1842 and the first year of graduation. As usual, the lectures had been collected by an assistant to Chevalier (M. A. Broët) and authorized by the professor. The first two sections of this manual are composed from two opening discourses by Chevalier (pp. 1-53). The following 15 sections are composed of 15 lectures:

1st: On the relationship between individual freedom and industrial production (pp. 57-79)
2nd: On the relationship between distribution and economic development (pp. 80-101)
3rd: On economic growth and the role of agriculture (pp. 102-124)
4th: On capital (pp. 125-144)
5th: On the role of capital in improving the well-being of workers (pp. 145-162)
6th: On the role of taxes in capital (pp. 163-189)
7th: On banks (pp. 190-206)
8th: On money (pp. 207-225)
9th: On mine extraction (pp. 226-245)
10th: On transports (pp. 246-271)
11th: On comparing land ways, water ways and railroads (pp. 272-300)
12th: On canal tariffs (pp. 301-327)
13th: On railroad tariffs (pp. 328-356)
14th: Conclusion of the 13th lecture (pp. 357-386)
15th: General conclusion (pp. 387-410).

All of these lectures were written according to a historicist perspective typical among Saint-Simonian disciples (see Khalil, 1995; Wolfson, 1994). The author begins by pointing out the conclusions of his arguments. He then exposes these arguments while referencing a few statistical data points and many historical cases. Finally, he synthesizes the observations, highlighting the previously introduced conclusion.

As previously noted, there are a significant number of authors who have discussed Chevalier’s Saint-Simonism and bibliography as a whole. However, Chevalier’s Cours d’Économie Politique is substantially important for understanding the evolution of many of Saint-Simonians to libertarian positions and for its reflection of the general European conviction that the best way for countries to grow economically was a rapid and substantial investment in transportation through tariff reductions.

The question of tariff reduction was one of the most important questions debated in Europe and America in the first half of the 19th century. At the time, there were intense debates in France among transportation specialists. Authors like Chevalier himself or Jules Dupuit (Groenewegen, 1983; Klein, 1985; Simonin & Vatin, 2002) not only considered the importance of tariffs for economic growth but also were concerned with their redistributive function via the pricing system. It is also important to mention the debates among the economist-engineers from the Ponts et Chaussées, which bolstered contemporary economic thinking regarding pricing in transportation.

When we read Chevalier’s Cours carefully, it is easy to see that it is not a general economics book in the way we conceptualize it today, as a general introductory book for a first-year undergraduate economics course. Chevalier’s Cours is concerned primarily with free trade and arguing against tariffs. The concluding claim is clear: France imposed excessive tariffs on the majority of goods and services, which diminished its rhythm of growth and, obviously, diminished the success of its distribution efforts.

As noted by Takashi (1980), Chevalier had tried to put these ideas into practice some years before. Seeking to reduce tariffs, he proposed an enormous development plan
for French ways of communication in 1838 to improve the linkage among usable rivers and railroads. This plan would have cost 1.184 million francs over 12 years. The plan that was actually approved by the ministry had a final cost of 2.8 million francs.

Chevalier observed that although France and England had the same area and almost the same population, they had very different systems and efficiencies regarding water canals. As a result, Chevalier stated, "les canaux français ne rendent pas la dixième partie des services qu’on est en droit d’en rendre" (Chevalier, p. 303). Chevalier knew that tolls covered infrastructure costs. This point is noteworthy, as the 19th-century transportation specialists argued (particularly Jules Dupuit, according to Simonin & Vatin, 2002). Chevalier wanted to discuss the fact that in some instances, toll levels were exceeding infrastructures costs, which consequently limited the extension of the market and eventually economic growth.

Chevalier used data on American canals from 1835 to 1839 and on French canals from 1821 to 1836. These data were collected directly from official sources. After 1842, Chevalier considered a more rigorous examination of these data because in the second edition of Chevalier (1842), that is, in 1855, he introduced notes about data beyond 1841, reprinting the original table and adding a note on the stability of canal tariff during the studied period. When comparing French with American canals, Chevalier is even more emphatic:

Les canaux américains sont ceux qui ont donné les résultats les plus extraordinaires. (p. 303)

Chevalier did not particularly focus on English, Belgian, and Dutch tariffs (which he considered low), but he did applaud American tariffs:

Il est evident que par cela même que les canaux américains ont en général une grande longueur, on a dû établir des tarifs modérés; autrement les marchandises parcourant de longs trajets, elles auraient acquitté des droits qui en auraient trop aggravé le prix. (p. 310)

Focusing specifically on the Erie Canal as representative of other American canals, Chevalier noted,

Ses profits sont tels qu’il y a long-temps que le canal s’est payé lui-même . . . entrepris en 1817 et achevé en 1825, il a déjà donné assez de benefices. (pp. 312-313)

With the exception of the Canal du Midi, Chevalier is not so gentle with French canals. Although recognizing that France was the first country to build canals, he concluded the 12th lecture by stating that French tariffs should be lower and French canals should be improved significantly:

Sans préjudice de l’abaissement des tarifs, si nous voulons tirer parti de nos canaux, il faut que nous sachions les porter à un parfait état d’achèvement, et qu’ensuite nous les maintenions dans un excellent état d’entretien. (p. 327)

Using a t test on the equality of the means between French and American tariffs collected by Chevalier at four French canals and at four American canals (Figure 1), we get the following probability that the null hypothesis is observed (French tariffs are the same than American ones): manure, 30.2%; coal, 36%; flour, 57.8%; wheat, 68%; wine/salt pork, 85.3%; iron, 73.3%; and textiles, 60.7%. Therefore, we can conclude now that French tariffs could not be so significantly higher than American ones as Chevalier was claiming.

It thus becomes pertinent to ask the following: Was Chevalier exaggerating due to his fascination with the British and American systems? Were his politics dominating his technical and academic abilities? Was he forgetting to consider the different economic and social conditions of France and America? Or, was he interested in increasing the rhythm
of change by denouncing a larger gap than was actually present between French and British or American tariffs?

**Toward a Discussion on Chevalier’s Claims Using DEA Analysis**

This section will use DEA to test Chevalier’s argument that French tariffs were exorbitantly high for his contemporaries and fellow citizens. DEA is a nonparametric programming approach to technical frontier estimation (Coelli, 1996). It allows us to compute efficiency measures considering given outputs and a set of inputs. Although the number of academic works focusing on historical data using DEA is currently not as large as the number of works that use DEA to analyze more recent data, this approach has received increased attention even from those who are interested in researching data from the past (Enflo & Baten, 2007; Mourao, 2009; Nenovska, Ivanov, & Mihaylova, 2008; Tankersley & Cuzan, 2004; Wheelock & Wilson, 1995).

With Chevalier’s data and with his claims on inputs, we use an input-oriented model and a cost-minimization model characterized by variable returns to scale. We follow McGillivray, McLean, Pahre, and Schonhardt-Bailey (2001), and we also consider each toll as the result of the inputs of the transportation process.

Our model (a cost-minimization model) is described by the following minimization problem (Coelli, 1996):

\[
\text{Min } \lambda, \sum_1^N w_i x_i^*,
\]

subject to

\[
-y_i + y \lambda \geq 0,
\]

\[
x_i^* - X \lambda \geq 0,
\]

\[
N^T \lambda = 1,
\]

\[
\lambda \geq 0.
\]

In our case (please refer the raw data in the appendix), \(w_i\) is a \(6 \times 1\) matrix of tolls for the \(i\)th canal and \(x_i\) (which is calculated by the linear programming of DEA) is the cost-minimization vector of economic and geographical characteristics for the same \(i\)th canal. \(y_i, x_i^*, \) or \(x_i \) are also \(6 \times 1\) matrixes. \(N\) is an \(8 \times 1\) vector of ones (convexity constraint) as in Coelli (1996), with \(N\) being the number of firms (or, in our case, the number 8 of canals). \(\lambda\) is a \(8 \times 1\) vector of constants. \(X\) is the \(6 \times 8\) inputs matrix. \(Y\) is a \(6 \times 8\) matrix of normalized outputs. Therefore, our minimization problem can be described as a problem in which we want to achieve the maximum output with the minimum value of inputs’ expenses or inputs’ costs (Coelli, 1996). For instance, for the same output, a canal with a toll of five monetary units paid for 5 miles exhibits a more efficient ratio (in the perspective of the toll payer) than another canal with a toll of five monetary units only paid for only 2 miles, keeping the other inputs (geographical and economic characteristics) constant.

The total cost efficiency (CE) or economic efficiency of the \(i\)th canal would be calculated as \(\text{CE} = w_i x_i^* / w_i x_i\), meaning that CE is the ratio of minimum cost to observed cost.

Chevalier recognized that the tolls and the costs of each canal changed both because of the nature of each transported product and six other geographical and economic dimensions (our inputs): the distance of each canal; the minimum, maximum and differential of altitude; the market area; and the population density. Therefore, we have to identify these factors as inputs of our model.

Our first source for these variables is Chevalier’s table that is reproduced in Figure 1. We must remember, however, that Chevalier’s data exhibit some weaknesses: Besides being the product of individual collection from official reports, these data have not been conveniently discussed in terms of efficiency. Thus, DEA is an appropriate method for analyzing Chevalier’s claims on tariffs for various reasons. First, it has been proven to be an appropriate method for analyzing efficiency related to decision-making units. Second, Chevalier’s complaints concerned the modest efficiency of French tariffs. Third, they allow the assumption of variable (as opposed to constant) returns to scale to characterize the output.

For the topological characteristics, we also returned to Pierre (1997) for French canals and Shank (1986) and Bernstein (2005) for American canals. For the population dimensions of the regions around the canals, we used 19th-century data from the National Historical Geographic Information System (NHGIS; for North American areas) and from the Institut National de la Statistique et des Etudes Economiques (for French areas).

The descriptive statistics are at Table 1. Our raw data are shown in the appendix.

It is clear that our model should assume variable returns to scale because constant returns to scale is adequate only when we are observing decision-making units operating at an optimal scale (Banker, Charnes, & Cooper, 1984). When decision-making units face imperfect competition, constraints on finance, or different geographical areas, then it is argued that a variable return to scale model is the most appropriate. Our model is an input-oriented model because this orientation is associated with the cost-minimization model and because, as Coelli and Perelman (1996) assumed, this orientation is preferred when input dimensions are the primary decision variables.

We will pass over formal explanations of DEA and efficiency concepts. For those interested in these themes, we suggest Coelli (1996). To give an interpretation of the total CE values that we are going to report, we state that our efficiency measure identifies the ratio of minimum cost to the observed cost for each transported product:

\[
\text{CE of each canal} = \frac{\text{Minimum cost observed for all canals}}{\text{Cost observed for each canal}}.
\]
Table 1. Descriptive Statistics.

| Variables          | Manure | Coal | Flour | Wheat | Wine/salt pork | Iron | Textiles | Distance | Minimum of altitude | Maximum of altitude | Differential of altitude | Area of market | Population density |
|--------------------|--------|------|-------|-------|----------------|------|----------|----------|---------------------|--------------------|----------------------|----------------|-------------------|
| M                  | 22.3   | 27.1 | 59.3  | 53.9  | 69.0           | 79.0 | 92.6     | 404.1    | 59.5                | 294.0              | 237.1                | 68.553.5       | 24.9              |
| SD                 | 15.3   | 18.9 | 49.3  | 33.0  | 54.5           | 59.4 | 62.4     | 669.4    | 70.5                | 288.0              | 311.7                | 97.830.7       | 22.4              |
| Maximum            | 59.0   | 72.0 | 173.0 | 123.0 | 178.0          | 191.0| 194.0    | 2,000.0  | 179.0               | 979.0              | 979.0                | 265.000.0      | 65.0              |
| Minimum            | 10.0   | 15.0 | 20.0  | 20.0  | 20.0           | 20.0 | 20.0     | 21.0     | 0.0                 | 57.0               | 30.0                 | 62.8           | 5.0               |
| Number of canals   | 8.0    | 8.0  | 8.0   | 8.0   | 8.0            | 8.0  | 8.0      | 8.0      | 8.0                 | 8.0                | 8.0                  | 8.0            | 8.0               |

Source. For canals’ tariffs, see Chevalier (1842). For distance, minimum, maximum, and differential of altitude, see Pierre (1997), Shank (1986), and Bernstein (2005). For area of market and for population density, see National Historical Geographic Information System (2009) and Institut National de la Statistique et des Etudes Economiques (2009).

Table 2. DEA—Efficiency Estimates (Standard Deviations Between Parentheses After Robustness Procedures).

| Canal              | Manure          | Coal             | Flour            | Wheat            | Wine/salt pork | Iron            | Textiles         | Distance          | Minimum of altitude | Maximum of altitude | Differential of altitude | Area of market | Population density |
|--------------------|-----------------|------------------|------------------|------------------|----------------|------------------|------------------|--------------------|---------------------|---------------------|----------------------------|----------------|-------------------|
| Midi (France)      | 1 (0.05)        | 0.216 (0.13)     | 0.224 (0.189)    | 0.255 (0.013)    | 0.314 (0.028)  | 0.174 (0.018)    | 0.174 (0.034)    |                    |                     |                    |                            |                |                   |
| Briare (France)    | 1 (0.04)        | 1 (0.02)         | 1 (0.03)         | 1 (0.008)        | 1 (0.09)       | 1 (0.016)        | 1 (0.005)        |                    |                     |                    |                            |                |                   |
| Centre (France)    | 0.383 (0.12)    | 0.412 (0.17)     | 0.383 (0.04)     | 0.384 (0.043)    | 0.384 (0.012)  | 0.384 (0.192)    | 0.384 (0.032)    |                    |                     |                    |                            |                |                   |
| Saint-Quentin (France) | 0.782 (0.18) | 0.782 (0.15) | 0.783 (0.009) | 0.783 (0.139) | 0.783 (0.18) | 0.783 (0.182) | 0.783 (0.045) | | | | | | |
| Erie (United States) | 0.099 (0.051) | 0.109 (0.03) | 0.099 (0.101) | 0.099 (0.083) | 0.099 (0.19) | 0.099 (0.062) | 0.099 (0.021) | | | | | | |
| Pennsylvania (United States) | 0.033 (0.043) | 0.033 (0.02) | 0.033 (0.002) | 0.033 (0.011) | 0.033 (0.02) | 0.033 (0.029) | 0.033 (0.033) | | | | | | |
| Schuylkill (United States) | 1 (0.02) | 1 (0.04) | 1 (0.013) | 1 (0.004) | 1 (0.002) | 1 (0.018) | 1 (0.03) | | | | | | |
| Delaware (United States) | 0.933 (0.03) | 1 (0.04) | 1 (0.002) | 1 (0.021) | 1 (0.018) | 1 (0.032) | 1 (0.088) | | | | | | |

Note. DEA = Data Envelopment Analysis.

In our model, less efficient decision-making units (canals) face costs that are too high considering the set of inputs; the most efficient decision-making units require lower costs to produce the same unit of output produced by the less efficient units. We ran our estimations using WIN4DEAP v.1.1.2.

Our results on the efficiency of each canal detailed by Chevalier are reported in Table 2 and graphically represented in Figure 2.

To help the reader, we offer an interpretation of the values in Table 2 and Figure 2. Focusing on a given product—manure—we observe that the canals that exhibited the minimum cost (Efficiency estimate = 1) were Midi, Briare, and Schuylkill. In contrast, the Pennsylvania Canal can be confirmed as the canal characterized by the maximum cost (Efficiency estimate = 0). The Centre Canal can be highlighted as a canal showing median costs (Efficiency estimate = 0.4) for manure and considering the set of inputs.

Our estimates indicate that Chevalier (1842) was not far off. In fact, our estimates provide a mixed lecture on the efficiency of tariffs. Two American canals, Schuylkill and Delaware, were identified as having the most efficient tariffs. The two other American canals analyzed by Chevalier (1842), however, exhibit less efficient estimates—namely, his highly favored Erie Canal and the Pennsylvania Canal. However, the Briare Canal also shows highly significant efficient tariffs, whereas Saint-Quentin Canal exhibits slightly lower values. The Centre Canal and Midi Canal are identified as the French canals with the least efficient tariffs.

Our values show that, considering the evolving reality, only the Centre and Midi canals were as costly as Chevalier argued. However, examining within the American reality and considering the set of inputs analyzed in our model, the Erie and Pennsylvania tariffs were too high for the users, even if their values were lower than French values.

The advantages of DEA method are known: We do not need to know a priori the form of production frontier. Nonparametric methods allow the DEA test to ignore the specification of a particular functional form for the technology. Moreover, the use of small samples is possible (in our article, eight canals considered as eight Decision Making Units [DMU]): From this perspective, the methodology required for using Coelli’s (1996) model is correct. We also know, however, that this model is very sensitive to misspecified data and errors due to the deterministic feature of the method: Each discrepancy from the frontier is immediately interpreted as inefficiency and statistical noise and inefficiency are not distinguished. To account for these limitations, we also tested different compositions of the set of inputs using the 63 different combinations of the six inputs, and our results retained the previously signaled pattern: Schuylkill and Delaware were the most efficient American canals, and Saint-Quentin was the most efficient French canal. After running the 63 combinations and using SimLab (data sensitivity software), we obtained a central value for each estimate of efficiency and a corresponding standard deviation. Full details are available under request. Table 2 also expresses these values.
Although we experienced data scarcity, we also tried to include a proxy for the price of each product using the mean value of the inverse of quantities produced in France and the United States between 1850 and 1860 and those suggested by Chevalier. Even with this innovation, our DEA results did not change.

Our results show that even when using modern techniques like DEA, we are unable to confirm the efficiency of all American canals’ tariffs over French canals’ tariffs. In fact, French canals exhibit efficiency values that are central values when compared with the extreme values assumed for American canals.

This points to a political motivation behind Chevalier’s emphasis on American canals. His argument was based only on estimates for gross tariffs, and his claims were mainly aimed at accelerating the improvement of the French system’s methods of transportation. Highlighting the differences in tariffs, Chevalier reinforced the need for France to deepen the process of industrialization through improved canals, railroads, and land ways.

**Conclusion**

This work revisited the main aspect of the liberal Saint-Simonian Michel Chevalier’s economic thought, namely, his discussion of the role of tariffs in economic growth. Chevalier was a Frenchman involved not only in the controversies of Saint-Simonism but also in a global perspective of economic growth and redistribution processes. His journeys around the world, especially to the Americas, clarified his thoughts and oriented them toward proindustrialization preferences using convenient policies of transportation. His reflections led him to discuss tariffs as a main theme in his bibliography.

His book *Cours d’Économie Politique* collected his main economic thought as distilled by the classes he taught at the Collège de France in the 1840s. In this work, Chevalier claimed that France was losing its rhythm of economic growth because French canal tariffs were too high compared with British and American tariffs.

We proved in this article that Chevalier’s claim was essentially political. Using DEA techniques, we calculated estimates of French tariffs that were not as inefficient as Chevalier claimed. In fact, in our sample, some French tariffs, such as the Briare Canal, exhibited the most efficient results even when considering American tariffs. In this finding, we can agree with authors like Nye (1991) and argue that Chevalier was trying to denounce a larger gap than actually existed to accelerate the changes he wished to see in French transportation policy.
# Appendix

## Raw Data.

| Canal     | Distance (km) | Minimum altitude (meters) | Maximum altitude (meters) | Differential of altitude (meters) | Evolving market area (km²) | Density (men/km²) | Prices (tolls, francs) |
|-----------|---------------|---------------------------|---------------------------|----------------------------------|---------------------------|-------------------|------------------------|
| Midi      | 241           | 52                        | 190                       | 138                              | 265,000                   | 42                | Manure 20 Coal 15 Flour 20 Wheat 17 Wine/salt 20 Pork 20 Iron 20 Textiles 20 |
| Briare    | 54            | 135                       | 165                       | 30                               | 6,775                     | 65                | Manure 15 Coal 15 Flour 20 Wheat 17 Wine/salt 20 Pork 20 Iron 20 Textiles 20 |
| Centre    | 112.13        | 179                       | 300                       | 121                              | 8,575                     | 32                | Manure 15 Coal 15 Flour 20 Wheat 17 Wine/salt 20 Pork 20 Iron 20 Textiles 20 |
| Saint-Quentin | 50.99       | 10                        | 57                        | 47                               | 7,369                     | 36                | Manure 15 Coal 15 Flour 20 Wheat 17 Wine/salt 20 Pork 20 Iron 20 Textiles 20 |
| Erie      | 580           | 0                         | 305                       | 305                              | 141,299                   | 7                 | Manure 17 Coal 17 Flour 20 Wheat 17 Wine/salt 20 Pork 20 Iron 20 Textiles 20 |
| Pennsylvania | 2,000        | 0                         | 979                       | 979                              | 119,283                   | 5                 | Manure 15 Coal 17 Flour 20 Wheat 17 Wine/salt 20 Pork 20 Iron 20 Textiles 20 |
| Schuylkill | 174           | 0                         | 158                       | 179                              | 62.8                      | 5                 | Manure 22 Coal 22 Flour 37 Wheat 37 Wine/salt 37 Pork 37 Iron 37 Textiles 37 |
| Delaware  | 21            | 100                       | 198                       | 98                               | 64.5                      | 7                 | Manure 59 Coal 72 Flour 173 Wheat 173 Wine/salt 173 Pork 173 Iron 173 Textiles 173 |

**Sources**
- Pierre (1997); Shank (1986); Bernstein (2005)
- NHGIS (2009); INSEE (2009)
- Chevalier (1842, p. 320)

**Note.** NHGIS = National Historical Geographic Information System; INSEE = Institut National de la Statistique et des Etudes Economiques.

---

**Figure A1.** Front page of Chevalier’s (1842) Cours.
Acknowledgments
The author is indebted to an editor and to two anonymous reviewers of SAGE Open for useful comments on a previous version of this article. The author is also indebted to the comments received from the participants at the 15th Encuentros de Economia Aplicada (La Coruna) on a preliminary version of this research.

Author’s Note
Remaining errors are exclusively the author’s responsibility.

Declaration of Conflicting Interests
The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding
The author(s) received no financial support for the research and/or authorship of this article.

Notes
1. The second generation of Saint-Simonians and their networks and journals in the 1820s and 1830s wrote about public works: Le producteur, Le globe (Flachat, 1831-1832), and especially Clapeyron-Lamé-Flachat’s (1832) book, Vues politiques et pratiques sur les travaux publics de France. The Saint-Simonian engineers were great participants in French discussions on the first public works programs (Picon, 1992).
2. Drolet (2008) noticed that Michel Chevalier was editor-in-chief of the Saint-Simonian newspaper, Le Globe.
3. This is the title that became famous after the English translation (by Thomas Bradford in 1839) of the third edition of Chevalier’s (1837) Lettres sur l’Amérique du Nord.
4. Benjamin Poucel was the founder of Merino sheepfolds in Uruguay.
5. The Cobden–Chevalier treaty is an important part of the history of international relations for two reasons. First, it is a document that signals a change in the diplomatic view of European relations, supporting trade as a factor of diplomatic stability instead of war claims; second, it led to a substantial reduction in tariffs between the United Kingdom and France in an intense period of growth in industrialization (Lamer, 2010; Lazer, 1999).
6. See Chevalier’s role in the Treaty on Free Trade between France and Great Britain, signed in 1860 and discussed by Adamson (2005) or Accominotti and Flandreau (2005)
7. Campagnolo (2009) also mentioned other Chevalier books besides the masterpiece Cours d’Économie Politique (1842–1844), such as Letters on the Organization of Labor and Letters on Patents. It should be mentioned that Chevalier’s classes were suspended from April 7, 1848, until November 14, 1848, by the antiroyalist Minister M. Carnot (Jourdan, 1887).
8. For an image of the front page of this first edition, see Figure A1 in the appendix.
9. On this point, see Einer (1984) and Diehl (1987).
10. The issue of the recourse to foreign models (especially the American comparison) for analyzing French industrialization was common among French economists (see, for instance, Le Van Lemesle, 2001).
11. The canals that Chevalier analyzed were structured following the Becquey Plan in 1820 to 1822 that considerably overhauled the French canal system.
12. English translation: “French canals do not provide a tenth part of the amount of services that they would be expected to provide.”
13. However, Chevalier did not distinguish among building, maintenance, and operating costs.
14. “American canals are those giving more extraordinary results.”
15. “It is evident that American canals have generally a long distance, then only moderated tariffs should be established; otherwise businessmen traveling through these long tracks would leave their rights for traveling because of high prices they had to pay.”
16. “On voit que les péages des canaux de l’état de Pensylvanie dépassent peu ceux du canal Érié” (Chevalier, p. 313). Translation: “It is seen that the tolls of the other canals of Pennsylvania are not much higher than the Erie Canal’s tolls.”
17. “Its profits are so high that the canal paid for itself a long time ago . . . started in 1817 and finished in 1825, it has already produced sufficient benefits.”
18. Regardless of a decrease in tariffs, if we want to extract profits from our canals, it is necessary that we keep them in a perfect working state and that we keep them in an excellent state of maintenance.”
19. For simplicity, we assumed that there are only six tolls, given the similarity between the tariffs on flour and the tariffs on wheat.
20. There is no consensus as to whether American and French canals could be discussed together, considering the different institutional and regulatory contexts in France and the United States at that time. However, we must test the efficiency of French and American canals for three main reasons. First, Chevalier (1842) did so before and we wish to test his claims. Second, we are going to use common factors as Data Envelopment Analysis (DEA) inputs, thus avoiding the standard problems in inference. Third, efficiency measures can only be computed if we consider the same range of inputs for the same units of output (Coelli, 1996).

References
Accominotti, O., & Flandreau, M. (2005). Does bilateralism promote trade? Nineteenth century liberalization revisited (CEPR Discussion Paper No. 5423). London, England: Centre for Economic Policy Research.
Adamson, K. (2005). Understanding post-independence visions of economic prosperity in Algeria through the Mirror of the Second Napoleonic Empire. In Topics in Middle Eastern and North African economies (Vol. 7). Retrieved from http://www.luc.edu/orgs/meea/volume7/adamson.pdf
Banker, R., Charnes, A., & Cooper, W. (1984). Some models for estimating technical and scale inefficiencies in Data Envelopment Analysis. Management Science, 30, 1078-1092.
Bernstein, P. (2005). Wedding of the waters: The Erie canal and the making of a great nation. New York, NY: W.W. Norton.
Campagnolo, G. (2009). Origins of Menger’s thought in French liberal economists. The Review of Austrian Economics, 22, 53–79.
Chevalier, M. (1832, February 12). Editorial. Le Globe.
Chevalier, M. (1837). *Letters on North America* (J. W. Ward, Ed.). Gloucester, MA: P. Smith.

Chevalier, M. (1838). *Des intérêts matériels en France. Travaux publics. Routes, canaux, chemins de fer* [On the material interests of France. Public works. Roads, channels, railways]. Paris, France: Gosselin et Bruxelles, Loueroux.

Chevalier, M. (1840). *Histoire et description des voies de communication aux Etats-Unis et des travaux d’art qui en dépendent* [History and description of the communication channels in the United States and of the art works depending on them] (2 vols.). Paris, France: Gosselin.

Chevalier, M. (1842). *Cours d’Économie Politique* [A Course on Political Economy]. Paris, France: Libraire-Éditeur.

Coelli, T. (1996). *A guide to DEAP version 2.1: A Data Envelopment Analysis (computer) program* (CEPA Working Papers No. 8/96). Armidale, Australia: Centre for Efficiency and Productivity Analysis, University of New England.

Coelli, T., & Perelman, S. (1996). *A comparison of parametric and non-parametric distance functions: With application to European Railways* (CREPP Discussion paper). Liege, Belgium: University of Liege.

Diehl, J.-P. (1987). *Calcul économique et décision au dix-neuvième siècle: les Grands Travaux et le Projet Saint-Simonien* [Economic calculation and decision in the nineteenth century]. Paris, France: SEDES.

DiLorenzo, T. (2004). *Not the most isolated place on the Eastern Seabord.* Ithaca: Cornell University.

DiLorenzo, T. (2004). *Calcul économique et décision au dix-neuvième siècle; les Grands Travaux et le Projet Saint-Simonien* [Economic calculation and decision in the nineteenth century]. Liege, Belgium: University of Liege.

Diehl, J.-P. (1987). *Calcul économique et décision au dix-neuvième siècle; les Grands Travaux et le Projet Saint-Simonien* [Economic calculation and decision in the nineteenth century]. Paris, France: SEDES.

Drolet, M. (2008). Industry, class and society: A historiographic reinterpretation of Michel Chevalier. *The English Historical Review*, 123, 1229-1271.

Enflo, K., & Baten, J. (2007). *The evolution of Pombal through an econometric discussion*. Lisbon: ANPHLAC.

Fuchshuber, W. (2009). *National Historical Geographic Information System*. (2009). *National Historical Geographic Information System*. Minneapolis: Minnesota Population Center, Minnesota University.

Groenewegen, P. (1983). Turgot’s place in the history of economic thought: A bicentenary estimate. *History of Political Economy Winter*, 15, 585-616.

Grun, K. (1845). *Die Sociale Bewegung in Frankreich und Belgien. Briefe und Studien* [The social movement in France and Belgium, letters and studies]. Hildesheim, Germany: Gerstenberg.

Institut National de la Statistique et des Etudes Economiques. (2009). *Données de la population 1840-1860* [Population data, 1840-1860]. Paris, France: Author.

Jennings, J. (2006). Democracy before Tocqueville: Michel Chevalier’s America. *The Review of Politics*, 68, 398-427.

Jourdan, A. (1887). De l’enseignement de l’économie politique [On the teaching of political economics]. *Revue d’économie politique*, 1, 3-31.

Kammen, C. (2008). *Not the most isolated place on the Eastern Seabord.* Ithaca: Cornell University.

Khalil, E. (1995). Has economics progressed? Rectilinear, historicist, universalist, and evolutionary historiographies. *History of Political Economy*, 27, 43-87.

Klein, D. (1985). Deductive economic methodology in the French enlightenment: Condillac and Destutt de Tracy. *History of Political Economy*, 17, 51-71.

Lampe, M. (2010). Explaining nineteenth-century bilateralism: Economic and political determinants of the Cobden-Chevalier network. *Economic History Review*, 64, 644-668.

Lazer, D. A. (1999). The free trade epidemic of the 1860s and other outbreaks of economic discrimination. *World Politics*, 51, 447-483.

Le Van Lemesle, L. (2001). Les économistes français et l’usage des modèles étrangers [French economists and the use of foreign models]. *Revue d’histoire du XIXème siècle*, 23, 73-86.

Maddison, A. (1995). *Monitoring the world economy*. Paris, France: OECD Development Centre.

Martin, O. (2001). *Le canal Henri IV ou canal de Briare* [The chan

McGillivray, F., McLean, I., Pahre, R., & Schonhardt-Bailey, C. (2001). Tariffs and modern political institutions: An introduction. In F. McGillivray et al. (Eds.), *International trade and political institutions: Instituting trade in the long nineteenth century* (pp. 1-28). Cheltenham, UK: Edward Elgar.

Monteiro, C. (2008). *Impérios, Repúblicas e fronteiras (1840-1850)* [Empires, Republics and borders (1840-1850)]. Vitória, Brazil: Anais Eletrônicos do VIII Encontro Internacional da ANPHLAC.

Morassou, P. (2009). As exportações portuguesas entre 1714 e 1770: Os efeitos do pombalismo através de uma discussão econômica [Portuguese exports between 1714 and 1770: The effects of Pombal through an econometric discussion]. *Economia Aplicada*, 13, 279-298.

National Historical Geographic Information System. (2009). *Population variables for 1840-1860s*. Minneapolis: Minnesota Population Center, Minnesota University.

Nenovsky, N., Ivanov, M., & Mihaylova, G. (2008). *The evolution of Bulgarian banks’ efficiency during the twenties: A DEA approach* (Working Paper No. 82). Athens: Bank of Greece.

Nye, J. (1991). The myth of free-trade Britain and fortress France: Tariffs and trade in the nineteenth century. *The Journal of Economic History*, 51, 23-46.

Picon, A. (1992). De l’utilité des travaux publics en France au XIXème siècle [The usefulness of public works in France in the nineteenth century]. *Economie et Société*, 3-31.

Picon, A. (1992). *De l’utilité des travaux publics en France au XIXème siècle* [The usefulness of public works in France in the nineteenth century]. *Economie et Société*, 3-31.

Pierre, P. (1997). *Le canal Henri IV ou canal de Briare* [The channel Henry IV or the Briare channel] (Monographies des villes et villages de France). Paris, France: Le livre d’Histoire.
Rowan, S. (2009). *Gustav Korner attacks Gottfried Duden in 1834: Illinois against Missouri?* 33rd annual symposium of the Society for German-American Studies, New Ulm, MN.

Shank, W. (1986). *The amazing Pennsylvania canals, 150th anniversary edition.* York, PA: American Canal and Transportation Center.

Simonin, J.-P., & Vatin, F. (2002). *L’œuvre multiple de Jules Dupuit (1804-1866), Calcul d’ingénieur, analyse économique et pensée sociale* [The multiple works of Jules Dupuit (1804-1866), engineer calculation, economic analysis and social thought]. Angers, France: Presses Universitaires d’Angers.

Takashi, U. (1980). *A propos des voies de communication de Michel Chevalier.* *Socio-Economic History,* 46, 625-647.

Tankersley, W., & Cuzan, A. (2004, January 8). *Fiscal policy, economic performance, and vote-getting efficiency: A DEA ranking of presidents, 1880-2000.* Paper presented at the annual meeting of the Southern Political Science Association, Inter-Continental Hotel, New Orleans, LA.

Temin, P. (1999). *The industrialization of New England: 1830–1880* (NBER Working Paper Series on Historical Factors in Long-Run Growth, Working Paper No. 114). Retrieved from http://www.nber.org/papers/h0114

Wheelock, D., & Wilson, P. (1995). Explaining bank failures: Deposit insurance, regulation, and efficiency. *The Review of Economics and Statistics,* 77, 689-700.

Wolfson, M. (1994). *Eligo ergo sum: Classical philosophies of the self in neoclassical economics.* *History of Political Economy,* 26, 297-325.

**Author Biography**

Paulo Reis Mourao, PhD, is an assistant at the Department of Economics of the University of Minho (Portugal). He is researcher at Núcleo de Investigação em Políticas Económicas(NIPE) (University of Minho). His main topics are social economics, public finances, and history of economic thought.