SOCIAL SAVING OF THE PANAMA

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Abstract

At the time when the Panama Canal was handed over to Panama, most people believed that the Canal was of little material worth to the United States. However, what was the value of this canal to the United States in the 1920s? We estimate the social savings generated by the Panama Canal for the United States in 1924 in order to assess the contribution it made to the social welfare of the United States. We estimate the direct social savings that resulted from lower shipping costs for both international and coastwise trade. Additionally, we estimate the benefits from two sources of indirect social savings. The first was generated as a result of the expansion of the feasible market area, due to reduced transport costs. The second source of indirect social savings is what we refer to as the pro-competitive effect of the competition between the water shipping via the Panama Canal and shipping via the transcontinental railroad. We argue that this competition resulted in lower freight rates for all railroad traffic due to the way in which the Interstate Commerce Commission regulated railroad freight rates. Estimates of total social saving range from 0.58 percent of GNP to 1.97 percent of GNP in 1924. Even the lower estimate of social saving is a value that is one quarter larger than the total cost of acquiring the land and constructing the Panama Canal.

1 Introduction

Robert Fogel (1964) shocked the Economic History profession when he challenged the notion that railroads were a necessary component of nineteenth century US growth. Since Fogel's investigation into the "social saving" of the railroad, others have applied this technique to assess the contribution of various innovations, such as canals (Ransom, 1970) and the inflow of immigrants (Neal and Uselding, 1972), to the growth process. Savings associated with these innovations are thought to have provided a significant stimulus to economic growth in the nineteenth century United States. One measures these social savings as the difference in GNP with and without the particular innovation under consideration.

Calculating social saving requires that one posit the counterfactual question: How would GNP differ if innovation X did not exist? We propose to calculate the social saving associated with the Panama Canal. That is, how much would United States GNP have differed from that which actually existed, if the Panama Canal had not been built? We shall evaluate the social saving of the Panama Canal for 1924.[1] This is a relatively stable period in which the there are few international disturbances and the world economy is neither at the peak nor at the trough of an economic cycle.

We provide a brief historical account of the building of the Panama Canal in the next section of the paper, followed in part three by a sketch of how one measures the social savings associated with a transport improvement such as the Panama Canal. Section four provides estimates of both the direct and indirect social savings that one may attribute to the Panama Canal. We conclude by offering some reflections on the significance of the canal to the United States and the world more generally.

[1] We use averages for 1923, 1924, and 1925 to avoid the idiosyncratic variation in data that might be associated with a particular year. When comparing 1924 with 1912 we use the average of data for 1911, 1912, 1913.

2 Background

In 1870, any sailor would have told you that finding a way to avoid Cape Horn and cut the travel time between the Atlantic and the Pacific would be a welcome discovery. The French were the first to attempt building a canal across the isthmus of Panama, employing the knowledge and skills accumulated from building the Suez canal. Ferdinand de Lesseps, builder of the Suez Canal, proposed building a sea level canal across the isthmus of Panama.[2] The cost of the canal was estimated to be $240 million in 1881 and de Lesseps thought that it would take approximately 12 years to construct. At more than twice the cost of the Suez, building the Panama canal would require the removal of nearly a third more earth than was necessary to build the Suez. (McCullough, 1977, p. 83)

Forecasting traffic of some 60 million tons of cargo per year[3], de Lesseps estimated that the canal would generate gross revenues of around $18 million per year. Thus, with $60 million in capital the French company, Compagnie Universelle, started work on the canal in February, 1881. Compagnie Universelle also purchased the Panama Railroad for $17 million to assist in the building of the canal. (McCullough, 1977, pp. 73, 125, 135-136.)[4]

Significant differences between the Suez and Panama doomed the French endeavor to failure: 1) the scale of the project was substantially larger; and 2) the climate and tropical diseases increased the casualty rate among canal workers. French equipment was not capable of efficiently removing the vast amounts of earth that building the canal required. The project would take sufficiently long that the company would expend all the capital available to finance

[2] Eventually de Lesseps realized that a system of locks would be necessary due to the topography of Panama.
[3] One should note that this estimated tonnage is approximately twice that which traversed through the Canal in any single year prior to World War II.
[4] The Panama Railroad offered an alternative to shipping around Cape Horn, but the unloading and loading costs at both ends increased costs sufficiently to make it an unacceptable alternative.

the project. More than 20,000 workers lost their lives working for the French on the canal. Thus, after seven years and spending $47 million more than de Lesseps had estimated for the entire project, Compagnie Universelle declared bankruptcy in December 1888. (McCullough, 1977, p. 235)

Although the Erie Canal was probably the most famous canal in the nineteenth century U.S., more than $150 million had been spent on canals and a great deal of knowledge of canal construction had been accumulated. The United States, in the Spooner Act of 1902, agreed to pay $40 million for the rights and properties of Compagnie Universelle. In addition the U.S. also paid $10 million to the Republic of Panama for the use of the land, with the stipulation that it would pay $250,000 annually for the right to operate the canal.[5] (McCullough, 1977, pp. 337, 393) The U.S. engineers and medical doctors were more successful than the French and the Panama Canal opened for traffic on August 15, 1914. The significance of the opening of the canal was diminished by the outbreak of hostilities in Europe that led to World War I. During World War I, the Canal was taken over by the US government and was not returned to independent operation until 1921.

3 Measuring Social Saving

Measuring the social saving associated with anything must take into consideration the particular reference group that is concerned. That is, for what country, area, or group are we attempting to measure the impact of some particular creation or institution. The Panama Canal was constructed by the United States, which derived considerable benefit from it. One could argue that the world in general derived benefits equal to or greater than the fees paid for usage.

[5] McCullough (1977:p. 617) indicates that under Woodrow Wilson the U.S. paid Columbia "an indemnity" of $25 million in 1921 for the loss of Panama.

However, measurement of benefits for the United States is sufficiently difficult, that we shall restrict our analysis to an evaluation of the benefits derived by the United States from the building of the Panama Canal.

Initially, it is the private rate of return on investment that one focuses on to assess the contribution of an investment to an economy, i.e., if the rate of return on the investment is not equal to or greater than the rate of return on alternative investments, then investment in the project reduced GNP below what it would have otherwise been if investment had been allocated to the best possible alternative. This is the approach followed by Fogel (1960) for the Union Pacific Railroad and by Ransom (1970) who calculated the rate of return on the Ohio Canal.

Tolls for the Panama Canal were fixed at $1.20 per ton of the earning capacity of a vessel, which is approximately $0.90 per ton of cargo carried.[6] (McCullough, 1977, p. 612) The ratio of revenue to cargo tons in Table 1 indicates that this approximation is slightly higher than the average, but this will bias the measure of direct social saving downward and guard against an overestimate. Average revenue for 1923, 1924, 1925 was $21 million for an average of 23.4 million tons of cargo that was shipped through the Panama Canal.

Data for 1923, 1924 and 1925 from the *Statistical Abstract of the US* (1926: 441), indicates that the average net revenue form the investment of $397million[7] was $14,194,346, yielding a rate of return of 3.58 percent. The rate of return on US Treasury bonds was 4.09 percent and the rate of return on railroad bonds was 4.85 percent. On the basis of this criteria alone, it would indicate that the canal was generating a relative loss with respect to GNP.[8] As had been the case for the railroads, the Panama Canal generated benefits that were not captured

[6] Huebner (1915) indicates that vessels with ballast were charged 40 percent less.
[7] This includes the $25 million President Wilson paid the Columbian government in 1921.
[8] Interest rates are from *Historical Statistics of the United States*: *Part 2* (1975) p. 1003.

in the net revenues resulting from Canal operation. The result is a social rate of return on the Canal that was greater than the private rate of return.[9].

We shall follow Fogel (1964) and attempt to measure the social rate of return of the Panama Canal for the United States. That is, we attempt to calculate the increase in GNP generated by the Panama Canal. To do so we will pose the following counterfactual: What would average U.S. GNP have been in 1923-1925 (hereafter referred to as 1924), if the Panama Canal had not been constructed? This period is ten years after the opening of the canal and is a period in which both the world economy and the U.S. economy are stable.[10] It is also the period in which the canal becomes profitable, i.e., revenues exceed operating expenses. We attempt to measure both the direct and indirect contributions of the canal to U.S. GNP. The direct benefits are derived from the lower transport costs incurred by shippers. The indirect effects are the market expansion that occurs as a result of the lowered transport cost and the lower railroad rates that prevailed as a result of competition from the canal. We shall examine each of these in turn.

4 Direct Social Savings

We calculate the reduction in shipping cost achieved by the construction of the Panama Canal in order to obtain a measure of direct social savings. Table 2 contains data on the reduction in shipping time for selected routes that resulted from the canal. A secondary issue, which we do not attempt to measure, relates to the larger number of ships or the larger number of rail cars that would have been necessary to carry the 1924 volume of trade, if it had been necessary to use longer routes and/or the transcontinental railroad.

[9] One must remember that freight rates for using the canal were set to cover the cost of operating the canal and not to maximize profits.

[10] Although technically 10 years after the opening of the canal, the canal was officially reopened for public traffic in 1921, after being taken over by the U.S. government during World War I.

First, we shall determine the import and export traffic that would have benefited from the existence of the Panama Canal. This will require the determination of the volume of U.S. imports from Asia, western South America, Australia, or New Zealand that arrive, via the Panama Canal, in Gulf or east coast ports. Analogously we will need to determine the volume of exports that originate at gulf or east coast ports and are shipped via the Canal to these same countries. The reverse will need to be determined for imports and exports of Pacific coast ports related to countries in Europe, eastern South America, and Africa. Using these data we can calculate the direct social saving derived from the Panama Canal.

A second component of the direct social saving derives from the reduced cost of coastwise shipping, i.e., shipping through the Panama Canal from east coast ports to west coast port and from west coast ports to east coast ports. If we represent coastwise trade as that between New York and San Francisco, then data in Table 2 indicate that opening of the Panama Canal reduced the shipping time by 7873 miles or approximately 33 days. As a first approximation we calculate the saving per ton shipped and compute the social saving realized from international and coastwise shipping using the Panama Canal instead of the longer Cape Horn route. As a second approximation, we calculate the difference in cost between shipping coastwise trade via the Panama Canal and shipping it via the transcontinental railroad.[11] The true saving would be somewhere between these two values.

The first approximation appears in Table 3 where the savings are calculated for each route and the coastwise shipping. These savings are approximately $45 million and, as reported

[11] It is unlikely that international trade would have been shipped via transcontinental railroad in the absence of the Panama Canal for the same reason that the Panama Railroad was not a viable alternative route.

in Panel [a] of Table 5 constitute less than one tenth of a percent of GNP in 1924.[12] Using data from Rockwell (1971) and assuming that the relationship between the rail and water rates that he found for green lumber holds for all goods, we use average per ton-mile railroad rates for 1924 to calculate the social benefit from not shipping the tonnage of coastwise traffic over the transcontinental rail system to be $121 million.[13]

According to the *Annual Report of the Governor of the Panama Canal*, approximately 60 percent of the coastwise shipping either originated from or was destined for the Gulf ports of the US. We use New Orleans (NO) as the Gulf port and New York (NYC) as the Atlantic coast port along with San Francisco (SF) as the West coast port, to determine travel distances. Assuming that the rate per ton-mile was the same between the West coast (SF) and the Gulf Coast (NO) as it was between the West coast (SF) and the Atlantic coast (NYC), we compute the cost of shipping coastwise trade by rail. If 60 percent of the coastwise tonnage was shipped between NO and SF and 40 percent was shipped between SF and NYC, then the benefit was $94.2 million.[14]

It is more likely that not all of the tonnage that went through the Canal would have been shipped by railroad in the absence of the Canal. Thus, we calculate the savings if 50% was shipped via the old pre-Panama Canal water routes and 50% by rail. The direct social saving is

[12] Although this direct social saving is less than one percent of GNP, the rate of return on the investment in the Canal, when the direct saving is combined with the private rate of return, is in excess of 14 percent. This is more than double the rate of return on bonds.
[13] The $121 million includes the saving from shipping international trade via the Canal instead of via Cape Horn.
[14] The $10.96 is net the saving for water relative to the railroad, and is the difference between the rail freight rate ($20.16) and the water freight rate ($9.20) from SF to NYC. The $8.25 is the net difference for railroad when the weighted average of the SF to NYC and the SF to NO rates minus the water rate via the Panama Canal is used, with 40 percent of the freight going to NYC and 60 percent going to NO: [(0.4)($20.16)+(0.6)($15.64)-$9.20=$8.25]. The $15.64 rate for hauling from SF to NO is the result of applying the per ton-mile rate for SF to NYC to the distance from SF to NO: [(2250)($0.006951)=$15.64].

then $83 million as reported in Table 3. If we calculate the saving when 60 percent goes to NO and 40 percent goes to NYC, the social saving is $69.6 million.

As reported in Panel [a] of Table 5, the direct saving due to the canal remains less than one percent of GNP. Unlike the direct social saving calculations made by Fogel (1965) for the railroad, which were a negative $38 million, the Panama Canal made a small but positive direct contribution to GNP in 1924. As in Fogel's case, we find that the indirect social savings are larger than the direct social savings.

5 Indirect Social Saving

In addition to the direct social saving generated by the Panama Canal, there are indirect sources of social saving. We shall focus on two: (1) the expansion of the feasible market, both export and import; and (2) the pro-competitive effect of water rates on railroad freight rates, i.e., using the Panama Canal instead of transcontinental railroad. To calculate the expansion of the feasible market area we need to examine the growth of net exports that may be attributed to the existence of the Panama Canal. That is, how much did exports and imports expand relative to what one would expect to occur as the result of normal income growth? The extent to which net exports expanded relative to what one would normally have expected, constitutes an increase in GNP that would not have existed without the canal.[15] The pro-competitive effect represents the saving realized because competition from water hauling via the Panama Canal kept railroad rates from rising more than actually occurred between 1914 and 1924.

[15] This is especially true due to the adverse effect of the Fordney-McCumber tariff which restricted trade after 1921. Moreover, we do not attempt to measure the growth of internal production due to the reduced cost of coastwise shipping, e.g., Rockwell (1971) attempts to evaluate the benefit of the Panama Canal to the lumber industry

5.1 Growth of Net Exports

Opening the Panama Canal reduced transportation costs for shipping between the east and west coast of the United States, between the east coast of the United States and western Canada, western Latin America, Asia, Australia and New Zealand and between the west coast of the United States and eastern Latin America, Europe, and eastern Canada. As a result, the feasible trading region was expanded and the range of products that might be profitably shipped also expanded. One would like to know how much of the United States net exports that existed in 1924 were due to the opening of the Panama Canal. Posing the counterfactual: what would net exports have been in 1924 without the Panama Canal, allows one to determine the amount of the actual net exports that were due to the canal. To obtain a measure of this, we estimate a gravity equation for both exports and imports in 1912[16] and use the estimated coefficients along with the 1924 values of the variables to determine what the level of net exports would have been in 1924, if the canal had not been opened in 1914. We subtract these estimates of the change in net exports from the actual change in net exports between 1912 and 1924, which provides an estimate of the expansion of the feasible market that resulted from the Panama Canal for the United States.[17]

Table 4 contains the estimated equations along with the predicted exports and imports for the major trading partners of the United States in 1912 and 1924.[18] Using the estimated coefficients from 1912 the predicted net exports for the United States in 1924 were $87 million,

[16] We use the average for 1911, 1912, and 1913 as the value for 1912.
[17] This will serve as an upper bound estimate for the market expansion effect of the Panama Canal. It is net exports that affect GNP so we focus on this measure of trade expansion.
[18] Since we are estimating a cross-section gravity model, only foreign GNP and GNP per capita appear in the regression equation. The uniform effect of US GNP and GNP per capita are captured in the intercept, whereas any cross country variation in the effect of US GNP and GNP per capita are contained in the error term. Dummies are included for common language (ENG), and regional effects (Asia and Latin America), with Europe being the omitted region.

which was $415.6 million *less* than the predicted net exports for 1912.[19] The actual US net export value for trade with these countries in 1924 was $448.4 million greater than actual net exports were in 1912. Thus, these counterfactual results indicate that the Panama Canal was responsible for an $864 million increase in net export, relative to what one would have predicted. This estimate is approximately 0.99 percent of GNP in 1924, which amounts to a sizable contribution for the Canal. Even if one argues that only half of the predicted increase in net exports can be attributed to the Panama Canal, the estimated expansion of the feasible market area still constitutes a significant contribution to GNP. These savings appear in Panel [b] of Table 5 as 0.99 percent and 0.49 percent of GNP, respectively.

5.2 Pro-Competitive Savings

A second source of indirect savings results from the "pro-competitive" effect of the canal, which we know put downward pressure on railroad hauling rates, especially for coast-to-coast rates. Daggett (1915) reports that the railroads almost immediately petitioned the Interstate Commerce Commission (ICC) to lower freight rates for coast-to-coast hauling without changing the interior rates. The ICC was very resistant to such discriminatory pricing. Based on the Fourth Section of Interstate Commerce Act as revised in 1910, it was "… unlawful for a common carrier to charge any greater compensation in the aggregated for the transportation of passengers or of like kind of property for a shorter than for a longer distance over the same line or route in the same direction, …, except as authorized by this Commission…."[20] When the railroads petitioned the ICC for permission to lower rates on coast-to-coast shipping, the ICC

[19] The R^2 for these two regression equations was 0.82 and 0.56, while the F-statistics were F(6,21) = 22.30 and 13.23 for exports and imports, respectively. The F-statistics were significant at the 0.00 probability level.

[20] Interstate Commerce Commission (1915) Twenty-Ninth Annual Report of the Interstate Commerce Commission, Part I, Washington, D.C.: Government Printing Office, p. 7. Also see Johnson (1921: 356-60) for a discussion of rate setting prior to 1920.

gave them a formula which provided rules of proportionality for rates from the interior to the coast and rates between interior points relative to rates for transcontinental traffic.[21] In the Transportation Act of 1920, the ICC was given the power to set freight rates such that the railroads would earn "normal" profits, which were deemed to be 6.0 percent of assets. The ICC was given the power to set maximum and minimum rates for the railroads, with half of any return in excess of 6.0 percent for a railroad going to a fund to support railroads that were in financial trouble. It is informative to note that the average rate of return on assets during the period 1923 to 1926 was less than 6.0 percent.[22] In fact, the ICC was encouraging the railroads to raise freight rates to increase their rate of return. The fact that railroads did not raise rates reflects the competitive effect of the Panama Canal with regard to transcontinental rates, given the linkage maintained by the ICC between transcontinental and interior rates.

Ocean freight rates for hauling lumber from west coast ports to east coast ports via the Panama Canal were 255 percent higher in 1924 than in 1914.[23] The 54 percent increase in railroad freight rates for similar hauling was not very different from the 44 percent increase in the Wholesale Price Index that occurred during this period.[24] Based on the ICC policy governing the relationship between transcontinental and internal freight rates, we argue that all freight rates were lower in 1924 than they otherwise would have been without the presence of the Panama Canal. The question is, what was the magnitude of this downward pressure on railroad freight rates which was exerted by the presence of the Panama Canal.

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[21] Discussions regarding a 1924 Fourth Section filing by the railroads for lower intercontinental rates than interior rates, indicate that the petition was continued from 1924 to 1925 and finally denied in 1926. ICC *Annual Reports*, 1924, 1925, and 1926.

[22] The average rate of return for 1924 was 4.67 percent. *Statistical Abstract of the United States 1925* p. 389.

[23] This is calculated as the percentage increase in the cost of water freight for lumber from the West coast to the East coast using data from Dagget (1915) and Rockwell (1971): [($9.20/$3.6)(100)=255].

[24] The increase in railroad rates assumes that the transcontinental freight rates remained the same proportion of the average aggregate freight rate in 1924 as it was in 1914. This assumption imparts a downward bias to our estimates of social saving, because any change in proportionality would have been for the transcontinental rate to fall relative to the average aggregate freight rate.

We present evidence in Table 5.c which offers five possible scenarios for calculating the effect of this increased competition from water hauling on the freight rates charged by the railroad. First, we examine the rate differential in 1914, based on the calculation of the rail freight rate assuming that transcontinental freight paid a rate that was the same proportion of the average rate paid by all freight per ton mile for that year as was the case in 1924. That is, using the data from Rockwell (1971) we calculate the per ton-mile transcontinental rate to be 61.4 percent of the average per ton-mile rate for all freight as reported by the ICC. We assume this same ratio holds for 1914, given the Section 4 was part of the 1910 revision of the ICC Act. The water freight rate comes from Daggett (1915:959) who cites sources indicating rates of $3.60 per ton. The result is a ratio of 3.63, for the transcontinental rail freight relative to water freight in 1914. [25]

Rates for water and rail freight were derived for lumber by Rockwell (1971) in a study of the effects of the Panama Canal on the lumber industry in the Pacific northwest. If one assumes that the rates for water hauling via the Panama Canal are for green lumber, then the transcontinental rail rate is 2.2 times the water rate in 1924. Thus, if competition generated this reduction in the differential between rail and water freight rates, one can argue that these reduced rates are additional savings which resulted from the building of the Panama Canal.

Panel [c] of Table 5 contains the results from estimating the savings due to competition between water hauling and railroad hauling of freight.[26] If we assume that 100 percent of the difference in the proportionality of freight rates was due to competition, then the savings would

[25] The 3.63 results from multiplying the calculated per ton-mile transcontinental freight rate ($0.0045) times the distance from SF to NYC (2900 miles) to obtain a rate of $13.05 per ton in 1914. The $13.05 is 3.63 times the all water rate of $3.60 per ton for West coast to East coast traffic quoted for the Panama Canal route in Dagget (1915).
[26] Calculating the saving that would result from a pro-competitive effect is done by calculating the area of the deadweight loss triangle that would result from a freight rate increase. If 100 percent of the differential is attributed to the Canal, then the price would have been 65 percent higher without the Canal. We also assume unitary demand elasticity which would have implied a 65 percent reduction in freight hauled

be $765.1 million or approximately 0.87 percent of GNP. However, it is more likely that a much smaller proportion of the rate differential is due to a pro-competitive effect from the Panama Canal. Thus, Panel [c] of Table 5 contains estimates of the social saving under various assumptions regarding the percentage of the freight rate differential one can attribute to a pro-competitive effect. The assumptions made and the method of calculation are described in the notes to Panel [c] of Table 5.[27] Social saving as a percentage of GNP ranges from 0.87 percent to 0.01 percent, depending on the proportion of the decrease in the rate differential that is assumed to result from the pro-competitive effect of the Panama Canal.

5.3 Total Social Savings Relative to GNP

Panel [d] of Table 5 contains data for total saving as a percentage of GNP as the various sources of saving are aggregated. Adding the indirect savings from the expanded international trade market results in a major increase in savings relative to GNP. Consequently, we report in parentheses the results if one assumes the market expansion effect of the Canal accounted for only 50% of the increase in net exports above what was predicted. The social saving resulting from competition between water freight and rail freight may have been substantial. Our social savings results for the Panama Canal range from a high of 1.97 percent of GNP to 0.58 percent of GNP in 1924. Thus, the total social savings generated by the Panama Canal for 1924 were between $508 million and $1,725.7 million, when the total cost of acquiring the land and constructing the canal was only $372 million.[28]

[27] We are calculating the welfare loss that would have resulted if rail freight rates had been higher due to lack of competition from the Panama Canal.

[28] The cost would be $397 million if one includes the payment of $25 million by the Wilson administration to Columbia.

6 Conclusion

These rates of saving are smaller than those found by Fogel for the railroad, where he argued that the social saving of the railroad was 4.7 percent of GNP in 1890.[29] However, if one considers the magnitude of the saving attributed to the Panama Canal relative to the cost of building it and compares that with the social saving attributed to the railroad relative to the cost of building the railroad system that existed in 1890, the Panama Canal is far more significant. It cost only $372 million to purchase the rights to the land and build the Panama Canal, whereas the estimated total savings in 1924 alone was over $500 million. This does not consider the fact that the Canal was earning revenues in excess of operating costs. The social saving of the railroad in 1890 did not come close to equaling the cost of constructing the existing rail system. The Panama Canal may well have been the best investment the United States government has ever made based on the social benefit relative to the cost of building it.

[29] The saving attributed to the railroad would have been approximately $616 million in 1890, or 4.7 percent of GNP of $13.1 billion. (*Historical Statistics of the United States: Part 2* (1975) p. 224. This value is far less than the cost of constructing the railroad system that existed in the US in 1890.

References

Daggett, Stuart. (1915) "The Panama Canal and Transcontinental Railroad Rates" *The Journal of Political Economy* 23:10 pp. 953-960.

Fogel, Robert William. (1964) *Railroads and American Economic Growth*. Baltimore, MD: The Johns Hopkins Press.

Huebner, G.G.. (1915) "Economic Aspects of the Panama Canal" *The American Economic Review* 5:4 pp. 816-829.

Governor of the Panama Canal. (various years) *Annual Report of the Governor of the Panama Canal* Washington, D.C.: Government Printing Office.

Interstate Commerce Commission. (various years) *Annual Report of the Interstate Commerce Commission* Washington, D.C.: Government Printing Office

Johnson, Emory R. (1912) *Report of Commission on Panama Traffic and Tolls.* . Senate Doc. 575, 62nd Congress, 2nd Session.

Johnson, Emory R. and Thurman W. Van Metre (1921) Principles of Railroad Transportation. New York: D. Appleton and Company.

McCull0ugh, David. (1977) *The Path Between the Seas: The Creation of the Panama Canal, 1870-1914* New York: Simon and Schuster.

Ransom, Roger (1970) "Social Returns from Public Transportation Investment: A Case Study of the Ohio Canal." *The Journal of Political Economy* 78:5, pp. 1041-1060.

Rockwell, Arthur E. (1971) “The Lumber Trade and the Panama Canal, 1921-1940” *The Economic History Review*, ns 24:3 pp. 445-462.

United States Department of Commerce (1926) *Statistical Abstract of the United States, 1925*. Washington: Government Printing Office.

United States Department of Commerce (1975) *Historical Statistics of the United States: Colonial Times to 1970* Washington: U.S. Government Printing Office.

Table 1 Panama Canal Toll Revenue and Cargo Tonnage, 1915-1940
(millions)

Year	Tolls (dollars)	Cargo (tons)
1915	4.3	4.8
1916	2.4	3.0
1917	5.6	7.0
1918	6.4	7.5
1919	6.1	6.9
1920	8.5	9.3
1921	11.2	11.5
1922	11.1	10.8
1923	17.5	19.5
1924	24.2	26.9
1925	21.3	23.9
1926	22.9	26.0
1927	24.2	27.7
1928	26.9	29.6
1929	27.1	30.6
1930	27.0	30.0
1931	24.6	25.0
1932	20.6	19.7
1933	19.6	18.1
1934	24.0	24.7
1935	23.3	25.3
1936	23.4	26.5
1937	23.1	28.1
1938	23.1	27.3
1939	23.6	27.8
1940	21.1	27.2

Source: U.S. Department of Commerce *Historical Statistics of the United States, Colonial Times to 1970* Washington, D.C.: U.S. Government Printing Office, 1975, p.
Note: All data are for the fiscal year, July 1 to June 30.

Table 2 Travel Savings for Particular Routes Using the Panama Canal

Route	Savings Nautical Miles	Days
Compared to Cape Horn		
New York to San Francisco	7873	33.3
New York to Valparaiso, Chile	3747	15.1
New York to Iquiqui, Chile	5139	20.7
New York to Guayaquil, Ecuador	7405	29.8
San Francisco to Liverpool	5666	24.0
Compared to Suez		
New York to Yokohama	3768	15.2
New York to Shanghai	1876	7.3
Compared to South Africa		
New York to Sydney	3932	15.8
New York to Wellington	2493	9.9

Source: G.G. Huebner (1915) "Economic Aspects of the Panama Canal" *American Economic Review* 5:4 December p. 818. The days saved are calculated assuming steamships traveled at 10 nautical miles per hour, which was the typical speed of a steamship during this period. This is the speed used in Emory (1912).

Table 3 Savings From Water Hauling via Panama Canal: Average Tonnage (1923-1925)

Route	Average Tonnage	Days Saved	Saving @ $0.10/ton/day
East US to West S. America[a]	2,248,771	21	$4,722,420
East US to Asia	1,464,786	11	1,611,264
West US to Europe	1,499,642	24	3,599,140
East US to Australia	636,977	12	764,372
East US to West Canada	466,228	33	1,538,554
East US to West US	9,933,538	33	32,780,675
Total Saving all water			45,016,426
Total Saving: Canal Tonnage Including East US to West US by Railroad @ $10.96[b] more than water			121,107,327
Total Saving: Canal Tonnage Including East US to West US 50% by rail and 50% by pre-Panama Canal routes			83,061,876
Total Saving: Canal Tonnage Including East US to West US by Railroad @ $8.25[b] more than water due to 60% New Orleans and 40% New York			94,187,438
Total Saving: Canal Tonnage Including East US to West US 50% by rail and 50% by pre-Panama Canal routes with 60% new Orleans and 40% New York			69,601,932

[a] The days saved for shipping from the East coast to West South America are the average for Valparaiso and Iquiqui, Chile and Guayaquil, Ecuador. [b] See footnote 10 in the text for an explanation of the derivation of these net values.
Tonnage hauled data are from the *Annual Report of the Governor of the Panama* Canal for 1923, 1924, 1925. Rail rate and water rate are from Arthur E. Rockwell (1971). The saving per ton-day is from Emory Johnson (1912).

Table 4 Predicted Changes in Net Relative to Actual Net Exports, 1914 to 1924
(millions of dollars)

1914 Predicted Exports	1914 Predicted Imports	1924 Predicted Exports	1924 Predicted Imports	Country
40.347	20.744	8.234	6.342	Belgium
13.994	15.307	5.606	5.738	Denmark
9.740	7.401	4.485	3.926	Finland
122.847	74.414	13.649	11.309	France
124.437	71.204	12.591	10.570	Germany
82.508	60.015	11.183	9.645	Italy
32.076	16.952	8.336	6.062	Netherlands
9.162	6.513	4.667	3.954	Norway
4.014	7.232	5.016	5.160	Portugal
47.075	35.477	9.420	8.398	Spain
23.989	14.457	6.451	5.267	Sweden
5.316	11.762	4.215	4.908	Turkey
272.022	80.569	25.892	13.416	United Kingdom
354.396	95.432	89.494	42.516	Canada
50.160	77.251	30.093	21.010	Mexico
55.479	48.803	12.414	14.349	Argentina
31.246	67.377	10.708	19.148	Brazil
14.082	9.209	5.158	4.028	Chile
3.304	6.166	5.486	6.000	Colombia
2.426	5.006	4.350	4.555	Peru
4.897	5.464	4.801	5.286	Venezuela
55.972	168.961	13.572	15.385	China
58.273	60.762	9.733	8.409	Japan
55.525	14.421	10.950	4.019	Australia
17.805	4.487	6.731	2.526	New Zealand
5.931	10.436	4.970	4.052	Philippines
8.252	4.453	7.612	3.175	South Africa
3.330	5.534	4.118	3.634	Egypt
	502.795		87.149	Predicted Net Exports

Change in Predicted Net Exports: $87.149 - 502.795 = - $415.646
Change in Actual Net Exports: $1126.321 – 677.957 = $448.364
Estimated Change in Net Exports Due to Panama Canal: $448.364 – (- 415.646) = $864.009
Estimating Equations:
log (Exports)=3.03 + 0.77 log(GNP)*** + 0.17 log(Per Capita GNP) -0.25log(Distance)
+ 0.52 English+ 0.43 Asian Region** + 0.1.30 Latin American Region*
log (Imports)=5.07+0.81 log(GNP)*-0.47 log(Per Capita GNP)-0.48 log(Distance) 0.10 English
+0.95 Asian Region*+0.77Latin American Region
***, **, and * reflect significance at the 0.01, 0.05 and 0.10 levels, respectively.

Table 5 Social Savings as a Percentage of GNP, 1924

[a]

Tonnage Passing Through Panama Canal	(Percent GNP)
Savings from Pre-Panama Canal water hauling	0.05
Savings from all rail hauling of Coastwise Trade	0.14
Savings from 50% rail and 50% Pre-Panama Water	0.09
Savings from all rail hauling of Coastwise Trade 60/40 Split	0.11
Savings from 50% rail and 50% Pre-Panama Water 60/40 Split	0.08

[b]

Saving Due to Expansion of Market Area

Net Exports Increased $864,009,500 more than gravity model would have indicated

	(Percent GNP)
All Additional Net Exports Due to Panama Canal	0.99
50% of Additional Net Exports Due to Panama Canal	0.49

[c]

Savings Due to Competition Induced Reduced Hauling Rates for Railroads

Competitive Effect	Savings	Percent GNP
100%	$765,100,476	0.87
50%	306,040,190	0.27
30%	68,859,043	0.08
20%	30,604,019	0.03
10%	7,651,005	0.01

Panel [c] calculated using following information: Total Tonnage = 391,945,000,000 tons; Average rate per ton mile = $0.01132; Freight Rate 65% higher if same ratio had maintained as in 1914; assumes unitary elastic demand curve for freight hauling.

[d]

Cumulative Effects[a]:

Scenario:	% GNP	(50%Mkt.)
Days Saved + 100% Market Area + 100% Competitive Effect (all rail)	1.97	(1.47)
Days Saved + Market Area + 50% Competitive Effect (50% rail)	1.32	(0.82)
Days Saved + Market Area + 30% Competitive Effect (50% rail)	1.15	(0.65)
Days Saved + Market Area + 10% Competitive Effect (50% rail)	1.08	(0.58)

[a]All calculations in Panel [d] used the results for direct social saving where 60% of transcontinental shipping was between the Gulf Coast (New Orleans) and the West Coast (San Francisco) and 40% was between New York City and the West Coast (bottom two rows of Panel [a].