The role of markets, governments, and new goods on transport improvements and the first globalisation era: Insights from the case of the Pacific railroad

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Draft and incomplete

February 2008

Abstract

1. Introduction

The Pacific railroad (PR) connected the Mississippi valley region to the Pacific Ocean and was built between 1863 and 1869 (see figure 1). Once it was inaugurated the railroad reduced travel times between eastern and western US to a little more than one week and with relative safety. The alternatives were three and clearly less convenient. Crossing the continent overland in a stage coach took between one and three months of hardships. Using ship to Central America, crossing the tropical jungle and exposing yourself to tropical diseases, and then heading to San Francisco by ship. Travelling the three to six months long and dangerous ship routes around the Cape Horn or the Cape of Good Hope (see figure 2). Additionally, the Pacific railroad connected more than eastern and western US, as it was connecting eastern US to Asia, western US to Europe, and Asia to Europe.

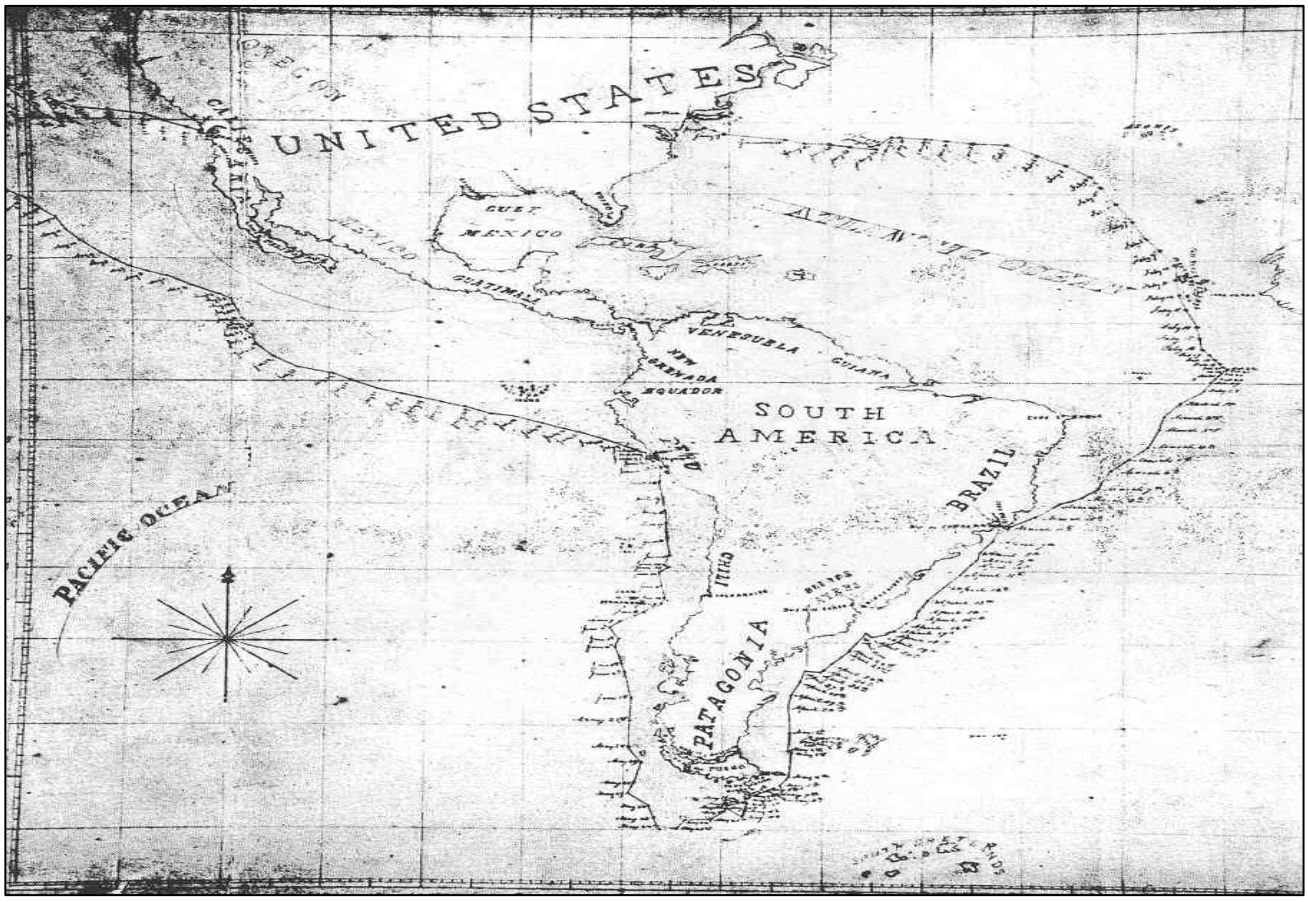
Viewed this way, the Pacific railroad was part of a broader set of efforts promoting the first period of globalization. In Boston and New York faster ships were being developed – the Clipper ships –. In the US and UK the application of steam power to shipping was reducing transport costs and improving speed on the North Atlantic. Several other major large scale projects also contributed to the development of the first globalisation era. Four additional transcontinental railroads built in the US, another one in Canada, and later the Tran-Siberian railroad was also built. A Canal across Central America was considered all along the second half of the 19th Century and in 1855 a railroad over the Panama Isthmus was built. The Panama Canal was finished during the second decade of the 20th Century. Finally, and competing with the PR for the Europe-Asia trade, the Suez Canal was inaugurated just a couple of months after the PR. All these transportation improvements changed dramatically transport routes, costs, speed and safety of moving goods and people between countries during the second half of the 19th century and represent a magnificent example of the diffusion and effects of the steam technology and the a force leading to the first era of globalization.

Moreover, most of these projects implied massive technical and economic efforts. The PR itself was a colossal infrastructure project. The railroad crossed two thirds of the US, the prairies, the Rocky Mountains, the deserts, and the Sierra Nevada. The size of the project also implied the economic effort had to be sustained for several years. Moreover, the territories it would cross were still being explored, had not been settled yet, and the relationship between Native Americans and whites was developing into conflict. As many of the large scale transport improvements pointed out above, substantial subsidies were also provided to finance the project and promote private construction. And it also ended up clouded in a corruption scandal. In 1873, just after the PR main line had been finished, the Credit Mobilier scandal erupted and it became clear that the directors of one of the companies involved in the project had devised a scheme to appropriate a substantial part of the subsidies as construction profits and had been giving stock to Congressmen favouring increasing subsidies. Suspicions that something of use of a similar scheme by the other PR company and many other companies involved in the large scale transportation improvement projects exists.

Figure 1. Map of the Pacific railroad

Source: Cisco (1868)

Figure 2. New York to San Francisco all-sea trade route, 1850



Source: Delgado (1990)

One may think that because subsidies were granted to most of all these transport improvements, the projects were not deemed to be profitable. However, the corruption scandals indicate that it could be possible private incentives to develop privately these railroads and canals existed. Moreover, the available literature on the social savings of these transportation improvements indicates that the PR and some other of these projects were profitable privately and socially[1].

In this paper the private incentives for the development of these large scale transport improvements are analysed by studying the case of the PR. More precisely, was the PR expected to be profitable? The approach is to study three sources of evidence. First, the expectations declared by entrepreneurs before the railroad was built and operated are studied. Second, the expectations, as drawn from the outcomes of a simulation model of the entrepreneurial investment decision, are analysed to control for any potential mistakes or untruthful information provided by the entrepreneurs in their declarations. Third, ex-post information of the railroad's performance is analysed to understand why it was profitable. The emphasis is on using the three different sources of information to identify a reasonable measure of expected profitability and distinguish between asymmetric information empowering the entrepreneurs and real uncertainty.

The findings indicate the PR should have been expected to be profitable. However, the PR could not have competed on prices with shipping around the Capes. Only by pricing to capture the rents derived from the new good benefits of substantial travel time reductions and safety improvements the PR should have been and was profitable. These findings suggest that the process of transport improvements leading to the first era of globalisation are is complex than we have acknowledged up to now.

First, globalisation was triggered by transport improvements leading to declining inter-oceanic transport costs mostly associated to the development of steamships, as many have suggested[2]. But globalisation was also triggered by transport developments that allowed for transport quality improvements. People were willing to pay more to obtain transport services that reduced travel time and improved safety. The product innovation angle (as opposed to process innovation leading to transport cost reductions) of the transport improvements during the second half of the 19th century has been very much neglected in the first globalisation era literature. Additionally, the fact that PR profit expectations were positive during the 1850s suggests that market was pulling for the introduction of the PR. In turn, as a substantial part of the market targeted by the PR was expected to come from international and inter-regional trade, it is also possible to suggest that globalisation caused transport improvements. Second, there are three facts that are not easy to reconcile: i) the PR entrepreneurs expected the PR to be profitable, ii) but still they requested subsidies, and iii) government granted subsidies. Additionally, we also know that since the PR would cross federal territories and would divert trade flows between regions, intervention of Federal Government and Congress

[1] See Fogel (1960), Mercer (1970, 1974, 1982), Fleisig (1974, 1975). What is most important and is missing in the literature surveyed is ex-ante information, information about the expectations entrepreneurs had by 1862, how they formed them, what information sources they used, and what this expectation was.
[2] See Harley (1988) and Williamson (2003).

would have been necessary to allocate the right of way and solve the inter-regional conflicts over benefits and costs of building and operating the railroad. On the whole, this papers highlights the transport quality improvement angle of the diffusion of the steam engine, while at the same time points to the complex causal relationship between international trade, transport improvements, and government interventions.

In the next section this paper introduces briefly the PR as a project and its construction by following, describing and evaluating the reports developed by the three most persistent entrepreneurs. It also identifies clearly profit expectations, as declared by the entrepreneurs. The third section develops an empirical model of the construction decision and evaluates the plausibility of the arguments put forward by the entrepreneurs to support the PR project. The fourth section evaluates the ex-post evidence to understand better why the PR was profitable. The fifth section compares the information collected to draw the distinction between uncertainty and asymmetric information. Finally, some conclusions are put forward.

2. Did entrepreneurs expect the PR to be profitable?

In this section the history of the PR as a business project is presented by following the proposals developed by the three most persistent entrepreneurs: Asa Whitney, Thoedore Judah, and Grenville Dodge. Additionally, the logic of the calculations performed by entrepreneurs to argue their case and their profit expectations are also highlighted.

2.1. Asa Whitney

The first entrepreneur to draw a project to build the PR was Asa Whitney, a merchant that had been active in New York, London and China and was connected to the Jay family. Asa Whitney's trip to China coincided with the end of the Opium wars and the opening to British trade of five Chinese ports, through the "Treaty of Nanking". In China he spent less than two years acting for a New York merchant house and returned to the US, just after the US had signed the preliminary treaty of Wang-Hae. In his way back to the US, in March 1844, Whitney formulated his plan for the transcontinental railroad: the Pacific railroad.

Any project to build a railroad between the Mississippi and Pacific coast had to go through Congress as the railroad had to go through federal territories and at the very least the right of way had to be donated by or bought from the Federal State[3]. Whitney presented three projects to the US Congress in 1845, 1848, and 1851. Additionally, he also published a booklet to describe the details of his project to anyone interested. The project remained essentially unchanged and argued for connecting the "railroad network between New York and Lake Michigan to a railroad traversing the west and linking Lake Michigan to the Pacific Ocean"[4]. The

[3] In 1845 when Whitney submitted his first memorial to Congress the US did not have direct access to the Pacific Ocean. In 1846 the Oregon question was settled and in 1848 the US-Mexico war was wan and the US gained access to the Pacific Ocean. See more on this below.

[4] Whitney, A. (1845), Whitney (1848) and Whitney (1849). Quote comes from Whitney (1845) p. 2.

purpose of the railroad to the Pacific was to substantially reduce time and cost to reach Asia and boost US-Asia trade. Additionally, Whitney also stressed on the potential markets to be opened to the US by the project and indicated "our continent is placed in the centre of the world; Europe with 250 millions of population, on one side, and all Asia on the other side, with 700 millions of souls … and no part more than 25 days from us; and it will be seen that this proposed road will change the present route for all the vast commerce of all Europe with Asia, bring it across our continent, make it and the world tributary to us, … . It would bind Oregon and the Pacific coast to us … It would open the vast markets of Japan, China, Polynesia and all Asia to our agricultural, manufacturing, and all other products"[5].

A statistical appendix also contained detailed information on distances, travel time and traffic between different national locations and international ports. Particularly relevant, Whitney identified traffic that could be diverted to the PR as trade between the US and Asia and trade between Europe and Asia through Cape Horn and the Cape of Good. He calculated a total of 1.26 million tons were traded on these routes (see figure 3). The information was collected from different sources publicly available[6]. Once observed traffic had been identified Whitney developed an estimate of expected price and traffic. Assuming observed traffic was similar both ways and setting PR rail rates at 0.5 cts per ton mile and eastern railroads rates at 1 cts per ton mile resulted in expected revenue for the PR of $13 million[7]. Whitney acknowledged that the PR was expected to be profitable but argued that the objective of the road should be to maximise trade diversion rather than profits, and thus should price just to cover operation costs and repairs[8].

The cost side of Whitney's analysis was, however, not fully developed. Whitney estimated construction cost by using an average construction cost of some eastern railroads and expected distance, reaching $40.6 million during a 10 year construction period[9]. He proposed to finance construction by using a 60 mile wide land strip between Lake Michigan and Puget's Sound (donated or bought from Federal government) to sell it to in-migrants into the US achieving to i) collect the necessary funds to build the railroad, ii) organising in-migration and saving eastern cities from threat of poor in-migrants becoming a danger to society, and iii) allowing the in-migrants to have a their own land, means to become self sufficient, and transport means to commercialise their crops[10]. The PR was, in Whitney's eyes more than a railroad. It was a plan to develop the nation, to control the forthcoming problems brought by mass in-migration and turn them into an opportunity for economic empire based on territorial expansion and control over international trade. Whitney

[5] Whitney, A. (1848) p. 7 and Whitney, A. (1849) p. 59.
[6] The sources include Treasury Reports on Commerce and Navigation for the US and from various sources for the other countries, like McCulloch, McGregor's Commercial Tariff and Statistics, Hunt's Merchant Magazine, Watterson's Cyclopaedia of Commerce, and Britain's Parliamentary Reports. Whitney also presented individual tables for every country (see Whitney, A. (1849) p. 69 and Appendices 5-16 in pp. 70-82).
[7] Whitney, A. (1849) p. 36. Whitney approximated 1.26 millions tons of freight to 1.3 and multiplied it by 2 to get traffic on both directions. Distance of the PR was expected to be 2,000 miles. Additionally, Whitney indicated the road would be able to run without losses, even if it had to pay dividends. Paying dividends of 6% was possible by charging 0.96 cents per ton and carrying 1 million tons.
[8] Whitney (1845), pp. 3-4.
[9] Whitney (1848), p 3.
[10] Whitney (1848) pp. 2-3. Whitney offered to pay 10 cents per acre.

also emphasised it was important to avoid the capital markets, as it would lead construction costs to almost double.

Figure 3. Estimation of observed freight through traffic for PR by Whitney

Country	Year of data	Inward			Outward		
		Ships	Tonnage	Men	Ships	Tonnage	Men
England	1842	877	329,404	16,698	823	348,724	18,468
US	1845	329	111,180	6,998	367	125,582	8,305
France	1833	117	36,040	2,048	117	36,040	2,048
Antwerp	1839	7	2,860	125		272	12
Bremen	1841	6	1,800	100	1		
Hamburg	1841	10	5,000	200	10	5,000	200
Netherlands	1840	188	97,231	5,150	221	113,862	5,625
Russia with China		50	25,000	1,000	50	25,000	1,000
Total		1,584	608,515	32,319	1,589	654,480	35,648

Source: Whitney (1849)

Parallel to his activities in Congress, Whitney developed a publicity campaign and invited different citizens and media to explore the route with him to confirm the railroad was practicable[11]. As Whitney developed his publicity campaign the US expanded to the West as the Oregon question was settled and the US-Mexico War was wan. In just a couple of years the US expanded into a massive territory on the Pacific, and the PR western terminus was suddenly within US borders. Public perception then turned from mildly positive to clearly positive. Several newspapers and specialised magazines pronounced positively about Whitney's plan. Explorers like Freemont, Fitzpatrick and Pollock and the prestigious American Railroad Journal indicated a railroad over the proposed route was practicable. Additionally, 14 States sent resolutions to the House in favour to the bill, and included the most important eastern seaboard Northern and Southern States[12]. Most of the States on the Mississippi, however, did not support Whitney's plan.

Whitney's last memorial was made into a bill that failed to pass through Congress, even after several modifications[13]. The negative of States on the Mississippi to support Whitney's plan hinted to sectional differences and competition over the profits derived from the PR. On the west, Puget's Sound was a natural port, and had been included in the Whitney plan. However, California also possessed a natural port in San Francisco's bay, and it became a potential alternative terminus for the Pacific for the railroad. The 1849 Gold Rush strengthened the position of San Francisco as the leading development pole in the Pacific coast[14]. San Diego, as the most southern port on the Pacific also became a potential alternative terminus. The issue of the

[11] Brown, M. (1933)
[12] Whitney (1849) Annex includes supporting declaration by Freemont, Fitzpatrick, and 14 US State legislatures. Brown (1933) p. 219 indicates the American Review, Hunts Merchants Magazine and the Democratic Review wrote positive articles about the PR and Whitney's proposed route, while DeBows supported the PR idea but preferred a different route.
[13] Cotterill, R. (1919) pp. 405-8.

route was to become a crucial one. In 1850 there were five different projects based on five different routes competing for Congressional approval[15]. When retiring, Whitney indicated that inter-regional conflicts of interests over the benefits and costs of the PR blocked his project[16]. Searching for a technical choice, in 1853 Congress decided to request the army to evaluate different alternative routes for the railroad and estimate their costs[17].

2.2. Theodore Judah

The second influential entrepreneur was Theodore Judah, a New York railroad engineer who had directed the construction of Niagara Falls Gorge railroad, an engineering feat of the time. Additionally, he also participated in the construction and operation of other large transport projects, including the Erie Canal[18]. In 1853 Judah was contacted by New York's state governor; he wanted to introduce him to the promoters of the Sacramento Valley Railroad. Judah became chief engineer of that company and in 1854 arrived to San Francisco to build the Sacramento Valley Railroad. The railroad was opened in 1856, and was expected to be the first stage of the Pacific railroad[19].

During construction of the Sacramento Valley railroad Judah also took the opportunity to explore the Sierra Nevada and started developing his own plan to build the PR. He published in 1857 "A Practical Plan for Building the Pacific Railroad". In this document Judah explained why the PR had not been built yet. First, speculators had been associated to the Pacific railroad projects. Second, "there are different routes, advocated by diverse interests, each eager that the road be built to subserve its own particular interest, but unwilling to make common cause upon a common route"[20]. Third, the surveys performed in 1853 were no detailed enough on key points of the route (as they did not identified the number and cost of bridges and tunnels) and generated "lack of confidence in private capitalists … (as) private capital can be had with which to build railroads, and sometimes even unprofitable ones, … (as) 25,000 miles (had already been built in the US) … costing (more than) $1,000 million dollars"[21]. Finally, after indicating that state and federal government intervention would mean defeat to the project, Judah finished in a surprising manner his plan. He requested federal government to: i) perform a detailed survey and build a wagon road on the route surveyed and ii) to pass a bill donating alternate sections of land to aid construction of either the railroad or the wagon road[22].

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[14] Lotchin (1974) pg 6.
[15] Loomis, N. (1912-13) p. 172 and Hittell (1898) pp. 447-49 indicates that by 1850 there were already five different routes proposed in Congress and supported by different States on the Mississippi.
[16] Also note the geography of the conflict over the gains and costs of the Pacific railroad neatly coincides with that of slavery, complicating further the political economy of the project.
[17] XXX
[18] Hittell, T (n.d.) 1st page
[19] Hittell, T (n.d.) 1st page and Hittell, T. (1898) p. 453
[20] Judah, T. (1857) pp. 4-5
[21] Judah, T. (1857) pp. 4-5
[22] Judah, T. (1857) p. 31.

The next couple of years Judah was involved in several local railroad initiatives, promoting the PR in Washington and exploring the Sierra Nevada looking for a pass[23]. In 1860 he discovered the Dutch Flat route and published a note titled the Central Pacific Railroad of California. Judah held several meetings in San Francisco and had no success in collecting the necessary funds. In Sacramento, however, he was able to convince a group of merchants of the value of the project. They also agreed to give Judah $35,000 to perform a thorough survey of the route. The survey indicated the feasibility of building the PR and on June 28th 1861 the Central Pacific Railroad of California Company was incorporated by Judah and the Sacramento merchants (the big four)[24].

Judah wrote the report on his activities surveying the route and handed it to the board of the Central Pacific Railroad of California on October 1 1861. The report was comparable to that performed to build other contemporary railroads in the sections it contained, the level of detail and the methods used to collect the information[25]. In this report Judah presented a detailed survey of the route between Sacramento and Virginia City, on the Washoe, Nevada. He showed it was possible to find a route with grades comparable to those of many eastern railroads. For instance, figure 4 shows the grade table provided in Judah's report. Note no single grade is above 116 feet per mile, the maximum grade of the Baltimore-Ohio railroad. He also identified the need for 18 tunnels and their expected costs as $870,500. Total construction costs were derived by estimating costs (including explicitly tunnels and bridges) by route stage[26]. Figure 5 shows construction costs per route stage. The total cost of the Sacramento to state border railroad was $12.4 million. The route design from Virginia City to Salt Lake City was completed using data from Lieutenant Beckwith drawn from the Army 1853 surveys. Judah argued it was possible to continue the railroad from Virginia City to Salt Lake City and then to the Missouri river with grades and curves less demanding than those for the Sacramento-California State line stage. Additionally, Judah also used Lieutenant Beckwith information to infer total cost of the Pacific railroad as $99.9 millions, from Sacramento to Council Bluffs, next to the Missouri river in Iowa[27].

Figure 4. Table of grades for the Central Pacific calculated by Judah

[23] Galloway, J. (1941) p. 57.
[24] The big four were Charles Crocker, Mark Hopkins, Hollis Huntington, and Leland Stanford.
[25] Twining, A (1849), Holcomb, F. (1847) XX NICE TO HAVE SOMETHING ON THE CHICAGO, PROCK ISLAND AND PACIFIC XXX
[26] Judah, T. (1861) pp. 18-26.
[27] Judah, T. (1861) pp. 26-29.

Table of grades.

Length of plane, feet.	Grade ascends per mile.	Grade descends per mile.	Length of plane, feet.	Grade ascends per mile.	Grade descends per mile.	Length of plane, feet.	Grade ascends per mile.	Grade descends per mile.
3,000	9		11,000	105		10,500	105	
3,000	53		4,000	53		1,000	53	
1,000	Level.		6,750	105		500	Level.	
3,000	45		18,250	Level.		5,000	79	
4,500	Level.		3,000	105		3,000	105	
6,500	45		1,000	Level		3,000	79	
4,000	36		6,000	36		38,000	105	
4,300	53		13,500	Level.		2,000	Level.	
6,300	79		17,500	105		1,000	53	
3,200	Level.		1,000	Level.		25,000	79	
500	53		3,500	105		2,750	26	
12,700	84		1,000	Level.		3,500	105	
3,300	Level.		3,500	105		2,000	Level.	
5,000	84		1,000	53		57,500	105	
6,000	65		2,500	105		1,750	53	
7,100	84		2,000	Level.		2,500	Level.	
1,300	53		13,000	105		13,750	105	Summit.
2,500	105		1,000	Level.		45,000		105
1,800	26		1,000	53		1,750		Level.
4,000	75		4,000	Level.		15,250		105
1,000	53		172,500	105		2,500		Level.
1,000	75		1,250	Level.		6,500		53
1,700	105		1,000	79		3,200		39
2,500	75		1,000	Level.		2,750		Level.
2,000	105		4,000	53		3,500		39
2,000	65		14,000	105		1,000		53
3,000	105		3,000	53		2,000		39
15,000	116		4,000	79				

Source: Judah (1961)

Figure 5. Table of construction costs for the Central Pacific estimated by Judah

Cost of road from Sacramento to State line, or Neil's, 140 miles.

	Miles.	Cost per mile.	Total.
Sacramento to Lincoln	25	$50,000	$1,250,000
Lincoln to Barmore's	6	60,000	360,000
Barmore's to Nevada road	12	90,000	1,080,000
Nevada Road to Clipper Gap	6	50,000	300,000
Clipper Gap to Long Ravine	12	80,000	960,000
Long Ravine to Gravel Ridge	9	110,000	990,000
Gravel Ridge to Bear River	5	85,000	425,000
Bear River to South Yuba	21	100,000	2,100,000
Yuba to Hall's Cañon	1	75,000	75,000
Hall's Cañon to Summit valley	11	100,000	1,100,000
In Summit valley	2	75,000	150,000
To Summit Sierras	2	150,000	300,000
Summit to Strong's Cañon	2	150,000	300,000
Strong's Cañon to Truckee	10	100,000	1,000,000
Truckee to Neil's, or State line	16	70,000	1,120,000
Add 18 tunnels			870,000
Total cost to State line	140		12,380,000

Or an average cost of $88,428 per mile.

Source: Judah (1861)

In order to estimate expected revenues, Judah defined the PR market as transport between Sacramento and the eastern slope of the Sierra Nevada. He identified three sub-markets of local freight and passenger traffic[28]. The report includes the observed price for different trips on these routes. Observed traffic information was developed by performing a traffic survey on the Placerville Wagon Road, one of the four

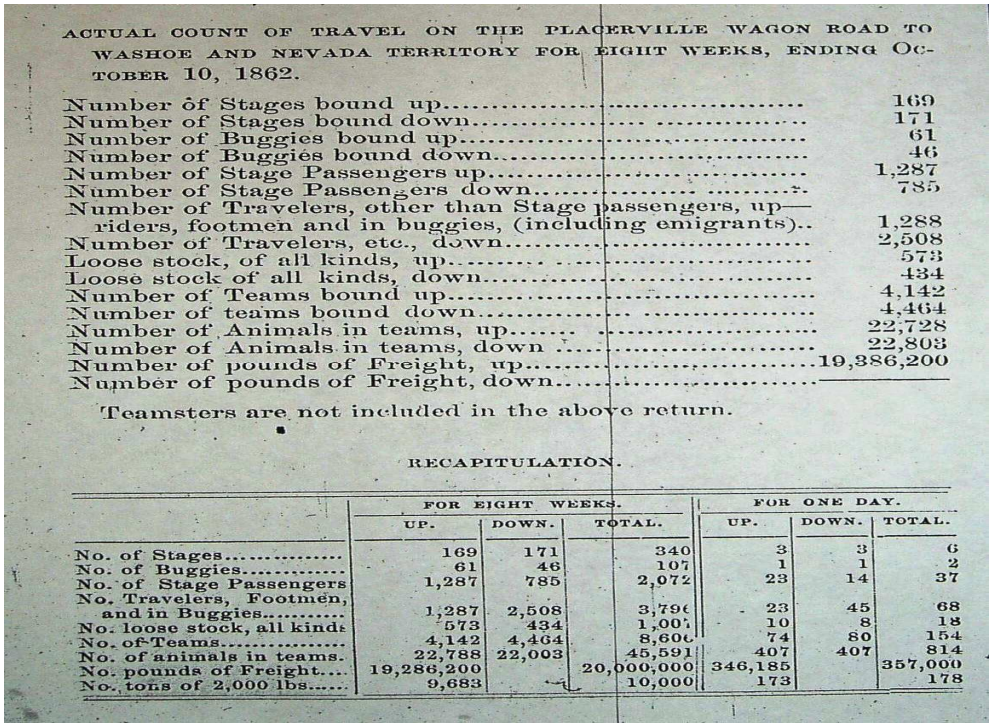
[28] The information on revenues was only included in the October 1862 version of the document, after the Pacific Railroad Act had granted subsidies. However, it was possible to control for the effects of subsidies on expected revenues (see details Duran (2008)). Additionally, and also very important, note that although Judah did not study quantitatively international and inter-regional freight and passenger traffic, it is clear from his 1857, 1861 and 1862 reports that he did consider these earnings in the long run, when the whole PR had been built.

wagon roads leading to the Washoe mining region[29]. Figure 6 shows the Placerville Wagon Road traffic survey summary statistics and indicates average passenger traffic was 37 per day and freight was 178 tons. Next Judah used observed price and traffic information to forecast expected revenues. For instance, he proposed to reduce passenger rates by 50% from $30. Additionally, he also assumed half of the Sacramento-Washoe travellers not using wagon (walking and using buggies) would indeed use the railroad if it offered lower transport costs. Thus, expected price was $15 and traffic was 71 passengers per day. Performing this exercise for every sub-market Judah arrived to total expected earnings of $4.2 million[30]. Additionally, Judah developed an operation cost estimate of $1 million, and operational profits resulted in $3.2 million, or 21% of construction cost for the first stage of the PR[31] (see figure 7). In summary, Judah's reports indicate the railroad's western route had been identified to a high level of detail, it would not imply operating conditions more complicated than those experienced by eastern railroads, and high profits were expected.

Once the 1861 report was written, the board of directors of the Central Pacific Railroad Company decided Judah should go to Washington to seek subsidies from Federal Government to build the railroad. After successfully lobbying Congress, on July 1st 1862 the bill was approved by President Lincoln[32]. The Act specified the Pacific railroad was to be built by two companies, the Central Pacific Railroad of California Company and the Union Pacific Railroad Company, and each company had access to land grant subsidies and a government loan in the form of treasury bonds[33].

[29] Judah, T. (1862) p. 48.
[30] The information above comes from a table in Judah (1862) p. 53 in which Judah summarised the revenue information, including revenue derived from exploitation of natural resources on the land grants, and giving a total of $4.7 million. The information reported in the text above results after re-calculation of total earnings, after excluding revenues coming from resources included in the land grants. Judah also added 30,000 tons of traffic down from Washoe to Sacramento without providing an explanation.
[31] Judah, T. (1862) p. 53 indicated operational profits including land grant revenues were to be $3.7 million and rounded construction cost to $15 million ($12.8 from Sacramento to State line plus $2.5 from State line to Big Bend/Virginia station), arriving to a rounded annual net earning of 25% of construction cost.
[32] Hittell, T. (1898) pp. 459-61.
[33] Land grant subsidies were alternate 1 squared mile sections on a strip of 10 miles on each side of the right of way. Loan subsidies were between $16,000 and $48,000 (depending on the inclination of the terrain), and had to be repaid after construction. The railroad companies also received the right to sell second mortgage bonds for up to the same value as the bond loan subsidy. Allocation of land grant rights and loan advancements would take place after completion of sections of 20 miles of track.

Figure 6. Local traffic survey estimated by Judah



ACTUAL COUNT OF TRAVEL ON THE PLACERVILLE WAGON ROAD TO WASHOE AND NEVADA TERRITORY FOR EIGHT WEEKS, ENDING OCTOBER 10, 1862.

Number of Stages bound up	169
Number of Stages bound down	171
Number of Buggies bound up	61
Number of Buggies bound down	46
Number of Stage Passengers up	1,287
Number of Stage Passengers down	785
Number of Travelers, other than Stage passengers, up—riders, footmen and in buggies, (including emigrants)	1,288
Number of Travelers, etc., down	2,508
Loose stock, of all kinds, up	573
Loose stock of all kinds, down	434
Number of Teams bound up	4,142
Number of teams bound down	4,464
Number of Animals in teams, up	22,728
Number of Animals in teams, down	22,803
Number of pounds of Freight, up	19,386,200
Number of pounds of Freight, down	

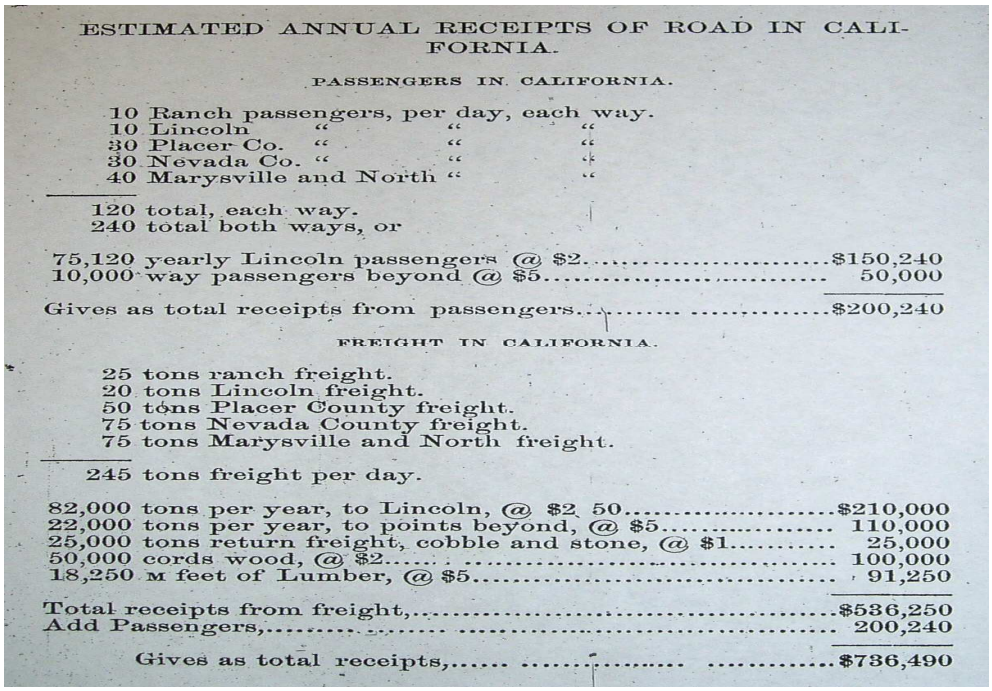
Teamsters are not included in the above return.

RECAPITULATION.

	FOR EIGHT WEEKS.			FOR ONE DAY.		
	UP.	DOWN.	TOTAL.	UP.	DOWN.	TOTAL.
No. of Stages	169	171	340	3	3	6
No. of Buggies	61	46	107	1	1	2
No. of Stage Passengers	1,287	785	2,072	23	14	37
No. Travelers, Footmen, and in Buggies	1,287	2,508	3,796	23	45	68
No. loose stock, all kinds	573	434	1,007	10	8	18
No. of Teams	4,142	4,464	8,606	74	80	154
No. of animals in teams.	22,788	22,003	45,591	407	407	814
No. pounds of Freight	19,286,200		20,000,000	346,185		357,000
No. tons of 2,000 lbs	9,683		10,000	173		178

Source: Judah (1862)

Figure 7. Revenue, operational cost, and operational profits estimated by Judah



ESTIMATED ANNUAL RECEIPTS OF ROAD IN CALIFORNIA.

PASSENGERS IN CALIFORNIA.

10 Ranch passengers, per day, each way.
10 Lincoln " " "
30 Placer Co. " " "
30 Nevada Co. " " "
40 Marysville and North " " "

120 total, each way.
240 total both ways, or

75,120 yearly Lincoln passengers @ $2 ..... $150,240
10,000 way passengers beyond @ $5 50,000

Gives as total receipts from passengers $200,240

FREIGHT IN CALIFORNIA.

25 tons ranch freight.
20 tons Lincoln freight.
50 tons Placer County freight.
75 tons Nevada County freight.
75 tons Marysville and North freight.

245 tons freight per day.

82,000 tons per year, to Lincoln, @ $2 50	$210,000
22,000 tons per year, to points beyond, @ $5	110,000
25,000 tons return freight, cobble and stone, @ $1	25,000
50,000 cords wood, @ $2	100,000
18,250 M feet of Lumber, @ $5	91,250
Total receipts from freight,	$536,250
Add Passengers,	200,240
Gives as total receipts,	$736,490

Source: Judah (1862)

2.3. Grenville Dodge

Grenville Dodge played an important role on the construction of the Union Pacific. Since the late 1850s, before President Lincoln was elected president, he was already influencing his decision about the route and

eastern terminus of the Pacific railroad. General Dodge became chief engineer of the Union Pacific after finishing his military duties during the Civil war. Since the Union Pacific was created by the 1862 Act, the company took XX to be incorporated and the President Lincoln only decided the starting point of the PR in XX , no final technical survey was available until XX , even though engineers had been surveying the area[34]. During his first years at the Union Pacific Dodge focused on identifying the pass over the Rocky Mountains.

A Union Pacific bond sale prospectus published in 1868 emphasised on the international dimension of the road. The need for the railroad was introduced in terms of the growing trade with Asia and the imperial expansionist efforts by the US[35]. The prospectus focused on inter-regional traffic. The PR had the potential to substitute the trade routes through Panama, Cape Horn, and over land. Observed traffic and price was identified. Trade from US Atlantic ports to the Pacific ports (also including US trade with China) going through the Cape Horn route was 80,000 tons a year, trade through Panama was 120,000 tons, and trade through overland was 30,000. Assuming traffic was similar in both directions; total observed traffic was about 460,000 tons of freight a year. Steamships through Panama carried 50,000 passengers, Vessels though Cape Horn carried 4,000, and over land wagons carried 100,000, or a total of 154,000 passengers per year. Present transport prices were $100 for passengers and $34 per ton, and total value of the transportation market was $31 million[36].

The entrepreneurs argued the railroad was not expected to generate full trade diversion. Most commodities would find that shorter travel time was an advantage and would use the Pacific railroad, but heavy and bulky trade would probably be transported by sea. Additionally, as the Pacific railroad was anticipated, economic activity in the Pacific increased. Mills, vine yards, farms and mining camps were opened in California and the western states and territories. Furthermore, miners were workers that travelled frequently to their origin regions. The international angle was also emphasised when anticipating business of the road, and it was noted new steamship companies offering transport to China were opening in San Francisco. Entrepreneurs expected total traffic to be 300,000 tons and 300,000 passengers, freight at $34 per ton and passenger rates at $150, and total value of the transport market was expected to be more than $55 million[37]. Next the entrepreneurs assumed that the Union Pacific would capture about $30 million out of the total $55 million. Operation costs were expected to be about $15 million, and net revenues would then be close to $15 million. By 1867 the Union Pacific local traffic was already earning $2.5 millions earnings, just over $1 million operating costs, and $1.4 million net earnings[38].

In addition, the prospectus also described the road and its technical specifications like grading, alignment, tunnels and bridges. The average cost of the 914 miles built by 1868 was $68,058, and total cost so far was

[34] Durant (1864) is an example of a detailed engineer survey report that was preliminary because the starting point of the PR had not been determined by President Lincoln
[35] Cisco, J. (1868) p. 4.
[36] Cisco, J. (1868) pp. 22-23.
[37] Cisco, J. (1868) pp. 23-25.
[38] Cisco, J. (1868) p. 21 and pp. 22-27.

$62.2 millions. The remaining 186 miles were expected to cost on average $90,000 and in total the Union Pacific Railroad was expected to cost $82.5 millions[39].

Shortly after finishing construction, in 1873, the Credit Mobilier scandal emerged. Union Pacific entrepreneurs had bribed Congressmen to increase subsidies and devised a scheme to appropriate subsidies as construction profits, and it was believed the Central Pacific also developed similar tactics[40]. Although it is not possible to know exactly how much did construction of the PR actually cost, precisely because the entrepreneurs performed explicit efforts to cover the scheme they developed, it is safe to indicate that actual cost of the railroad was not more than 100 million[41].

4.D. Comparing declared expectations and developing a general declared expected profitability estimate

The documents left by the three most persistent entrepreneurs and other sources allow characterizing the decision they faced, their approach to the making this decision, the outcomes they expected, and the potential incentives to lie they faced.

The decision the entrepreneurs faced, in modern economics jargon, was the decision whether to invest a sunk cost (build the PR) to enter the transportation market or not. The entrepreneurs collected information and evaluated it to make an informed decision. In fact, entrepreneurs developed substantial efforts for long time periods to collect the information and evaluate it. The technical surveys they performed look, essentially, like the surveys performed today for new transport projects. The route was divided into stages and each stage was measured in several dimensions: length, grades, number of curves and acuteness of their angles, number of bridges to build and technology to use, and tunnels to excavate and materials to extract. Construction costs were developed in a similarly sophisticated way, by activity and route stage. Operational costs appeared more difficult to manage and entrepreneurs used eastern railroads information detailed by activities, by freight or passenger service, or simply assumed operation costs were 50% of revenues. Revenue expectations were also derived. First entrepreneurs identifying observed traffic and price using trade statistics, specialized press or direct surveys. Next, entrepreneurs considered a pricing policy (increasing/reducing observed price by X%) and indicated an expected effect of the price policy on traffic. Implicitly entrepreneurs used the concept of elasticity, even though it was not to be formally developed until the end of the 19th century by

[39] Cisco, J. (1868) pp. 7-10 and p. 21.
[40] See Fogel (1860) for a description of the scandal and analysis of the causes of corruption.
[41] The Wilson Commission indicated the cost of the road to the Union Pacific subcontractors – the real construction cost - had been $43 million current dollars (Fogel (1960) p. 66). The resources available to the Central Pacific for construction of the road were $48 million current dollars, and there is no indication of how much did it cost to subcontractors as the company archives were lost in a fire (Dagget (1966) p. 21). If these numbers are approximately correct the PR could not have cost more than $100 million, even after accounting for capital costs of 10% ($43 million cost of Union Pacific to subcontractors + $48 million cost of Central Pacific to Central Pacific)*1.1 = $100 million). If we consider substantial inflation during the Civil War, the 1860 real value per dollar decreases even more. A sum of $100 million current dollars spent over the 1863-9 period is equivalent to about $66 to $75 million once the effect of inflation is taken into account (depending on the deflator chosen and the actual cash flow over time). Thus, an 1860 real dollar value of $100 million seems a reasonable maximum cost for the PR.

Marshall. Most frequently entrepreneurs assumed the elasticity of demand was 0 or 2. When assuming an elasticity of 0 they sometimes had proposed a price reduction (reducing profits consciously) and some other times had proposed a price increase (increasing profits consciously). When assuming an elasticity of 2 entrepreneurs always had reduced prices. It was not explicit in the reports what guide the entrepreneurs used to determine the pricing policy (sign or magnitude). Finally, the entrepreneurs considered total expected earnings, and subtracted operational costs to obtain operational profits. Then the ratio of operational profits over construction cost was used as a profitability measure.

In sum, entrepreneurs were acting rationally. Rationality is understood here as an effort to collect information and perform a calculations to evaluate the likelihood of a certain positive outcome as the main guidance for a decision (invest or not) – procedural rationality[42]. In this sense rationality is an appropriate description of entrepreneurial observed behavior. Additionally, since entrepreneurs developed expensive efforts to collect the necessary information and perform the necessary calculation, it also indicates they valued being rational. Moreover, entrepreneurs were using "economic common sense" to structure their decision problem by using implicitly the concept of elasticity to go from observed traffic and prices to expected traffic and prices. Finally, entrepreneurs seemed to be aware of the profit and welfare implications of different pricing policies.

The contents of the reports indicated that technical uncertainty had been substantially reduced by 1862. Although the existence of technical uncertainty cannot be fully discarded as the PR clearly implied work in a scale never performed before, efforts to overcome uncertainty had been performed successfully. By 1861 information as detailed as that produced for any other railroad project up to 1850s had already been produced for the PR. The most difficult part of the route had been planned in detail. Grades, curves, tunnels, bridges and their costs had been identified. Additionally, less detailed information involving mostly grades had been collected for the rest of the route. The most difficult construction tasks had been identified, studied and their costs evaluated.

Profits expectations were positive. The three entrepreneurs thought the project would be profitable. Most revenues would come from through freight and passenger traffic as the main the PR was aimed to serve inter-regional and international trade. Moreover, the fact that a diverse group of entrepreneurs were pushing for i) five other different transcontinental railroad routes within the US, ii) another transcontinental railroad route through Canada, iii) Canals though Central America and the Suez, and iv) invested in the development of the Clipper ships to bring luxury perishable goods from Asia, were all an indication of profit expectations connected to the Asia trade.

[42] Note that in this definition whether the entrepreneurs have collected the correct information and have performed the appropriate calculation to evaluate the decision is not relevant – entrepreneurs may be wrong or right about their predictions, what matters is collecting info and performing calculations. Whether the entrepreneurs get the procedure right or not puts their behavior closer to perfect foresight or to bounded rationality.

The entrepreneurs indicated clearly that the PR would offer new good benefits in the form of reduced travel times and safety. Whitney emphasized on examples associated to tea trade to illustrate how the PR would provide cost, travel time and insurance savings to merchants. The Pacific railroad "… requiring not over 40 days (from China to New York) … and the present (all sea) route requiring 100 to 160 days … (the Pacific railroad also) saving on insurance and other expenses"[43]. Judah identified two key advantages to the railroad: "(for a trip between eastern US and the Pacific Ocean the PR would) reduce (travel) time (from 100 days) … to 40 hours … and (provide) comfort in travelling with equal degree of safety"[44]. He then presented a brief history of transportation to emphasise on the progress made on increasing travel comfort and safety with the development of the stage coach, canals and railroad[45]. In his 1862 report, when explaining why traffic would switch from the Placerville wagon road to the PR he also argued "a saving in time from 9 days to 1 would give satisfaction to both merchants and consumers"[46]. Dodge used an excerpt of Harper's Weekly asking "when hundreds of thousands of persons, with their faces towards the west, have tramped over the plains at the risk of their scalps, how many peradventure will ride when they can make the journey with safety in few days?"[47]. The point made by Dodge was that the lack of safety of the existing routes had kept demand for travel low. The PR would bring substantial safety improvements to the trip and uncap demand. In summary the three entrepreneurs clearly expected the PR to provide some new good benefits.

In sum, entrepreneurs had identified clearly the decision problem, collected the information necessary make the decision and evaluate the information. They also reached the conclusion that the PR should be expected to be profitable, mostly by focusing on the international and inter-regional traffic flows and providing them with improved travel times and safety. But can we trust that entrepreneurs were declaring their true beliefs about the PR?

Entrepreneurs also faced a complex environment of opposing incentives when pursuing the project. Entrepreneurs declared to face sectional differences in Congress and that these differences were blocking the project during the 1850s. The complex environment is a characteristic of large scale projects as it generates externalities affecting some social groups positively and others negatively. In turn, these externalities trigger political conflicts and take at least part of the economic decisions regarding the infrastructure project out of the realm of markets and into political institutions. Under these circumstances entrepreneurs had incentives to *underestimate* private profits and regional gains and costs, and *overestimate* national gains when in Congress (i.e. declare they would reduce prices). In this way it was easier for Congressmen to defend the project and justify a supportive vote. When approaching capitalists, they had incentives to *overestimate* private profits (i.e. declare they would increase prices)[48].

[43] Whitney (1849) p. 53.
[44] Judah (1857) p. 28.
[45] Judah (1857) pp. 21-28.
[46] Judah (1862) p. 54.
[47] Cisco (1868) p. 25.
[48] Also recall that during the 1850s the division between states supporting slavery and those opposing it coincided broadly with the possible routes of the railroad. The northern and central routes would greatly benefit states opposing to

Entrepreneurs declared to follow pricing policies that were consistent with the incentives they faced in Congress and capital markets. Whitney and Judah consistently reduced prices (independently of whether they implicitly assumed elasticity of demand to be 0 or 2) while Dodge always maintained observed price or increased it to capture new good benefits (and always assumed an implicit elasticity of 0). More precisely, the declarations were sequential so entrepreneurs first declared to reduce prices when they went to Congress, and once they were granted the right of way and subsidies, they declared to increase prices when going to capital markets. Also connected to the chosen pricing policies was the competitive environment they described. Whitney suggested the PR should use its technological advantages to compete on prices with shipping, while Dodge argued that new good benefits gave the PR a distinct technological advantage that should produce rents and proposed to increase prices (a policy consistent with the capture of these rents). Thus, the observed entrepreneurial behaviour is consistent with hypothesis emphasising their informational advantages and strategic conduct.

But how could entrepreneurs declare to reduce prices initially and then to increase prices and get away with this inconsistent behaviour? One hypothesis is that pricing policy and competitive environment information is information on which the entrepreneur's possesses advantage as it is a promise not a fact and it is very difficult to dispute. Additionally, the fact that the entrepreneurs were in fact three independent individuals with no formal organisational or even social ties also helped them to defend their pricing policies from comparisons. Moreover, construction technology and costs was the information most frequently debated and disputed in Congress. The implied grades, the difficult ravines, impenetrable tunnels, or harsh winter snows blocking the right of way were the preferred arguments against the project. One may suggest two reasons for this. First, it is more legitimate to discuss about facts than promises. Second, detractors of a specific route were generally associated to a competing PR projects proposing an alternative route, and therefore were not interested in affecting the perception about potential profitability or national convenience. They were only interested in destroying the case for a specific (competing) PR route, not the PR business case.

Finally, and counter-intuitively, entrepreneurs consistently declared they expected the PR to be profitable, but also requested Congress the provision of subsidies. The contradiction between profits and subsidies is difficult to reconcile and highlights the possibility that entrepreneurs were lying. Not only they had incentives to lie, but they also behaved consistently with the patterns predicted by the incentives to lie they faced. An alternative explanation is that entrepreneurs were optimists, and as optimists always declared the railroad to be profitable. Entrepreneurs were likely to be optimists, as the sample of entrepreneurs available is precisely the group of entrepreneurs that had a positive view of the project's profitability (either through construction or operation of the railroad, or both) and had the belief it was a project that could be performed

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slavery, while the southern route would benefit states supporting slavery. Under these circumstances, entrepreneurs had incentives to underestimate regional benefits (Chicago, for example) and costs (St Louis and New Orleans, for example), and overestimate national gains. Thus, the slavery question pretty much magnified the incentives for entrepreneurs to declare expectations different than their true beliefs.

directly by them. No other entrepreneur would invest time and effort to develop the necessary plans and lobby congress. Thus, a sample selection bias is likely. Since we do not know if the entrepreneurs were effectively lying, and if they were, the magnitude of the biases they introduced to their declared outcomes, and additionally it is likely the information they provided is biased to high profits, it is simply not possible to anticipate the overall sign and magnitude of the bias in expected profitability. It is not easy to interpret the information above. In order to control for these potential biases (lying and optimism) that may be contaminating the information declared by entrepreneurs, a model of the entrepreneurial decision problem following the entrepreneurial methods and information available by 1860 and focusing on operational profits is developed to derive "simulated expectations" clear of the perverse incentives faced the entrepreneurs and any optimism they may have suffered.

4. An empirical model of the entrepreneurial decision to build the Pacific railroad

The previous section described how entrepreneurs followed a simple and sensible procedure to forecast expected outcomes for the PR. First, they assumed demand on each of the four market segments (through freight and passenger traffic and local freight and passenger traffic) was independent. Second, they also assumed that operation costs of providing transport services to freight and passenger was independent. Given these two conditions, it is possible to divide the problem into four separate maximisation problems, one for each of the four market segments. The process to derive expected profits in each market segment implied identifying first observed traffic and price. Then, entrepreneurs would assume a certain expected elasticity of demand for the PR market segment. Depending on the elasticity value chosen entrepreneurs would then derive the appropriate pricing policy (i.e. increase/reduce price and by how much). Using the desired price, it is possible obtain expected traffic and calculate revenue. Assuming some given operational costs allows obtaining operational profits. The process is repeated for each of the market segments and then operational profits for each of the four market segments are summed up. Finally, total operational profits are compared to construction costs and profitability measures are derived.

Additionally, and in order to control for the perverse incentives faced by the entrepreneurs and any biases they introduced to the information they declared, the approach is to set up a model assuming competitive market transactions for land (right of way) and capital. Assume entry was free and the right of way for the road could be appropriated automatically, just by buying the land and with no negotiation or dealings with State or Federal governments. Additionally, also assume that capital was available (as Engerman (1972) has suggested) at the observed market rate. Under these circumstances, the decision for the PR entrepreneurs depends on essentially whether expected market size was large enough and expected mark-up high enough in 1860 to support the road or not.

The following model follows the spirit of the procedure performed by entrepreneurs and described above. First, observed demand is presented, followed by expected demand and expected operational costs. The

maximization problem faced by the PR entrepreneur is then presented and the entry condition deduced. The model is presented using the case of freight through traffic for ease of exposition and to maintain the connection with the previous section, but the model is general enough to be used to understand the problem faced by the entrepreneur in forecasting outcomes for the other three market segments.

4.1. Transport demand

The evidence discussed in the previous section indicated that entrepreneurs defined market potential for the PR as a set of *N* origin *i*-destination *j* pairs of regions (i.e. Canton to New York), each denoted by sub-index *ij*, for which the distance reduction provided by the overland route (compared to the all sea route) would imply a significant reduction in travel distance. Additionally, entrepreneurs considered that transport demand between an origin-destination pair was determined by their economic size and the distance to be travelled. Whitney and Dodge emphasised that the PR route would connect two large populations, Asia and Europe, and implied that trade increases with economic size[49]. Additionally, Whitney in his several memorials and booklet described in several different ways the distance savings expected from the PR route and how it would lead to control of international trade transportation[50]. Thus, transport demand (in tons-mile per year) for an origin-destination pair, *ij*, would be given by:

$$q_{ij} = a_{ij} P_{ij}^{-b}$$

where a_{ij} is a constant specific to each *ij* and associated to the economic size (and other relevant origin-destination pair specific effects) of the trade partners; *b* is the transport demand-price elasticity; and P_{ij} is the freight price $P_{ij}=f^m d_{ij}^m$ where *f* is the average freight rate per ton-mile and is constant across all origin-destination pairs and commodities for a given transport mode, *m*, and d^m_{ij} is the distance covered on transport mode *m* between origin region *i* and destination region *j*. Hence,

$$q_{ij} = a_{ij} (f^m d_{ij}^m)^{-b}$$

The intuition behind the demand function is simple: as distance or freight rates per ton-mile decline (and, thus, freight price between the two trading partners falls), transport demand increases. The constant elasticity functional form of the demand equation facilitates the derivation of the appropriate empirical demand equation used in for freight through traffic: the gravity equation[51].

As discussed in the previous section, when making the decision of whether to build the PR or not, entrepreneurs *observed* the demand for transport when the only transportation mode available was sea travel,

[49] Whitney (1848) p. 7 and Cisco (1868) p. 23.
[50] Whitney (1845, 1848, and 1849).
[51] For details of the empirical strategy pursued please see annex.

and used it to derive the *expected* demand for transport if the PR were to be constructed. The latter was the demand function relevant to calculate expected operational profits.

For instance, take the case of trade between Canton and New York. Figure 10 illustrates the two possible routes that would become available if the PR were to be constructed. First, the route *AS* corresponds to the all sea route around the Cape Horn, which would be the demand observed by the PR entrepreneurs for the Canton-New York origin-destination pair. Let us define the *observed* demand for a given origin-destination pair *ij*, q_{ij}, as:

$$(1) \qquad q_{ij} = a_{ij} P_{ij}^{-b} = a_{ij} (f^{s} d_{ij}^{AS})^{-b}$$

where f^{S} is the observed sea freight rate per ton-mile and d^{AS}_{ij} is the distance covered in the all sea route between an origin-destination pair of regions.

Second, the introduction of the PR would open a new route. The new route would be composed of three segments: from Canton to San Francisco by sea, denoted segment *S* in figure 1; from San Francisco to the Mississippi region on the PR, *PR*; and, finally, from the Mississippi region to New York on the ER, *ER*. In this case, the demand for transport expected by the PR entrepreneur would be given by the trade that merchants were willing to take over the new route given the expected freight price of the new route. Let us define expected demand for transport for a given origin-destination pair *ij*, $\hat{q}_{ij}$, as:

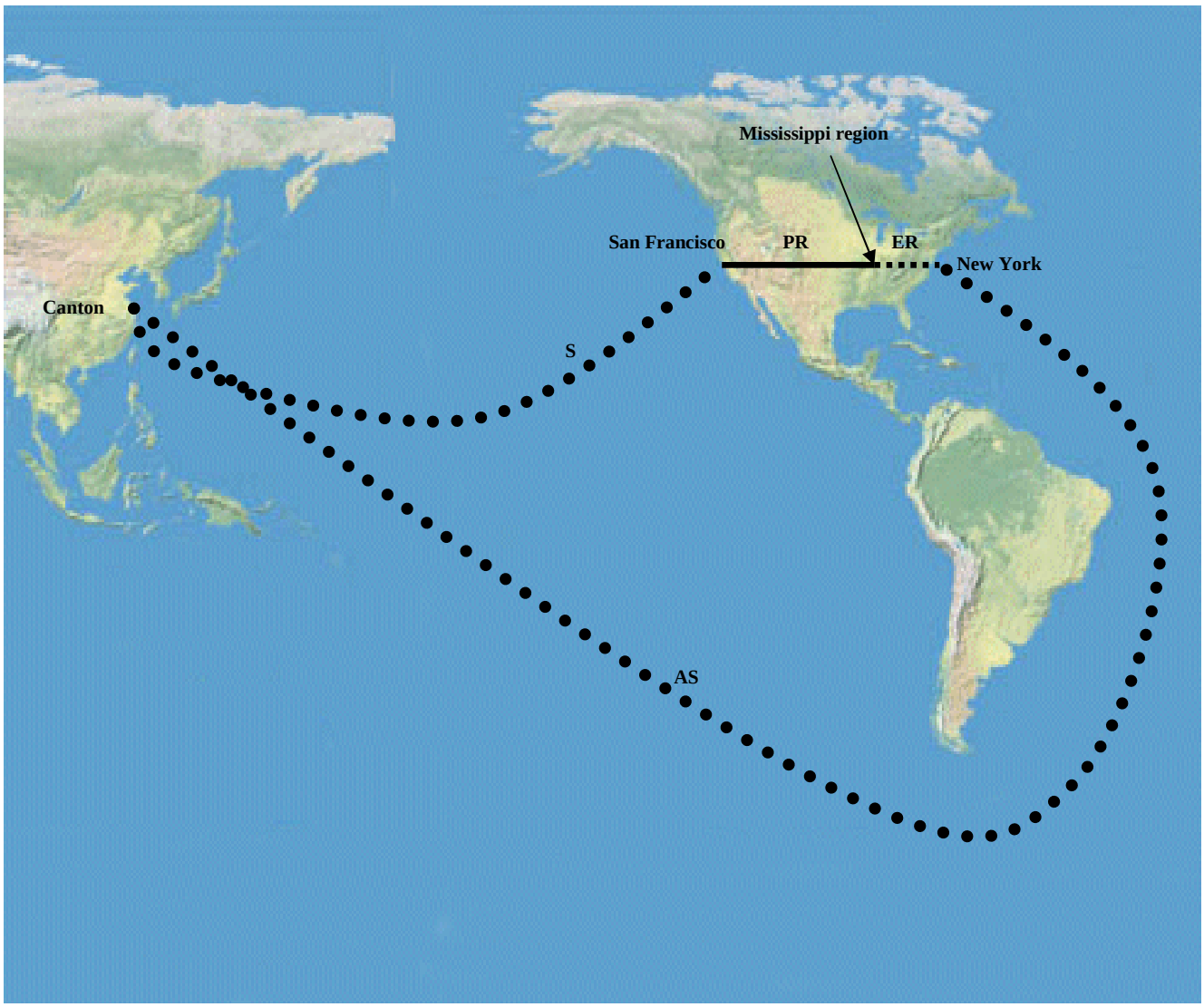
$$(2) \qquad \hat{q}_{ij} = \hat{a}_{ij} \hat{P}_{ij}^{-b} = \hat{a}_{ij} (\hat{f}^{PR} \hat{d}_{ij}^{PR} + \hat{f}^{ER} \hat{d}_{ij}^{ER} + \hat{f}^{S} \hat{d}_{ij}^{S})^{-\hat{b}}$$

where ^ denotes expected and f^{PR} is the expected average freight rate per ton-mile that the entrepreneur would set for the PR (i.e. the entrepreneur's decision variable); f^{ER} and f^{S} are the expected average freight rate for the ER and the sea segment of the route; and d^{PR}_{ij}, d^{ER}_{ij}, d^{S}_{ij} are the distances covered by the PR, the ER, and the sea segment, respectively[52]. Information on freight rates was expected because observed values could have changed because of the economic effects of the construction of the PR (more on this below). Information on the PR and the ER distances was expected in the sense that they were planned distances and the plans were contingent on the actual route and terminus choices for the PR once built. The sea segment distance was well known to the entrepreneurs as the routes were already in use by the shipping industry.

[52] Average freight rate means average across commodities for the Pacific and the ER and average across commodities and across origin-destination pairs involved in segment *S* of the Pacific railroad route. Additionally, the Pacific railroad route implied two transhipments not necessary by the all sea route, at San Francisco and the Mississippi region, in the example of trade from Canton to New York. The transhipment costs are easily included into the expected price through the Pacific railroad route, but for simplicity have been excluded at this stage. They will be considered below in the sensitivity analysis section.

Additionally, at this stage it is also convenient to note that d^{PR}_{ij} and d^{ER}_{ij} are constant across origin-destination pairs for reasons discussed below, and therefore their *ij* sub-indices may be dropped, facilitating notation. Finally, the PR route would induce more competition in the transport market and would also bring about new good benefits like speed and safety, leading *b* to change into $\hat{b}$ [53].

Figure 8. New York-Canton via the all-sea and Pacific railroad routes



4.2. Operational costs

As discussed in section 3 of this paper, according to entrepreneurs' project reports, in 1861 they expected railroad operational costs (*O*) to be a fixed fraction, γ, of total revenues:

$$\hat{O}_1 = \gamma \hat{f}^{PR} \hat{d}^{PR} \hat{Q}$$

[53] Entrepreneurs were conscious about both issues (intensifying competitive vs new good benefits) and their effects. However, because they were not explicit about the price-elasticity of demand it is not possible to know if and how they

where,

$$\hat{Q} = \sum_{ij} \hat{q}_{ij}$$

Although it is clear that operational costs should depend on the PR's distance, it is unclear why they should be affected by the freight rate rather than input prices (i.e. wages paid to workers or capital employed). A more conventional railroad operational cost function is therefore also considered, which depends on the constant marginal cost incurred in the provision of the transport service, κ:

$$\hat{O}_2 = \kappa \hat{d}^{PR} \hat{Q}$$

4.3. Optimal operational profits

Entrepreneurs then derived expected operational profits, given by:

$\hat{\pi}$ = Expected Revenues – Expected Operational Costs

Taking into account the operational cost function as defined by the entrepreneurs, expected profits would be equal to:

(3) $$\hat{\pi}_1 = \hat{f}^{PR} \hat{d}^{PR} \hat{Q} - \gamma \hat{f}^{PR} \hat{d}^{PR} \hat{Q} = (1-\gamma) \hat{f}^{PR} \hat{d}^{PR} \hat{Q}$$

Expected profits considering the conventional operational costs function are equal to:

(4) $$\hat{\pi}_2 = \hat{f}^{PR} \hat{d}^{PR} \hat{Q} - \kappa \hat{d}^{PR} \hat{Q} = (\hat{f}^{PR} - \kappa) \hat{d}^{PR} \hat{Q}$$

Assuming the PR entrepreneur chooses an expected PR freight rate, $f^{PR}*$, maximising expected operational profits subject to expected transport price, $\hat{P} = (\hat{f}^{PR} \hat{d}_{ij}^{PR} + \hat{f}^{ER} \hat{d}_{ij}^{ER} + \hat{f}^{S} \hat{d}_{ij}^{S})$, be less or equal than the observed price, $P = f^S d^{AS}$ for at least one origin-destination pair, *ij*. Such a condition is imposed because the choice of f^{PR} is not unconstrained to the PR entrepreneur. If the freight price via the PR route is higher than the freight price via the all sea route, merchants would always choose to transport their merchandise using the all sea route.

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thought these two factors would affect the elasticity value.

More formally, the entrepreneur's problem is to:

$$(5) \qquad \underset{f^{PR}}{Max}\, \hat{\pi}_1 = (1-\gamma)\ \hat{f}^{PR} \hat{d}^{PR} \hat{Q} = (1-\gamma)\ \hat{f}^{PR} \hat{d}^{PR} \sum_{ij} \hat{q}_{ij} \quad \text{st } \hat{P}_{ij} \leq P_{ij} \text{ for at least one } ij$$

Or, alternatively:

$$(6) \qquad \underset{f^{PR}}{Max}\, \hat{\pi}_2 = (\hat{f}^{PR} - \kappa) \hat{d}^{PR} \hat{Q} = (\hat{f}^{PR} - \kappa) \hat{d}^{PR} \sum_{ij} \hat{q}_{ij} \quad \text{st } \hat{P}_{ij} \leq P_{ij} \text{ for at least one } ij$$

Note that that P_{ij} may be different for each origin-destination pair, and that $\hat{P}$ does not have to be lower than P for all of the N origin-destination pairs included by the entrepreneur in the market potential definition. Geography defines travel distances between different origin-destination pairs via the all sea route and the PR route. Subtracting the travel distance of the PR route to the all sea route allows identifying the specific distance saved over the PR route for each origin-destination point. In turn, distance savings define the equivalent ceiling price the PR may charge if traffic on a specific origin-destination pair is to divert from the all sea route to the PR route. The greater distance savings, the higher the equivalent ceiling price. If the PR entrepreneur wants to divert all traffic that may be potentially diverted to the PR, the expected freight rate must be set to be equivalent to the lowest ceiling price of the N origin-destination pairs included in the market definition.

However, it may not be optimal for the PR entrepreneur to choose a $\hat{P}$ such that all traffic diverts to the PR. Consider the New York-San Francisco pair. In this route the distance saving is the highest of all origin-destination pairs, as the trip around Cape Horn is replaced by an overland trip. The PR entrepreneur may then charge the highest expected freight rate per ton mile. The entrepreneur will only derive profits from reducing $\hat{f}^{PR}$ to attract traffic from a second origin-destination pair if the proportional reduction in $\hat{f}^{PR}$ is compensated by a higher than proportional increase in traffic coming from the second origin-destination pair considered. Thus, depending on the expected elasticity of transport demand it may be more profitable for the PR entrepreneur to choose a $\hat{P}$ leading merchants to choose to use the PR route for all N origin-destination pairs or just a few of them. The point is important because it implies that two qualitatively different outcomes may be observed once the PR is introduced: i) the PR as a monopoly and ii) the PR sharing the market with the shipping industry[54].

[54] The intuition behind the model proposed above is similar to that of the dominant firm-competitive fringe model. See Stigler (1950 and 1965) for the for the initial explanation of the logic behind the model; Kydland (1979) for a dynamic version of the model; and Gowrisankaran and Holmes (forthcoming) for a fully fleshed modern dynamic version of the model.

Also note the pricing strategy described above is different from price-discrimination. In this model the PR entrepreneur sets one single price, while price discrimination involves setting at least two different prices for two different market segments. Potentially, price-discrimination between two origin-destination pairs may deliver additional profits to the PR. However, existing evidence indicates that the shipping and railroad industries did discriminate between commodities and between local-through traffic but not between overall origin-destination points. Additionally, it is not clear how could the PR segment the market to perform discrimination depending on the origin-destination pair. How could a merchant trading between eastern and western US be prevented from declaring the merchandise was actually going to China rather than San Francisco (if by declaring this the merchant could get a cheaper freight price)? Price discrimination on commodities works because it is not easy for merchants to disguise the commodity transported. Price discrimination against local traffic works because the entrepreneur may monitor were the merchandise gets off on the railroad line.

Finally, if new good benefits are perceived by merchants using the PR, then the PR will face a lower expected elasticity of demand and will be able to set a price higher than the observed all-sea transport price. The PR entrepreneurs believed the key benefits delivered by the PR were to be speed and safety, as discussed above. Additionally, the view that speed and safety were important was not expressed only by the entrepreneurs. The New York and Boston ship industry developed the Clipper to reap the profits of the Asia trade[55]. And scattered evidence indicates merchants valued speed. For instance, in 1849 the Oriental Clipper ship made very fast passage times and was then contracted to sail to London fully loaded with tea. The "… Russell an Co. chartered the Oriental at £6 per ton of 40 cubic feet, whilst British ships lay waiting for tea at £3 10s per ton of 50 cubic feet"[56]. Thus, merchants indicated implicitly that (at the very least) 20 days of tea "freshness" were worth more than 65% of the alternative transport cost in the London tea market, and several similar examples are available[57]. The PR would also improve safety. The closest to safety at sea was marine insurance. Persson (2004) collected data on marine insurance for several different trips in 1863. The long haul trips in his table all have relatively high insurance rates, of about 1.5% of the value of the good insured, while grain insurance was about 1.75%. Additionally, he indicated that the freight for grain was about 10.45% of the price of the good[58]. Thus, maritime insurance was probably close to 15% of freight costs. In sum, PR entrepreneurs expected merchants to value speed and safety benefits to be delivered by the PR.

The model presented above is easily extended to include the effects of new goods. General new good benefits are perceived by the entrepreneurs as a higher relevant observed price. Thus, merchants are now willing to pay more to move every single ton of freight included in the level of observed traffic, and general new good benefits are equivalent to a rightward shift in the demand schedule faced by the PR entrepreneur.

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[55] Lubbock (1933) pp. 36-102.
[56] Lubbock (1933) p. 107.
[57] The Clipper ship was expected to make the trip in about 100 days, while an East Indiamen, the alternative transport mode, would take at least 120 days. More scattered evidence on the same line and implying similar magnitudes for the value of speed was collected by Evans (1964).
[58] Persson (2004) pp. 138-142.

Commodity specific benefits are perceived by entrepreneurs as a group of commodities within observed traffic for which merchants are willing to pay more than the observed price to transport them. Thus, commodity specific new good effects may be thought as an upward extension of the existing demand schedule, and as entrepreneur's increase the price over the observed price, traffic willing to use the PR decreases proportionally with the elasticity of demand – a movement over the demand schedule[59]. Also important, once the new good effects are introduced the model predicts three qualitatively different types of equilibrium: i) price competition leading to full trade diversion from sea transport to the PR, ii) price competition leading to partial trade diversion and iii) competition in quality leading to partial trade diversion.

Once the maximization process for each of the market segments has been performed, operational profits for each market segment are obtained. Profits derived from international and inter-regional passenger traffic are denoted by $\hat{\varphi}^*$ and the observed market is defined by sail and steamship transportation. Profits derived from local freight traffic are denoted $\hat{\vartheta}^*$ and the observed market is defined by wagon transport in California and Nevada. Profits derived from local passenger traffic are denoted $\hat{\nu}^*$ and the observed market is defined by wagon transport in California and Nevada. Finally, total profits, $\hat{\eta}^*$, is the sum of the profits in each of the four submarkets.

Also note that in this larger model price discrimination may now be observed. Within each submarket no price discrimination will be observed (as explained above). However, between submarkets, as inter-regional and local freight traffic, now it is possible for price-discrimination to arise as each submarket is characterized by a different demand function and it may be optimal to set different prices in each submarket. This certainly adds to the realisms of the model.

4.4. Entry decision

Finally, as explained above, entrepreneurs would compare the optimal expected operational profits stream, $\hat{\eta}^*$, to the expected construction costs stream to decide whether to build the PR.

Expected total construction costs (*TC*) are then given by the sum of the stream of expected construction costs (C_t) and the right of way fixed fee, *L*:

$$\hat{TC} = L + \sum_{t=1}^{T} \hat{C}_t$$

[59] Note that when commodity specific new good effects are considered the expected elasticity of demand must be strictly inelastic, otherwise a price increase leads to a reduction in revenues and profits. Empirical evidence indicates a

The entry condition would compare the present value of $\hat{\eta}^*$ to that of $\hat{TC}$ and would be defined as[60]:

$$(7) \qquad \sum_{t}^{T} \frac{\hat{\eta}_t^*}{(1+r)^t} \geq L + \sum_{t}^{T} \frac{\hat{C}_t}{(1+r)^t}$$

where T is the total life time of the project and r is the discount rate.

4.5. Empirical strategy and parameter values

Next it is necessary to provide reasonable parameter values to plug into the model. The empirical strategy followed to obtain each parameter is presented in detail in the annex, and at this stage only the procedure to obtain them is presented. First, observed traffic and price were collected from sources consulted by the entrepreneurs and publicly available by 1862 or before in order to maintain the ex-ante spirit of the exercise. Second, it is discussed for each parameter if the introduction of the PR will generate any changes leading the parameter value to change. For instance, consider the sea freight rate and recall it has been characterized as a competitive industry. Since the PR will not change the nature of competition in sea transportation, it will only bring more competition to that market, it is likely that the observed freight rate is close to marginal costs and will not change due to the PR's entry. In this way each of the parameters has been anchored to the 1850s conditions and its likelihood to change due to the introduction of the PR.

The value of parameters used is presented in table 1. Comparing the data collected to the data proposed by the entrepreneurs (see table 2). One very important similarity and several differences exist. First, there seems to be agreement about the level of sea freight rates. Whitney's data and the data collected here are all close to \$0.0014. Dodge's estimate of the sea freight rate is a little higher (\$0.0022) than the one identified here, but still reasonably close. Second, the railroad freight rates proposed by Whitney (\$0.005 per ton mile for the PR and \$0.0100 for the ER) and Dodge (\$0.0113 for the whole east to west rail transport segment) seem low compared to the average operation costs collected here (\$0.0118). Consequently, the cost difference between sea and rail was underestimated by the entrepreneurs. Third, inter-regional all-sea passenger rate proposed by Judah (\$150 2nd class) seems to be high compared to that indicated by Dodge (\$100) and the one collected here (\$100). Fourth, the PR passenger rail rate suggested by Dodge (\$0.05) is higher than that proposed by Judah (\$0.02) and that collected here for the ER (\$0.017). Fifth, international and inter-regional freight traffic was overestimated by Whitney and Dodge. Whitney assumed that Europe-Asia trade could be targeted by the PR when the distance savings do not compensate for the sea-rail freight cost differences, not to mention that he never considered in his projects the possibility of the Suez Canal diverting that trade from

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strictly inelastic elasticity of demand is a characteristic of transport demand as it is a derived demand (see XXX).

the PR. Dodge assumed a baseline scenario where freight traffic both ways was similar; we do not know if this could have been the case for the Panama traffic, but we know this could not have been the case for the Cape Horn traffic[61]. Finally, passenger traffic was also overestimated by Dodge as he assumed that traffic was similar both ways, although migration was mostly going westward.

In summary, i) the ceiling price seems to be clearly identified as the data provided by the entrepreneurs and that collected here are very similar, ii) the rail freight rate proposed by entrepreneurs was substantially lower than the costs observed in the ER, indicating an underestimation of rail freight costs, iii) the proposed passenger rail rates are higher than the passenger rates observed in the ER, indicating the Judah and Dodge may have intended some sort of monopoly pricing, iv) it is likely entrepreneurs overestimated eastbound freight and passenger baseline traffic.

[60] The entrepreneurs did not use the present value to sum a cash flow. The precise entry conditions they specified are introduced and discussed in the model solution section below.

[61] The Report of Internal Commerce indicates during the late 1860s traffic though the Cape Horn was about 100,000 tons westward and 30,000 tons eastward. Unfortunately traffic on the Panama route cannot be identified accurately as it was mixed in the accounts with trade to and from the New Granada. However, total trade to and from the New Granada was about 100,000 tons on the Caribbean and the Pacific (Nimmo, 1885).

Table 1. Ex-ante values for model parameters

Market segment	Parameter	Value	Type of information
Freight trough Traffic	Observed freight through in tons	300,082 tons	Estimated on observed data 1856-60, Commerce & Navigation Reports
	PR through distance	2,000 miles	Engineer reports
	Observed ER freight rate p t-m	$0.02412	Average estimated on observed data 1856-60, Poor (1881)
	ER distance	850 miles	Estimated on observed data 1856-60. Close to value declared by entrepreneurs
	Observed sea freight rate p t-m	$0.01265	Average estimated on observed data 1856-60, 1850s specialised press
	Sea segment distance	Changes with *ij*	Estimated on observed data 1856-60
	Operation freight costs (conventional)	$0.0118	Average estimated on observed data 1856-60, Poor (1881)
Passenger through Traffic	Observed Passenger through traffic	45,000 pass	Estimated on observed data 1856-60, from Nimmo (1885) & Unruh (1979)
	Observed ER passenger rate per p-m	$0.0176	Average estimated on observed data 1856-60, Poor (1860)
	Operation passenger costs (conventional)	$0.0088	Estimated on observed data 1856-60, Poor (1860)
	Observed sea passenger price per trip	$100	Estimated on observed data 1856-60, Unruh (1979)
Freight local Traffic	Observed freight local traffic	43,800 tons	Declared by entrepreneurs, Judah (1862)
	Observed wagon freight rate per t-m	$1.4343	Declared by entrepreneurs, Judah (1862)
	PR local distance	155 miles	Declared by entrepreneurs, Judah (1862)
Passenger local traffic	Observed passenger local traffic	13,505 pass	Declared by entrepreneurs, Judah (1862)
	Observed passenger rate per p-m	$0.3030	Declared by entrepreneurs, Judah (1862)
Expected Demand equations	Constant in expected demand	Changes with *ij*	Calibrated
	Elasticity of demand	0.5-3 0.01-1	Range of existing gravity equations and transport demand literature[a] Full range of inelastic demand elasticity values
	PR average freight rate p t-m	Decision variable	
Entry decision	Construction cost	$100 million	Declared by entrepreneurs
	Land fixed fee 1	$1 million	Fishlow (1965) antebellum eastern private railroads (3%) & declared by entrepreneurs ($320,000)
	Project life	15	Average of Fogel (1960) and Mercer (1982)
	Discount rate	9%	Average for Mercer (1982)

Source: See annex

Table 2. Parameter values declared by entrepreneurs and collected in this study

Parameter	Whitney	Judah	Dodge	Our data
PR freight expense p t-m	$0.005 p t-m		50% earnings	$0.0118
ER freight rate p t-m	$0.01 per t-m			$0.02412
Sea freight rate p t-m	$0.0012 per t-m (6,600 sm) $0.0015 per t-m (18,000 sm)		$34 per ton trip for all routes	$0.0014
PR passenger expense p p-m		50% earnings	50% earnings	$0.0088
ER passenger rate p p-m		Not treated explicitly	Not treated explicitly	$0.0176
Sea passenger rate p p-m		$250 (1st class) $150 (2nd class)	$100 per passenger trip for all routes	$100 per passenger trip for all routes
Wagon freight rate p t-m		$1.4343 per t-m		Entrepreneur data used
Wagon passenger rate p t-m		$0.3030 per p-m		Entrepreneur data used
International & inter-regional trade traffic	1.3 mlls tons		80,000x2 tons Cape Horn 120,000x2 tons Panama 30,000x2 tons overland	131,600 tons inter-regional 300,082 tons total
International & inter-regional passenger traffic		118,800 1st class pass (expected) 140,400 2nd class pass (expected)	4,000 pass Cape Horn 50,000 pass Panama 100,000 pass overland	45,000 pass
Local freight traffic		43,800 tons		Entrepreneur data used
Local passenger traffic		13,505 pass		Entrepreneur data used

Source: See annex

4.6. Results

The PR entrepreneur may decide whether to compete on prices or on quality with the shipping industry. The model indicates the two pricing policies produce substantially different outcomes[62].

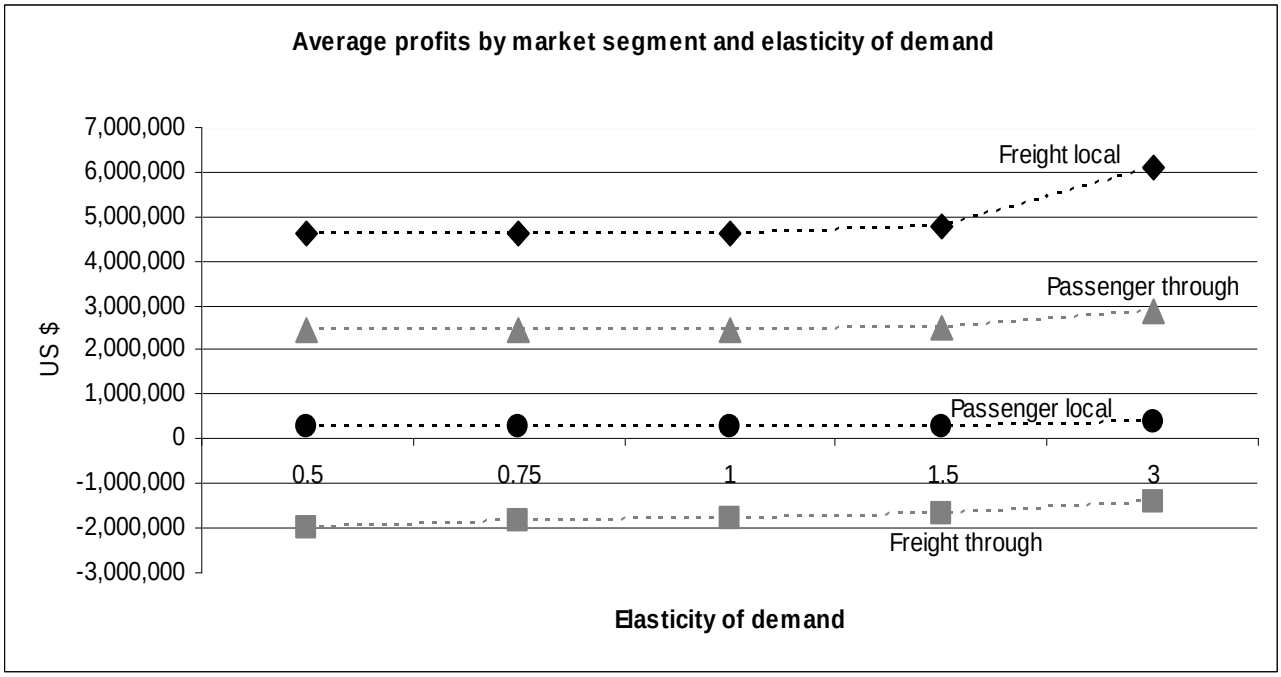
Competing on prices

When the PR entrepreneur chooses to compete on prices he faces a strict ceiling price set by the equivalent shipping price. Figure 8 presents average (entrepreneur and conventional operational cost) profits by elasticity of demand as produced by the empirical model described above. The results are interesting and surprising. First, it is unlikely the PR should have been expected to be profitable if it was to compete on prices. The cost difference between sea and rail transport was so large and advantageous to sea that the PR would need to offer negative freight rates to compete with sea transport for all origin-destination points except eastern-western US. Additionally, for eastern-western US trade the PR was unlikely to generate any operational profits. The result is surprising in that this was the market segment that entrepreneurs emphasized on their reports as the most attractive one. Second, through and local passenger traffic should have generated operational profits, but these would not have been less than $2 million per year. Third, local

[62] See annex for full set of model outcomes and analysis.

freight traffic should have generated substantially higher profits than the other three sources of earnings. The results are robust for a reasonable range of transport demand elasticity values.

Figure 9. Average operational profits when PR competes on prices



Total profitability measures indicate, as expected, the PR was unlikely to be profitable pricing to compete with shipping (see table 3). The NPV of the project is always large and negative independently of the cost function and the elasticity of demand. The usual contemporary profitability measure, net earnings over construction cost, is also low compared to the 18%-25% entrepreneurs initially predicted and accepted as reasonable profit levels. Finally, entrepreneurs would take at least 10 years after construction finished to finish paying for construction.

Table 3. Profitability of PR competing in prices

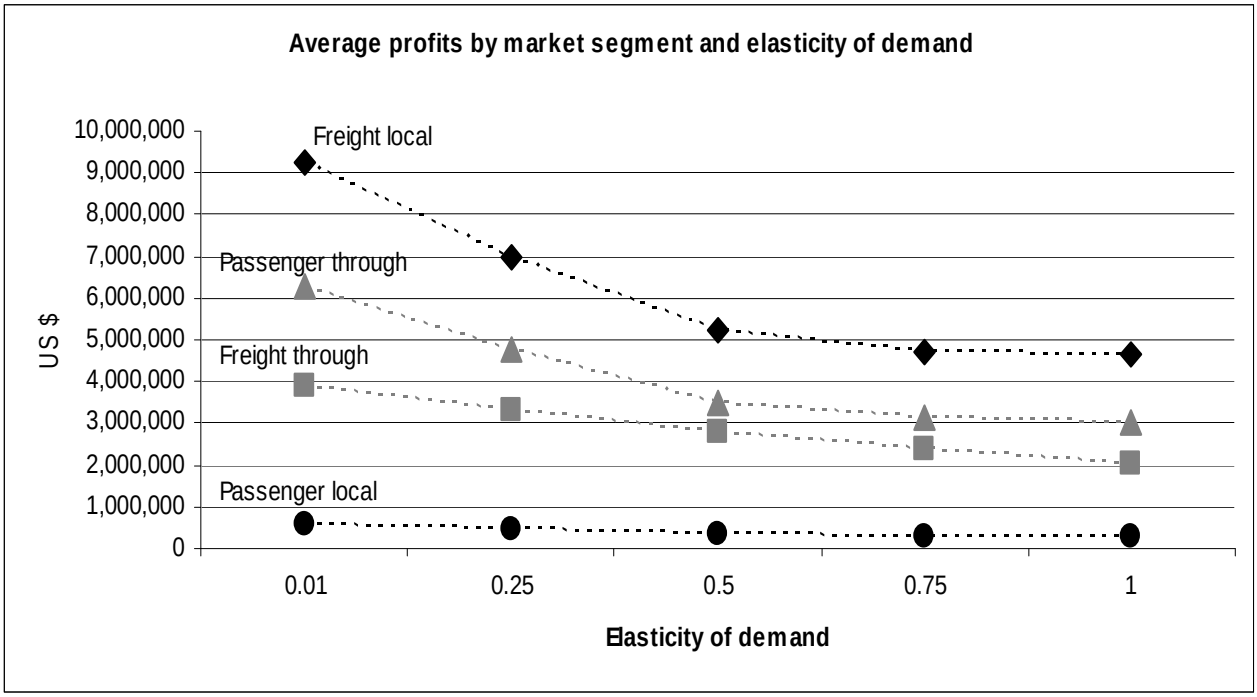
Type of operation cost	NPV	Net earnings/ construction cost (%)	Years to pay investment
Entrepreneurs cost function	-37.2	5.6	18.0
Conventional cost function	-13.0	10.1	9.9
Overall average	-25.1	7.8	12.8

Competing on quality

When the PR chooses to compete on quality the entrepreneur must decide the pricing policy and how much rent he perceives can be extracted from merchants. Entrepreneurs will expect a certain value for the general and commodity specific new good effects and then use this expectation to set the PR price. The results here

presented correspond to the case where the entrepreneur expects general new good effects to be proportional savings in insurance, or 15% of observed freight cost, and commodity specific new good effects proportional to the value of time savings observed during the 1850s, or 155% of observed freight costs for time savings of about 70% of travel time. The average (between the entrepreneur and conventional operational cost function) profits by market segment and elasticity of demand when the PR entrepreneur prices in this way are presented in figure 10 (see annex for results with other various values for new good benefits). The results suggest that if new good benefits are proportional to 1850s experience with small improvements in speed and safety, then all four sources of earnings should have been expected to be profitable independently of the elasticity of demand and the operational cost function. Most revenues and profits should have been expected from local freight traffic, with profits between $5-9 million. Through traffic should have also been expected to be profitable. Passenger through traffic should have generated profits between $3-6 million, while freight between $2-4 million. Finally, passenger local traffic although likely to be profitable should not have been expected to generate high profits.

Figure 10. Average operational profits when PR competed on quality and prices to value general new good benefits at 15% and commodity specific new good benefits at 155% of observed price



If new good benefits are proportional to the valuations revealed during the 1850s for small improvements in speed and safety, the entrepreneurs should have expected the PR to be profitable (see table 4). The NPV was about $9 million in present value, the net earnings to construction cost ratio was very close to that accepted by Dodge (18%) and it would take 6 years after finishing construction to repay fully construction costs – independently of the elasticity of demand or the operation cost. The results for the cases when commodity specific benefits are valued less than 155% are less clear. When commodity specific effects are valued at 100% the PR passes the NPV criteria in some scenarios (i.e. depending on operational cost and elasticity of

demand). And for commodity specific new good effects values at less than 100% it is unlikely the PR should have been expected to be profitable. Thus, the results indicate a moderate case for the PR to be profitable. The key for the PR to experience profits depends on the valuation by merchants of the new good effects. If these were valued proportionally to the valuations merchants had reveled during 1850s when exposed to small improvements in speed and safety, then the PR should have been expected to be profitable.

Table 4. Profitability of PR competing in quality

Rent captured by pricing policy	NPV	Net earnings/ construction cost (%)	Years to pay investment
33%	-20.0	9.1	11.0
66%	-10.6	11.5	8.7
100%	-2.0	13.6	7.3
155%	9.5	16.6	6.0

Additionally, if the valuation of new good benefits was proportional to that observed during the 1850s, the case is for expecting the PR to be profitable was strong. First, robustness checks of the model's outcomes indicate results are strong. Changes in key variables like the price of alternative transport mode, complementary transport mode (the eastern railroads in the case of through traffic) and costs generate only marginal changes in profitability[63] (see annex). Second, estimated profits correspond to a lower bound of profits. Collected information on observed traffic was consistently downward biased and construction cost was assumed to be 100% sunk cost[64].

In summary, the simulation exercise has indicated that i) entrepreneurs underestimated the cost advantage of sea transport over rail, ii) the potential for the PR to engage profitably in price competition with the shipping industry was very low, iii) the PR should have only been expected to be profitable if new good benefits were valued by merchants proportionally to what they had revealed during the 1850s in reaction to small improvements in transport speed and safety, iv) the pricing strategy proposed by Whitney and Judah (price reduction) was credible as they (sometimes) also assumed elastic demand schedules; but the results presented here indicate exceptionally elastic demand schedules would be required to produce profits for the PR following their proposed pricing strategy and it is more likely the PR would have been profitable by exploiting market power derived from new good benefits provided by the PR (increasing prices and inelastic

[63] See annex for full robustness analysis
[64] See annex for full explanation of why the profit estimates produced by the model are downward biased.

demand schedule) as Dodge suggested, and v) entrepreneurs behavior was consistent with the incentive to lie they faced in Congress and capital markets.

5. The PR performance and comparison with declared and simulated expectations

6. Conclusions

XXXX

The privatisation and liberalisation of markets for public utilities have been accompanied by the development of the economics of contracts applied to regulated industries, and the findings in this study have implications on this literature. The models in this literature have indicated implications for optimal contracting schemes in the presence of projects with different phases (construction vs operation), different connections between phase (quality of infrastructure service vs cost reduction), uncertain costs and demand, and so on. However, issues that have been emphasised in the study of the case of the Pacific railroad (different incentives to lie to the public sector and the capital markets and the creation of political/economic conflicts as a consequence of construction of the project) have not been studied and are likely to be important to understand the frequency of outcomes like over-costs, delays and corruption frequently associated to these projects, particularly the really large ones.

Research finding also has important implications for the literature on globalization. The literature on globalisation has emphasised the role of technological progress, particularly the invention and diffusion of steamships, as the key explanation of the transport costs decline leading to the first globalisation era during the second half of the 19th century[65]. Research presented here indicates the issues were more complex and other factors may have importantly influenced the timing of declining transport costs. First, on the technological dimension of the problem, the decline of transport costs should be seen as a complex process of application of steam technology to sea transportation (steamships) and i) development of complementary larges scale infrastructure projects (3 proposed routes over Central America and 1 in the Suez), ii) in combination with major infrastructure projects involving application of steam to rail transport (6 transcontinental railroads in North America and 1 over Panama), and iii) the co-ordination of a global transport system. Additionally, existing research has focused on the decline of transport costs, while research presented here indicates new good benefits like radical travel time reductions and safety improvements also played an important role in the process of globalisation. Second, on the institutional dimension of the

[65] Harley (1988) indicates substantial transport cost decline was caused by the steamship, rather than other institutional forces indicated by North (1958).

problem, governments played an important role in the timing of construction of these large scale projects. As explained above, large scale projects tend to generate positive and negative externalities leading to political and economic conflicts that are dealt with in the realm of political institutions as much as in markets. More precisely, many entrepreneurs from different countries were proposing different canal and railroad projects improving long haul transportation. These entrepreneurs faced selection mechanisms associated to i) competitions within firms and between firms (markets) to achieve profits, ii) competitions in national institutional settings like Parliament and Congress to allocate rights to exploit the direct and indirect benefits of the project, and to bear the direct and indirect costs of the project, and iii) competitions between countries/empires the US, Great Britain and France for possession of strategic resources to gain dominance over international trade (and international aggression).

References

Ames, C. (1969) PIONEERING THE UNION PACIFIC: A REAPRAISAL OF THE BUILDERS OF THE RAIROAD. Appleton Century Crofts.

Atack, J. and Passell, P. (1994) A NEW ECONOMIC VIEW OF AMERICAN HISTORY. Norton

Brown, M. (1933) "Asa Whitney and his Pacific railroad publicity campaign" The Mississippi Valley Historical Review, Vol. 20, No. 2

Cisco, J. (1868) The Union Pacific Railroad Across the Continent West from Omaha Nebraska. (First Mortgage Bonds Sale Prospectus). April 2. p. 4.

Cotterill, R. (1919) "Early agitation for a Pacific railroad, 1845-1850" The Mississippi Valley Historical Review, Vol. 5, No. 4

Delgado, J (1990) TO CALIFORNIA BY SEA: A MARITIME HISTORY OF THE CALIFORNIA GOLD RUSH. University of South Carolina Press

Fogel, R. (1960) THE UNION PACIFIC RAILROAD: A CASE IN PREMATURE ENTERPRISE. John Hopkins University Press.

Galloway, J. (1941) "Theodore Judah – Railroad pioneer" Civil Engineer, October-November

Hittell, T (n.d.) "Memoir of Theodore Judah, The pioneer engineer and successful projector of the Pacific railroad" Transactions of American Society of Civil Engineers.

Hittell, T. (1898) HISTORY OF CALIFORNIA, Vol. 4

Hughes, J. and Cain, L. (2003) AMERICAN ECONOMIC HISTORY. Addison Wesley

Judah, T. (1857) A Practical Plan for Building the Pacific Railroad

Judah, T. (1860) Central Pacific Railroad of California,

Judah, T. (1861) Report of the Chief Engineer on the Preliminary Survey, Cost of Construction and Estimated Revenue of the Central Pacific Railroad of California. October 1.

Judah, T. (1862) Report of the Chief Engineer on the Preliminary Survey, Cost of Construction and Estimated Revenue of the Central Pacific Railroad of California. October 22.

Loomis, N. (1912-13) “Asa Whitney: father of the Pacific railroads” Proceedings of the Mississippi Valley Historical Association, Vol. 6

Mercer, L. (1970) “Rates of return for land grant railroads: the central pacific” Journal of Economic History, 30, pp. 602-26

Mercer, L. (1974) “Building ahead of demand: some evidence for the land grant railroads” Journal of Economic History, 34, pp. 492-500

Montague, S. (1864) Report of the Chief Engineer on the Preliminary Survey, Cost of Construction and Estimated Revenue of the Central Pacific Railroad of California. October 8.

Schumpeter, J. (1939) BUSINESS CYCLES. Mc Graw Hill

Walton, G. and Rockoff, H. (1998) HISTORY OF THE AMERICAN ECONOMY. Harcourt

Whitney, A. (1845)

Whitney, A. (1848)

Whitney, A. (1849) Project for the Pacific Railroad. George Wood, New York. p. 59.