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The Cost of Railroad Regulation: The Disintegration of American Agricultural Markets in the Interwar Period[1]

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Abstract: We investigate the costs of transportation regulation using the example of agricultural markets in the United States. Using a large database of prices by state of agricultural commodities, we find that the coefficient of variation (as a measure of market integration between states) falls for many commodities until the First World War. We demonstrate that this reflected changes in transportation costs which in turn in the long run depended on productivity growth in railroads. 1920 marked a change in this relationship, however, and between the First and Second World Wars we find considerable disintegration of agricultural markets, ultimately as a consequence of the 1920 Transportation Act. We argue that this benefited railroad companies in the 1920s and workers in the 1930s, and we put forward an estimate of the welfare losses for the consumers of railroad services (i.e. agricultural producers and final consumers).

Keywords: Market integration, price convergence, United States, agriculture, transportation regulation

JEL Codes: K23, L51, N5, N7

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1) Introduction

The literature on market integration, although quite extensive, features some glaring gaps. Some issues are neglected, possibly because the conventional wisdom is very strong and thus the marginal productivity of further research seems low. One of these issues is the integration of domestic markets. Some research has confirmed that European domestic markets integrated in the 'long 19th century' (for a survey see Federico forthcoming), mostly, but not exclusively as a result of the construction of railroads. Further developments have attracted very little if any attention. This seems to be because all the literature considers domestic integration to be a state of nature – once achieved, it is achieved for good, unless the country breaks down, as in the case of Austria-Hungary (Schulze and Wolf 2009).

This view also applies to the United States. Slaughter (1995), following the earlier lead by Fishlow (1965), has argued that the 'antebellum transportation revolution' caused widespread convergence in prices before the Civil War. Price gaps from the Midwest to New York City fell by about a half from 1870 to 1910 (Williamson 1974 Appendix A). As far as we know, no work covers the period after 1910. By neglecting the issue, we claim, scholars have missed a very interesting story, which this paper aims at presenting. We measure the integration of agricultural commodity markets by the convergence of producer prices for 22 agricultural commodities at the state level from 1867 to 1967. In the long run prices converged as expected, although at different rates across commodities. However, a look at short-term movements highlights some unexpected features, such as a widespread slowdown of this process in the 1920s to the point of stagnation, and a short but substantial reversal of integration during the Great Depression. In fact, in the early 1930s, the market for wheat was as (dis-)integrated as it was in the late 1860s.

The next three sections explore the causes of these movements, focusing on the interwar years. They must have reflected changes in transportation costs, since the American constitution forbids legislative barriers to internal trade, and there is no evidence whatsoever of a dramatic change in market efficiency. Indeed, Section 3 shows that (real) rail fares decreased from the 1880s to a minimum in 1917-1918 and then increased again, and that this increase was not wholly compensated for by substitution to other means of transportation[3]. Section 4 argues that trends in real rates reflected productivity growth in railroads before World War One but that that relationship broke down after 1920. In Section 5 we claim that this was ultimately a consequence of the 1920 Transportation Act, which marked a major discontinuity in the history of the regulation of railroads. Section 6 deals with the effects of this policy. We argue that it benefited railroad companies in the 1920s and workers in the 1930s, and we put forward an estimate of the welfare losses for the consumers of railroad services (i.e. agricultural producers and final consumers). Section 7 concludes.

2) Price convergence: a statistical analysis

The data are taken from the ATICS dataset, collected and described in detail by Cooley et al (1977), which was kindly made available to us by Stephen J. DeCanio and converted from the NBER's obsolete TROLL format to Excel through invaluable research assistance. This provides prices, on an annual basis by state between 1866 at the earliest and 1970 at the latest, for 22 products (barley, buckwheat, cotton, corn, flaxseed, 'all hay', hops, oats, peanuts, potatoes, rice, rye, soybeans, sweet potatoes, sugar-beets, tame hay, tobacco, wheat, 'all cattle', hogs, milk cattle and 'stock sheep and lambs'). The figures refer to prices received by farmers (farm gate prices), including the proceeds from government purchases.

Before 1909 we have December 1 prices, and thereafter 'season average prices', weighted by monthly sales. Thus, the data may differ from the yearly average prices which are commonly used in the literature and the change of the period of reference in 1909 may introduce a discontinuity in time. Neither concern seems serious enough to distort the analysis substantially however. Prices on any specific day are undoubtedly less representative than seasonal ones, as they may reflect a temporary disequilibrium position, not yet absorbed by arbitrage. Yet, there is no clear evidence of breaks in the series after the switch to seasonal prices in 1909. Besides, our analysis focuses on the period after this date. Seasonal prices are clearly different from yearly averages, and farm gate prices are bound to differ from market prices, for example by the transportation costs to cities. Furthermore, they might be noisier than comparable market prices, to the extent that farmers and

[3] See Estevadeordal et al 2003 on the role of transportation costs for international market disintegration between the wars.

traders during the season had imperfect information about supply in other areas. A comparison between our farm gate prices and market prices from wheat collected by Jacks (2005) for the major cities in some states is reassuring: the series follow each other very well and the mark-up is fairly constant. Furthermore, seasonal farm gate prices are more relevant than market ones for some issues, most notably the welfare of farmers and their impact on politics in agricultural communities.

As argued elsewhere (Federico forthcoming) market integration involves two different processes: the increase in the speed of return to equilibrium levels after a shock (a test of efficiency à la Fama) and the convergence of prices. As a disequilibrium process in a (most likely) quite efficient market, the latter must be tested using high-frequency data - at least monthly if not weekly or daily. Thus, we have to focus on long-run changes in price dispersion, measured by movements in the coefficient of variation. We omit series which are too short or which are for commodities of which very little was grown, and focus on eight main crops (barley, cotton, corn, oats, potatoes, rye, tobacco, and wheat) and three animals (hogs, milk cattle, and 'stock sheep and lambs')[4].

Table 1 reports five-year averages of the coefficient of variation for the eleven products at the beginning and at the end of the period. As expected, the coefficients declined in the long-run, but the convergence is far from impressive and levels of dispersion remain fairly high, except for wheat. Just for a comparison, the coefficient of variation for wheat prices in European markets declined from a peak of slightly below 0.4 during the Napoleonic wars to about 0.10-0.15 at the heyday of free-trade in the 1870s (Federico 2011). The other columns report the results of an econometric analysis of the process of convergence (Razzaque et al (2007). The regression

$$\Delta lnCV_t = \alpha + \beta TIME + \psi lnCV_{t-1} + \phi ln\Delta CV_{t-1} + u_t \quad (1)$$

tests jointly the existence of a deterministic trend in the series of the coefficient of variation and of a systematic return to it after each shock (e.g. the opening of a new railroad). The hypothesis of convergence is accepted if β is negative and significant, with the long-run rate of change given by $t = -(\beta/\psi)$. The coefficient of variation returns to the long-run trend if the ECM coefficient ψ is between -1 and 0. The lagged shock term is added to address possible serial correlation.

[4] In 1929, the eight products accounted for 73% of the total gross output of crops, and the omitted ones for 6% (Strauss and Bean 1940).

Table 1: A statistical analysis of price convergence

	Average CV		Yearly rate	
	1867-1871	1963-1967	of change	ECM
Wheat	0.239	0.055	-1.749***	-0.275***
Rye	0.290	0.249	-0.244	-0.510***
Corn	0.391	0.143a	-1.330***	-0.670***
Oats	0.394	0.130	-1.030***	-0.477***
Barley	0.237	0.113	-0.905***	-0.329***
Cotton	0.076b	0.239c	0.880	-0.418***
Potatoes	0.375	0.270c	-0.491***	-0.769***
Tobacco	0.430	0.601	0.234	-0.311***
Milk cattle	0.331	0.223	0.182	-0.128***
Sheep	0.322	0.168	-0.780***	-0.240***
Hogs	0.511	0.130	-1.302***	-0.269***

*** significant at 1%
a:1956-60; b:1876-80; c:1961-65
Source: see text

All the ECM are negative and significant, and they imply half-lives of shocks ranging from a minimum of six months for potatoes to a maximum of five years and one month for milk cattle. Prices converged in seven cases out of eleven (eight if rye is included), albeit at different rates. The coefficients, extrapolated over the century, correspond to a decrease in dispersion ranging from a massive 80% for wheat and to a still substantial 38% for potatoes, a much less tradable commodity. Turning to the three exceptions, the dispersion of cotton prices was very low from the beginning, as the plant was cultivated only in a few Southern states, and thus there was not much room for further convergence. The high dispersion of tobacco prices reflects atypical prices in Massachusetts, Connecticut and (from the 1920s) Louisiana, which jointly accounted for less than 2% of American acreage. Omitting these three marginal states, the coefficient of variation drops sharply (to 0.3 in the 1860s and to 0.25 one century later) and the time trend becomes negative, although not significant. Last but not least, milk cattle were a production good, with huge qualitative differences, which increased price dispersion and made arbitrage difficult. Thus, these three exceptions do not question the existence of a massive process of convergence.

Finding convergence in prices in the railroad era is not really a surprise. What is surprising is the time pattern of the process, as exemplified in Figure 1 by the case of wheat. Prices converged fairly steadily until 1920, then the trend suddenly reversed and until the late 1930s the coefficient of variation remained above trend. The 1930-32 average was higher than in any other three-year period since 1866. Dispersion declined somewhat in the late 1930s and fell during World War Two to well below trend.

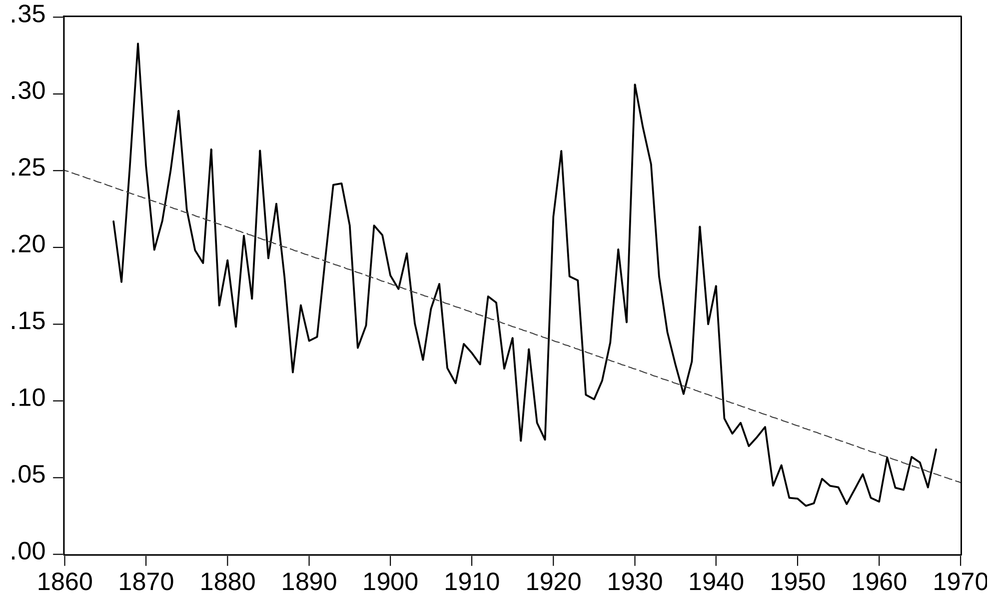

Figure 1: Coefficient of variation, wheat 1867-1967
Source: ATICS database

To buttress the point, Figure 2 looks at the significant breaks in the trend, from 1-step Chow test statistics for recursive estimation of regressing the CVs for wheat on a trend.

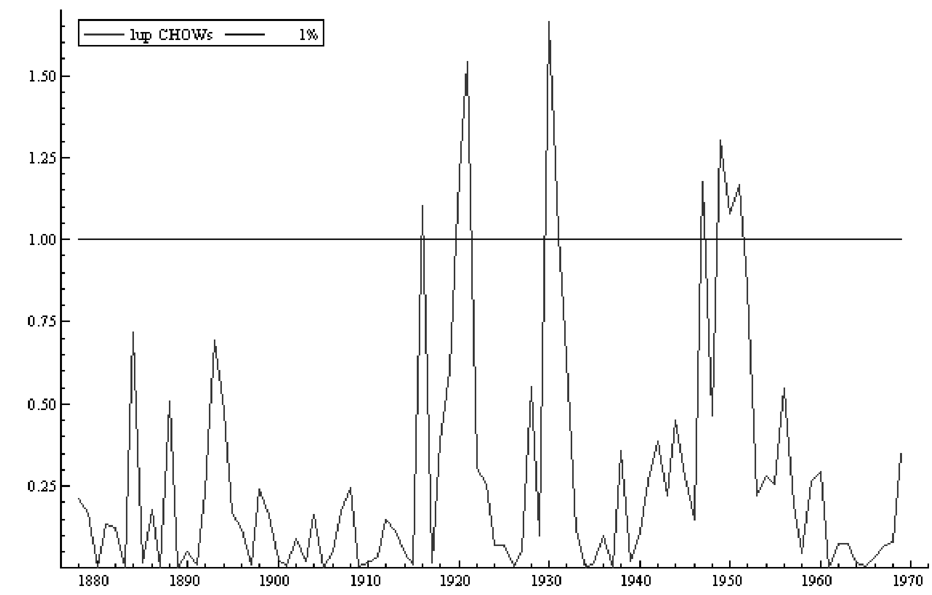

Figure 2: 1-step Chow tests for recursive estimation of CVs for wheat on a trend

The largest Chow statistics (F-statistics of over 11) are for the years 1920 and 1930. Other large breaks fall in 1916, and in the period immediately following the Second World War.

One might argue that wheat was not representative, since its fast convergence process (Table 1) magnified a small fluctuation in dispersion as a major reversal.

Table 2: Ratio of prices to trend and significant breaks

	Ratio to trend		Significant breaks
	1920-1940	1930-1932	
Wheat	1.435	2.351	1916,1920, 1930, 1948, 1950, 1951, 1952
Rye	1.155	1.667	1930, 1948
Corn	1.151	1.579	1920,1935, 1936
Oats	1.198	1.499	1920
Barley	1.342	1.778	-
Cotton	0.885	0.720	-
Potatoes	1.026	1.212	1956
Tobacco	1.049	1.255	-
Milk cattle	1.248	1.370	1924,1926,1932
Sheep	1.034	1.038	1926,1956,1960
Hogs	0.924	0.936	1908,1924,1934,1944

Table 2 shows that wheat was indeed an extreme case. Yet, the level of dispersion was substantially above trend throughout the whole interwar period for about half the products and it was exceptionally high in the early 1930s for all products except cotton, hogs and sheep[5]. Furthermore, the majority of significant break points are concentrated in the early 1920s and in the 1930s. There is therefore something to explain.

3) Transportation costs and market integration

In the absence of barriers to trade and of changes in market efficiency, convergence (divergence) of prices for a product must reflect a fall (increase) in transportation costs. To enhance comparability across time and among commodities, these latter are usually measured as a ratio to the price at origin, the so-called freight factor (Hummels 1999).

Following an established tradition in the field, we start our analysis with a look at the Chicago-New York grain trade. It was one of the major trade flows in America, since the Chicago market

[5] Hickey and Jacks (2010) look at market integration within Canada during the twentieth century and find somewhat similar patterns for the interwar period for some goods, although there is no discussion of this in their paper.

collected grain from a wide area of the Midwest and the Great Plains, to be shipped to the East Coast for local consumption and export. Commercial all-rail transportation between the two cities started in the late 1850s (MacAvoy 1965). Furthermore, it was also possible to ship grains via the Great Lakes to Buffalo and from there to New York along the Erie Canal (all water route) or by rail (mixed route). These shipments via the Great Lakes accounted on average over the whole period for about two fifths of the total, although their share of total shipments fluctuated widely, from 4% in 1943 to 74.5% in 1877. In fact, all-water transportation cost about half that of transportation by rail (and the mixed route about two thirds), but it was impossible during winter, when the Great Lakes froze[6].

It is possible to compute the freight factor by dividing the all-rail average freight rate for Chicago to New York either by the Chicago market price or by the farm gate price in Illinois[7]. The two series differ by the cost of transportation from farm to city, plus whatever difference there is due to the time coverage within the year (see Section 2). In practice, the difference is small: the two series are cointegrated at the 1%-level and the coefficient of correlation is 0.941. Figure 3 uses the Illinois freight factor simply because the Chicago price series stops in 1941 and compares it to the price ratios between the two states.

[6] Data on transportation by means from Chicago Board of Trade, freights Chicago Board of Trade (after 1907 domestic trade), except all water 1908-1920 from the US Statistical Abstract.

[7] Price of wheat in Chicago market from NBER: (http://www.nber.org/databases/macrohistory/rectdata/04/m04001a.dat, Accessed 30 June 2008).

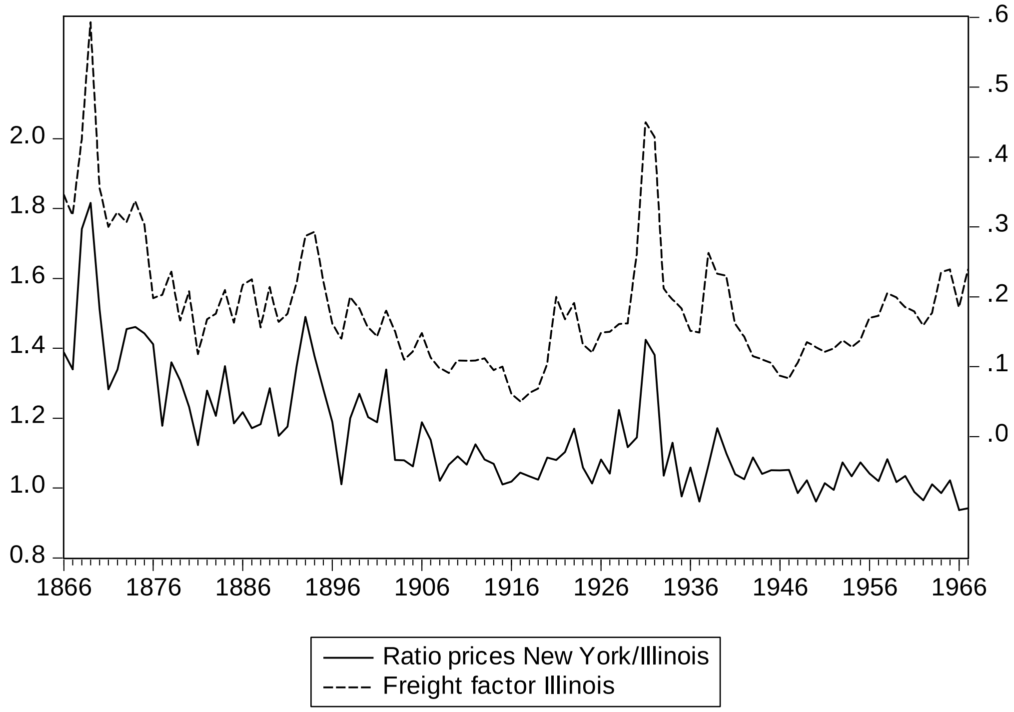

Figure 3: Price ratios for wheat New York/Illinois and the Illinois wheat freight factor, 1866-1967

The similarity between price gaps and freight factors is striking at first glance and is confirmed by a log-log regression with the price gap as dependent variable, explained by the all-rail freight factor and by time, as a proxy for gains in market efficiency, including the fall in all-water transportation costs. Both variables are significant at 1%, with the expected sign[8]. The coefficient of the time trend (-0.27% per year) implies a 25% convergence, ceteris paribus, over the whole period. The coefficient for the freight factor (0.14) is nicely close to its long-run average (0.183). This elasticity implies that the nine-fold increase in the all-rail freight factor from its all-time low of 5% in 1917 to the 1931 peak (45%) could have increased the price gap by 125%.

The effect on transportation costs was partially dampened by substitution with water, which increased from 10% to 73% of total shipments in the same period. However, the supply of water transportation was not perfectly elastic. In fact, nominal water rates increased by about 40% and

[8] The results are identical using the freight factor and the price ratio computed using market prices, or when adding the lagged freight factor (i.e. adjustment within the year), which is not significant. The results are also identical using instrumental variables, using the lagged freight factor as an instrument. New York market prices are taken from Jacks (2005) for 1868-1913 and from Statistisches Jahrbuch (1939) for 1924-1937.

the shipment weighted average freight factor increased by about five times between 1917 and the early 1930s. A simple log-log regression of the share of all rail transportation as a function of relative costs (all rail vs. lake and rail) plus time, yields an elasticity of -0.5 – i.e. a 1% increase in the relative cost of all rail shipment caused a 0.5% fall in its market share. Thus any increase in railroad fares between Chicago and New York was bound to augment transportation costs, and thus price differentials. How much does this conclusion extend to all domestic trade? The rail rates on the Chicago-New York route may not be representative of fares for other routes/commodities and the scope for substitution may have differed between commodities and areas.

Some additional evidence for the wheat market, although scattered, confirms the basic insight, however. The Chicago-New York all-rail rate on the eve of World War One seems to have been somewhat higher than fares on other routes[9]. On the other hand, the coefficient of correlation between the Chicago-New York freight factor and that for St. Louis-New York exceeds 0.98[10]. Besides, the best evidence is the coincidence of trends in the all-rail (Illinois) freight factor and the coefficient of variation for wheat, at least until WWII. For the period 1866-1939 the series are cointegrated at 1% and the coefficient of correlation is 0.79[11].

Unfortunately, the data on transportation costs of agricultural commodities other than wheat are scarce. The rail freights can be proxied by the revenues per ton mile. This is an aggregate measure, and, as such, may not be representative of changes in transportation costs on any specific route or for any specific commodity. Yet the series, if deflated with the index of farm prices (HS 2006, Cc127), is fairly similar to the all-rail freight factor (Figure 4). The fluctuations are smaller, especially in the 1930s, but the trends, until World War Two, are the same[12]

[9] One can compute an elasticity of railroad fares to distance with the data from Comparison (1915), which covers 56 routes. A log-log regression with distance yields a elasticity of 0.45 (t-stats 14.2). Given the distance between Chicago and New York (959 miles) the rate should have been 0.0615$/bushel, vs. an actual one of about 0.10.

[10] Data of all-rail fares from St. Louis to New York 1889 to 1920 from US Statistical abstract 1911 and 1920.

[11] The relationship breaks down after the end of World War Two. Over the whole period 1866-1967 the Illinois freight factor and the coefficient of variation for wheat are no longer cointegrated at 5% (although the t-stat is quite close to the threshold) and the coefficient of correlation drops to 0.64.

[12] For the period 1882-1946, the two series are cointegrated, albeit only at 10% and the coefficient of correlation is 0.603.

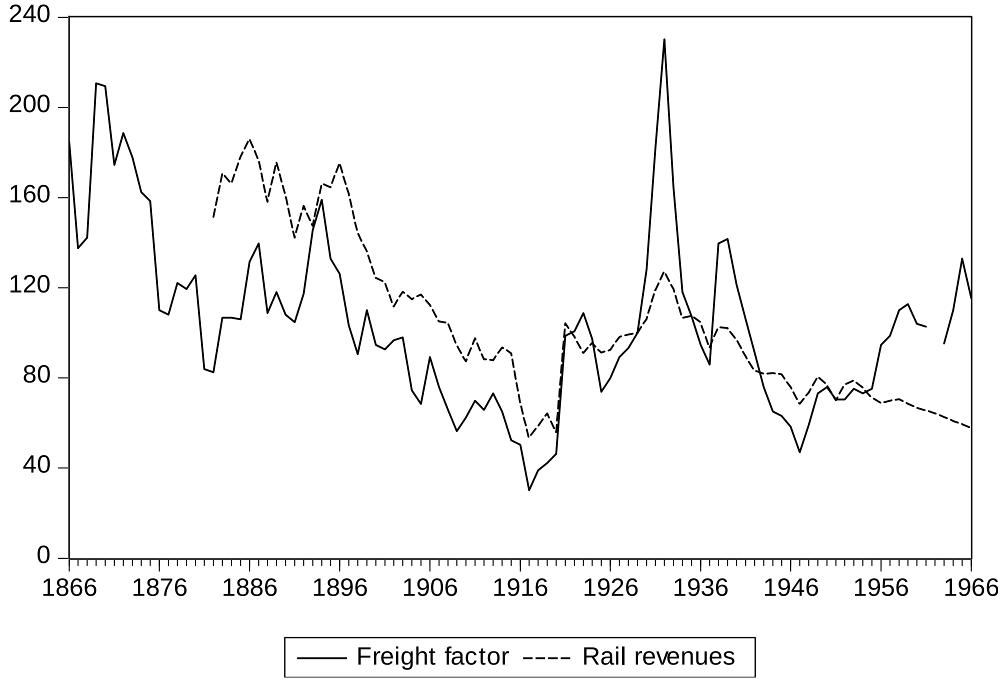

Figure 4: Freight factors and rail revenues, 1866-1966

There is no evidence on costs of transport by water, and thus one has to infer the extent of substitution of water to rail transportation from data on shipments (in tons). The share of railroads in total transportation by rail and water declined from about 75% before the Great Depression to a minimum of 68.2% in 1932, rebounded during World War Two and then began a steady decline. These data are not weighted with the length of trips and include all products, including very bulky goods such as coal and iron ore[13]. Actually, agricultural goods accounted for only between 10 and 15% of total shipments by rail. It would be imprudent to draw from aggregate data any inference about the substitution between means of transportation for such a small subset of shipments. Furthermore, one should consider transportation by road. Trucking was faster and more flexible than rail transport and thus a potentially serious competitor for perishable commodities and small loads (known in the trade as 'less than carloads freight'). The number of registered trucks exceeded 1 million in 1920, 5 million in 1941 and 10 million in 1955 (HS 2006, Df342). On the other hand, the development of long-range road traffic was hampered by the technical shortcomings of early trucks and the dearth of suitable roads, before the construction of the interstate highway

[13] Series in ton/miles are available after 1939 (HS 2006, Q12-Q22). The railroad share fell from 64% to 42% in 1967. In the same period, the share of inland waterways remained stable at around 17% and that of pipelines and motor vehicles, doubled, from 21% to 41%.

system from the 1950s. For the mostly bulky products we are considering, the speed of service was a minor issue, so competition was based on prices. As late as the 1970s, the cross elasticity of demand for road transportation to rail prices, as estimated by Friedlander and Spady (1985), was only 0.20.

An alternative approach to the issue is to compare shipments by rail with the gross output for each product. If the overall shipment/output ratio remained constant, any fall in the ratio of shipments by rail to output would be evidence of substitution away from rail transportation. Such a comparison is possible for eight goods out of the eleven we are covering (all but barley, rye and potatoes) over the period 1920 to 1940 (US Statistical Abstract). The average ratios differed widely across products and thus they are normalized to their 1920-1940 average in order to make results comparable. From 1929 to 1930-1932, the normalized ratios fell for all products, by a minimum of 9% for tobacco to a maximum of 38% for oats. However, part of this decrease is likely to reflect a decline in total shipments rather than a shift away from railroads into water or trucking. In fact, the ratio of receipts from market sales to total farmer income fell from 86.8% in 1929 to 82.7%[14]. Thus, substitution must have been only partial. This conclusion is buttressed by a look at the coefficients of correlation between the changes in the ratio of rail shipment to output and the change in the coefficient of variation by product over its long-run trend in 1930-1932 (Table 2). If the ratio measured substitution, the correlation would be negative. The more transportation by rail could be substituted by other means, ceteris paribus, the smaller the impact of an increase in rail freight rates on total transportation costs was. In contrast, the simple coefficient of correlation is positive (0.20).

To sum up, there is little doubt that changes in railroad rates for transportation of wheat from Chicago to New York determined parallel changes in price differentials, in spite of the competition by water transport. The available evidence suggests that this specific case was not an exception. Also for other agricultural commodities and other routes, substitution between alternative means dampened only very partially the movements in railroad rates. Thus, these latter caused changes in the total transportation cost and thus ultimately in the level of market integration.

[14] The percentage is obtained as ratio of series HS 2006, Da1290 to the sum of HS 2006, Da1290 and Da1288.

4) Railroad productivity and railroad costs

Given the conclusion of the previous section, the next question is obvious: what drove real rail rates? What caused their long term decline and why do they display wide deviations from this trend, such as the collapse during World War One, the sudden recovery in 1919-20, and the peak of the early 1930s (Figure 4)?

The (most) basic theory is quite simple. In the long run, if the market is competitive, real prices reflect productivity growth. If, in contrast, competition is limited by collusive agreements or by regulation, part of the productivity gains could be transformed into rents, to be appropriated by sector-specific factors (capital or labor). Productivity gains in railroads were indeed huge: from the 1870s to the early 1950s, the total factor productivity of railroads increased nine times (Kendrick 1961 table G III). Thus, railroads easily outperformed the rest of the economy, as the total factor productivity of the American economy increased by 'only' 3.5. There is no doubt that this productivity growth caused the long-run decline in real rail revenues per ton mile[15]. Indeed the elasticity of real rates to TFP for the period 1889-1953 is close to unity (-0.94)[16]. However, a look at yearly movements (Figure 5) highlights substantial differences in the short-term (TFP is reported on an inverted scale for the sake of comparison).

[15] In this case, revenues are deflated with wholesale prices (HS 2006, Cc84), rather than with prices of agricultural products only, as we are considering the whole transportation. Anyway, the results of a deflation with farm prices are qualitatively very similar.

[16] The coefficient is significant at 1% (t-stat 4.10) and residuals are stationary.

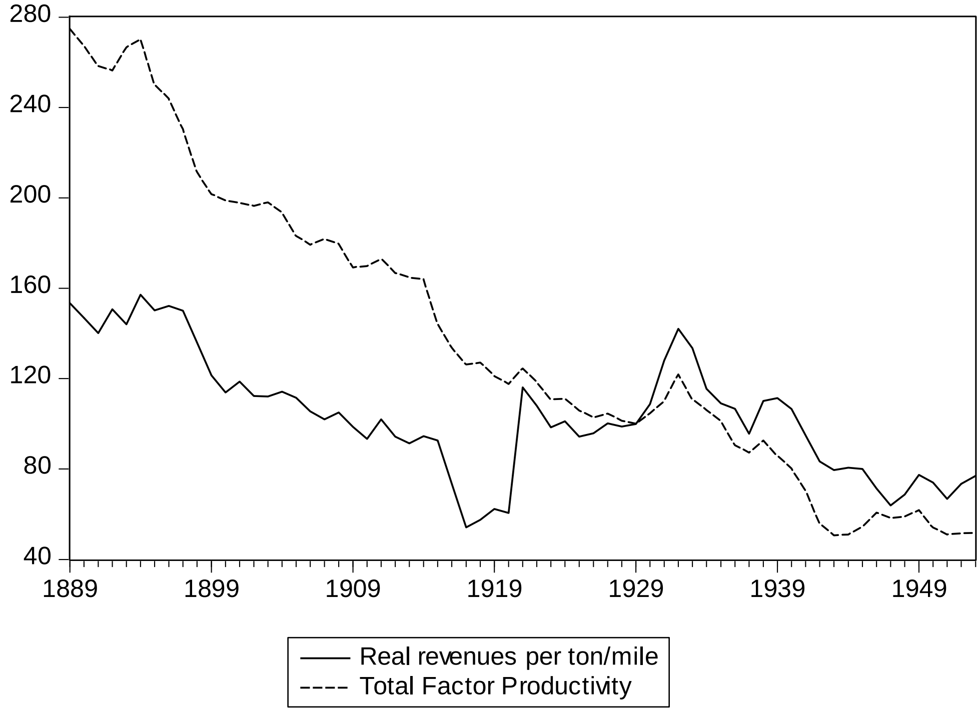

Figure 5: Rail revenues and total factor productivity (inverted) for rail, 1889-1953

The collapse in revenues during World War One was not related to a sudden (and quite unlikely) boom in productivity, nor their abrupt recovery after 1920 to an (equally unlikely) fall in productivity. In the 1920s, total factor productivity increased by about 15%, while real revenues increased by 40%. On the other hand, the increase in rates in the early years of the Great Depression did coincide with a sharp, but short-lived fall in productivity (an 18% decline from 1929 to 1932). A Quandt-Andrews test shows that the year 1921 marked a break in the relationship, and indeed separate regressions for the periods 1889-1920 and 1921-1953 yield widely different coefficients. The elasticity of rail revenues to TFP drops from -1.19 (t-stat 10.88) in 1889-1920 to -0.48 (t-stat 5.99) in 1921-1953 and the difference is highly significant[17]. Furthermore, the elasticity in the period 1920-1940 is as low as -0.07, and it is not significant. The model is admittedly an over-simplified one, and thus the results are to be regarded as evidence of a discontinuity rather

[17] Using as dependent variable the Illinois freight factor yields higher elasticities to TFP (-1.54 over the whole period, -1.69 and -1.10 in 1889-1919 and 1920-1953), but the coefficients of the two periods are still significantly different.

than a precise estimate of its magnitude[18], but the message is clear. Before 1920, railroads transferred almost all their productivity gains to their clients, including the traders in agricultural products. In the 1920s and early 1930s they were able to retain most of the gains.

5) Regulation and competition in American railroads

As anticipated in the introduction, the year 1920 featured the approval of a major piece of railroads legislation, the Transportation Act, which we claim marked a major discontinuity in the long history of regulation[19]. It had started thirty-three years before, with the approval of the Interstate Commerce Act (February 1887). Farmers had been vociferously asking for some intervention since the 1860s, accusing railroad companies of colluding in order to extract monopoly profits (Higgs 1970, Ulen 1980). In the early 1870s several Midwestern states approved the so-called Granger laws (‘The Grange’ being the name of a major farmers’ organization), which imposed maximum rates. However, most of these laws were soon abolished and in 1886 the Supreme court ruled that interstate commerce had to be regulated by federal law. With the Interstate Commerce Act, Congress allowed companies to set common rates, but not to share traffic (so-called pools) and it prescribed that rates should not discriminate between short and long haul, had to be duly publicized and had to be ‘reasonable and just’ (whatever these words meant). Monitoring was entrusted to a new federal agency, the ICC (Interstate Commerce Commission), which however had only limited powers. In fact, it could act only upon complaints from shippers and it had to rely on courts to enforce its decisions. Furthermore, in 1897, the Supreme Court dealt a very severe blow to the ICC’s power, by allowing exceptions to the short-long range clause at the companies’ discretion, and by repeating that the ICC had no right to set rates. On the other hand, in the meantime, Congress had approved the Sherman Anti-Trust Act (1890), which prevented mergers among railroad companies and thus enhanced competition.

During the ‘progressive’ era, under the presidencies of Roosevelt and Taft, Congress approved four main pieces of legislation in nine years: the Elkins Act (1903), the Hepburn Act (1906), the Mann-Elkins Act (1910) and the Panama Act (1912). Out of these four acts, only the first may have

[18] A more comprehensive model should also take into account trends in productivity in other sectors (if not already accounted for in a perfect price index) and any difference in the rate of growth in demand across sectors. The necessary data for building such a model, however, are not easily found, and the task would steer us too far away from the main issue of the present paper.

[19] This account is based on Locklin 1935 and 1947, Albro 1971 and 1992, Kolko 1965 and Stone 1991.

affected competition negatively, as it prohibited discrimination among shippers – i.e. rebates for large-scale clients - and allowed a sort of (disguised) pooling. The three others enhanced competition. The Panama Act protected water companies from the competition of railroad companies, which were forbidden to own water transportation companies on the same route and to manipulate their own rates in order to drive competing water companies out of business. The Hepburn Act authorized the ICC to impose a maximum rate, at its discretion and upon shippers' complaints, without waiting for a court order. The Mann-Elkins Act subjected all changes in rates to a preventive authorization from the ICC. Thus, before the First World War, the ICC could prevent companies from raising rates if it deemed the increase unjustified, but it could not prevent companies from cutting rates, provided that the cuts did not discriminate between their clients. As Stone (1991, p.22) puts it, 'generally, the commission's task [was] of keeping rates down and competition up'.

In December 1917 the federal government took charge of the management of railroad companies to cope with the increase in traffic caused by the war. It returned the companies to private ownership in March 1920. The move was prepared for by the approval of a new comprehensive piece of legislation, the Transportation Act (February 1920; 41th n 456), introduced by Esch-Cummings. It dealt with many issues, from the capitalization of companies to labor relations, but the key provisions from our point of view are those related to regulation. They were clearly meant to reduce competition in order to make investment in railroads attractive again. In fact, the Act allowed pooling among companies, subjected the building of new lines (a major source of competition) to preventive authorization by the ICC and, above all, it gave the agency the task of setting minimum rates, according to the principle of 'fair return'. The ICC was instructed to guarantee the aggregate profitability of the railroad companies (not of each single company), aiming at a return to capital of around 5.5-6%. Five years later, Congress sought to balance this pro-business stance by approving the Hoch-Smith resolution (1925). It asked the ICC to take into account, while setting the fares, the needs of distressed productive sectors (a code-word for agriculture). It is likely that the proponents aimed at forcing the Commission to cut rates, but in practice the legal status of the regulation was ambiguous and thus the ICC could ignore it. The principle of 'fair return' thus remained the guiding light for the ICC until the 1933 Emergency Transportation Act, which was part of the New Deal legislation. It substituted the principle of fair return with a more generic appeal to the needs of traffic, the overall interests of the economy and, only as the third item on the list, the condition of the companies.

The Great Depression also saw an increase in the remit of the ICC. The Emergency Transportation Act set up a new office of the Federal Coordinator of Transportation, which was to last until 1936. Actually, the coordinator, Eastman, did very little for the rationalization of the railroads, but he had a deep impact on the overall regulation of the transportation system (Latham 1959). In fact, he successfully pushed for the approval of the Motor Carrier Act (1935), which extended the regulation to road transportation, exempting anyway the transportation of agricultural products by farmers or specialized firms. Eventually, the 1940 Transportation Act extended the powers of the ICC to water transportation, with the exception of bulky shipments[20]. Thus, from 1940 onwards the ICC could regulate all modes of transportation, with few exceptions. The Act instructed it to 'recognize and preserve the inherent advantage of each [means of transportation]' (quoted in Harbeson 1941, p.293). The ICC interpreted this provision by keeping ratios between rates by road, rail and water roughly constant – the so-called 'umbrella rate' policy (Stone 1991). Thus, the Act tightly regulated the transmission of benefits of technological progress to consumers (Dewey 1941). The limits to competition among means of transportation were relaxed by the Transportation Act of 1958, as interpreted by court decisions in the early 1960s (Healy 1985). However, the ICC was only to lose this power in 1980, with the Staggers Rail Act and the Motor Carrier Act (Winston 2010). To sum up, this very brief sketch of legislative history suggests dividing the period from the Civil War to World War Two into four periods – the unfettered and unregulated market until 1887, the mild but increasingly assertive pro-competition policy under the Interstate Commerce Act 1887-1920, the protection of railroad companies under the 1920 Transportation Act, and lastly the heavy intervention under the New Deal legislation, which lasted under the final liberalization.

How much did these policies affect actual price setting and thus can explain the changes in the rate of pass-through of productivity gains to lower prices? The period before 1887 is useful as a yardstick for the effect of regulation. Both Albro (1992) and Kolko (1965), who disagree on almost everything else, deem the market highly competitive, as shippers had many options and new lines

[20] Water transportation had previously been regulated only indirectly by the ICC for joint transportation with rail or partially by the Shipping Board for the regular services on coastal trade. The regulation of transportation by pipeline had been transferred to the ICC in 1934 (Dewey 1941).

were being built. The whole argument of Kolko's book is that, contrary to conventional wisdom, companies welcomed, if not actively sought, regulation to avoid this cutthroat competition[21]. However, both authors rely on anecdotal evidence, such as statements by railroad managers in official enquiries, which is highly suspicious for examining these issues. Indeed, there were several cartels (or pools) on specific routes (Ulen 1980) and economic historians have tried to assess their effectiveness. They have focused, as usual, on the Chicago-New York route, with different methods and somewhat different results. According to MacAvoy (1965), cartels were unstable and rate wars were quite frequent, while Ulen (1984) stresses that they worked for most of the period, breaking only during periods of poor business. However, the Chicago-New York route may have not been so representative, as it featured two major rail companies, and two minor ones, on top of the water transportation. A monopoly agreement or a collusive agreement could be easier on a local railroad. More work is necessary before reaching any firm conclusion.

Historians do not agree in their assessment of the action of the ICC before the Transportation Act of 1920. The procedure was very cumbersome, and it could be easily nullified if companies changed rates in the meantime. Furthermore, in most controversies the courts ruled for the companies. Thus, Ulen (1980) and Stone [1991, p.8] deem it 'ineffective', also because it was too sympathetic towards companies. MacAvoy has a less negative view, especially for the period before 1897. Unfortunately, it is impossible to test econometrically whether the Interstate Commerce Act made any difference to the pass-through of productivity growth, as the TFP series start in 1889. However, the rate of pass-through in 1887-1920 was quite high (Section 3). From the perspective of this paper, the key fact is that the ICC could have been either ineffective or pro-competitive but surely not anti-competitive. Indeed it could not prevent price wars, as in 1901 (Kolko 1965). The legislation of the 'progressive' era increased its powers, but it is unclear how much difference this actually made in terms of actual rate-setting. Albro (1971) argues that before 1910 the ICC paid very little attention to the level of rates, and it focused on avoiding discrimination among shippers. He singles out the rejection of a (rather unpopular) request for a generalized increase in rates in 1910 as the turning point in the policy of the ICC. But there is no evidence of a discontinuity in trends in the Chicago-New York rate for any year of the pre-war period, while the best break point for the series of nominal revenues is 1900, at the nadir of the

[21] The argument is very controversial (cf e.g. Albro 1992 p.353) and not very convincing. It is unclear which provision of the 1887 Act, if any, could reduce cutthroat competition.

powers of the ICC. The 40% decline in nominal revenues over the whole pre-war period accounted for about half the fall in real revenues (the rest reflecting the increase in agricultural prices). On the eve of the war, rates for grain transportation on American railroads were on average lower than those in Britain, Germany and France (Comparison 1915). Fishlow concludes that before World War One 'consumers of rail services benefited at the expense of owners of railroad inputs' (2000 p. 598).

Grain prices in Chicago started to rise in the summer of 1916, but the ICC did not allow any increase in rates until March 1918. Thus, the all-rail freight factor plummeted to a minimum of 4.3% in May 1917 and remained stuck between 6% and 8% for all the period of management by the USRA (United States Railroad Administration). In other words, the federal budget was subsidizing shippers. These transfers were no longer possible in peacetime under private management and the ICC allowed rates to increase by 40% from July to September 1920. For a few months in the fall of 1921, the freight factor exceeded 20%. From January 1922 to January 1934, rates on the Chicago-New York route remained unchanged, and the movements in the freight factor solely reflected price changes. In the 1920s, real revenues remained broadly stable, while productivity increased by 25%.

The outbreak of the Great Depression, and the ensuing collapse of prices (a 25% fall in the index of wholesale prices to a minimum in 1932) transformed the whole situation for the ICC and the companies. These latter reacted in a somewhat inconsistent way, asking for a 15 percent increase in 1931 and for a 25 percent cut in 1933. It is unclear if accepting any of these requests would have improved the companies' situation, but the ICC decide to ignore them, and so the real cost of transportation soared, peaking in November 1932. The ICC kept rates on the Chicago-New York route unchanged even after the approval of the Emergency Transportation Act, and acted only in May 1934, with a modest cut of 10%. In the next 12 years it changed rates only six times and by very small steps, in spite of the rising prices. In May 1946, both specific rates and nominal revenues were still 10% lower than in 1929, and the freight rates were almost as low as during World War One. Given the 'umbrella rate' policy, one could surmise that all transportation costs remained low during the war, although companies did not complain too much as traffic boomed.

Since 1946, the ICC started to increase rates, and the freight factor returned to its long-term trend levels (Healy 1985).

To sum up, changes in the regulatory framework and in policy decisions by the ICC can explain the movements in nominal and real costs of transportation, especially during the Great Depression and the two world wars. These changes tally well with trends in integration.

6) Winners and losers from regulation

The evidence so far points to a clear-cut hypothesis about winners and losers from railroad regulation in the 1920s and 1930s. Railroad companies earned rents at the expense of consumers and the whole American economy paid a price in terms of foregone trade and income. How big were these gains and losses?

As stated above, the 1920 Transportation Act set a ('fair') return on capital as the main yardstick of companies' performance which was to determine ICC policy. However, the estimation of capital was a controversial issue. The stock exchange valuation was considered unreliable as companies allegedly over issued stock, so Congress approved a Valuation Act (1913) in order to have an independent assessment of the capital of the companies. Thus, Figure 6 reports the ratio of net returns to both the (market value of) capital and to total revenues[22].

[22] Capital (HS 2006, Df982) is net of shares of other companies. The net income series (HS 2006, Df998) is gross revenues less expenditures, including payment of interests.

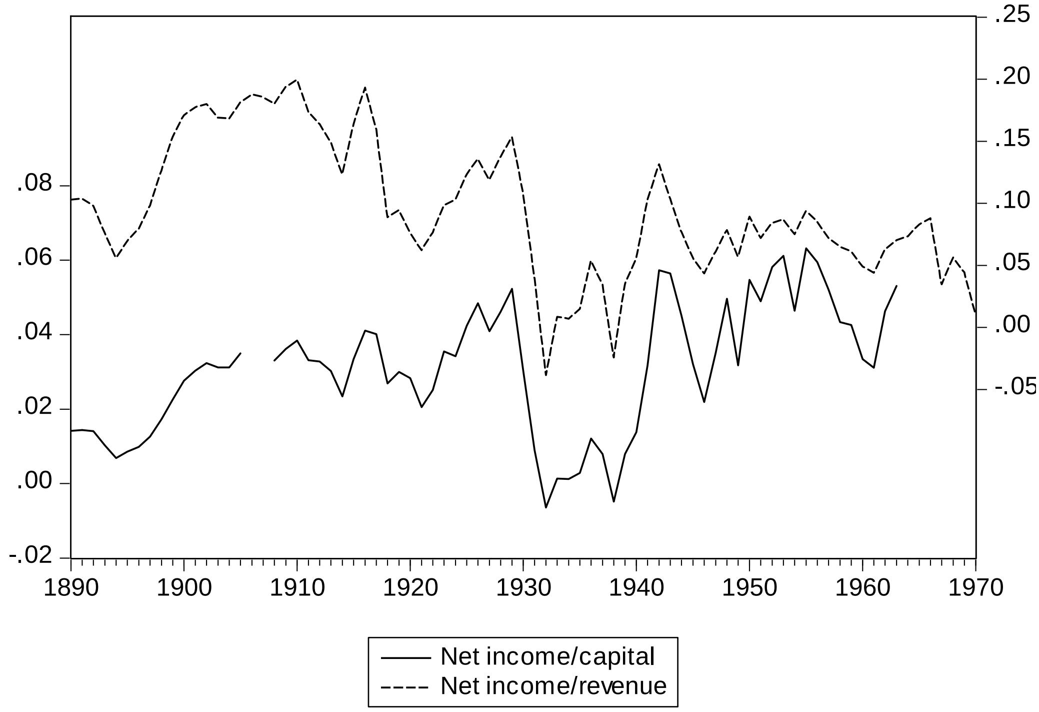

Figure 6: The profitability of railroad companies, 1890-1970

The two series are poorly correlated for the whole period 1890-1970 (0.41), but they coincide almost perfectly in the key years 1920-1940 (0.98). The pre-war period had been a golden age for railroads, with both measures of profits growing quickly after the depressed 1890s. Unsurprisingly, the period of management by the USRA coincided with a sharp deterioration in railroad profitability. The net income/revenue ratio was half the level of the period 1910-1916 (8.7% vs. 16.8%) and the net income/capital ratio was about a sixth lower (2.8% vs. 3.3%). From 1921, the policy of the ICC thus achieved its statutory aim of restoring the profitability of railroads. By 1929, the net income/revenue ratio was back to 15% and, above all, the return to capital had reached 5%. Railroad employees also gained, although the increase in their average compensation (about 10% in real terms) did not match the 30% growth in output per worker[23]. The Great Depression hit the companies quite hard: revenues became negative in 1932 and both indexes of profitability remained very low (2.68% and 0.6% respectively) over the decade 1930-1940. The gainers in those years were the workers – or to be precise those among them who were lucky enough to keep their

[23] Average compensation computed as total wages/number of employees (HS 2006, Df1003 and Df1002). Deflated with BLS consumer price index (HS 2006, Cc1). Output per worker from Kendrick 1961, tab G-III.

jobs. In the four years from 1929 to 1933, the companies shed about 40% of their workforce (785,000 out of 1.8 million), while total traffic halved. Output per worker decreased by 6%, and the average compensation per employee fell by 17% in nominal terms but in real terms it increased by 9%. It continued to grow for the whole of the 1930s, so that in 1940, on the eve of the war, it was a third higher than in 1929.

How much did producers and consumers lose? Federico (2008) shows that the deadweight losses for a producing (or consuming) area from an exogenous price change ΔP can be expressed as

$$\frac{DWL}{GDP} = \Delta P|\alpha - \beta| + 1/2\, \Delta P^2(\eta\alpha + \varepsilon\beta), \qquad (2)$$

where η and ε are the price elasticities (in absolute terms) and the parameters α and β are the shares of production and consumption of GDP in each area for the relevant goods (i.e. those transported by rail). Thus, $\alpha > \beta$ in a producing area (e.g. 'Chicago') and vice-versa in a consuming one ('New York'). The difference $|\alpha - \beta|$ is greater the more specialized producing and consuming areas are.

As a first step, we need an estimate of ΔP –i.e. of how much rates would have fallen had the Transportation Act not been approved. To this aim, we use the revenue-TFP ratio equation (Section 4) for the period 1889-1919 to extrapolate the 1920 real revenues over the whole period to 1940. To convert this index into an estimate of the freight factor, one would need to compare with the total value of transported goods. This latter is unavailable, so we will assume that the nationwide freight factor was 10% in 1920[24]. If it had changed as much as productivity, it would have fallen to 7% in 1939 rather than increasing to 18%. The difference between this counterfactual freight factor and the actual one is a crude measure of losses from regulation (or ΔP). Since we have no information on elasticities, we will simply assume that the price elasticity of demand ranged from -0.5 to -1 and the price elasticity of supply from 0.5 to 1.5.

The next steps towards estimating the total losses according to equation 2 are more complex. In theory, one should consider separately all trading areas for each product, and for each of them one should also know the shares of production and consumption of GDP. Last but not least, one

[24] In that year the Chicago and Illinois freight factors were respectively 7% and 10.5%, and the Missouri one (the ratio of transportation costs from St. Louis to New York to the farm gate prices) 13%.

should guess how the total change in the price wedge is distributed between (each pair of) producing and consuming areas. These tasks are plainly beyond the reach of this paper. Just to give a hint of the possible outcomes, we provide here a highly simplified back-of-the envelope estimate, for two areas only (a producing area P and a consuming one C). The losses are thus respectively

$$\frac{DWL}{GDP_P} = \Delta P_P|\alpha_P - \beta_P| + 1/2\, \Delta {P_P}^2(\eta_P\alpha_P + \varepsilon_P\beta_P) \tag{3.1}$$

and

$$\frac{DWL}{GDP_C} = \Delta P_C|\alpha_C - \beta_C| + 1/2\, \Delta {P_C}^2(\eta_C\alpha_C + \varepsilon_C\beta_C) \tag{3.2}$$

The total losses for the country are the sum

$$\frac{DWL}{GDP_{TOTAL}} = \frac{DWL}{GDP_P} + \frac{DWL}{GDP_C} \tag{3.3}$$

It is possible to simplify further the expression by assuming that the total increase in the price wedge (10%) was evenly distributed between the two areas – so that $\Delta P_C = \Delta P_P = \Delta P = 0.05\%$ and that demand and supply elasticities were equal ($\eta_C = \eta_P = \eta$ and $\varepsilon_C = \varepsilon_P = \varepsilon$). Thus the expression becomes

$$\frac{DWL}{GDP_{TOTAL}} = \Delta P(|\alpha_C - \beta_C| + |\alpha_P - \beta_P|) + 1/2\, \Delta P^2[\eta(\alpha_C + \alpha_P) + \varepsilon(\beta_P + \beta_C)] \tag{4}$$

We hypothesize that all tradable goods were transported by rail and that both areas were fully specialized – i.e. that nothing was consumed in the producing area ($\beta = 0$) and nothing was produced in the consuming area ($\alpha = 0$). In this extreme case, the differences $|\alpha - \beta|$ would be equal to the share of tradables (the sum of agriculture, mining and manufacturing) in American GDP, around 30-35%. (HS 2006, Ca35-53). On the other hand, not all products were transported by rail, and not every area was fully specialized. Thus, we also consider a lower bound, with a difference $|\alpha - \beta|$ as low as 0.05 (e.g. as a result of $\alpha = 0.175$ and $\beta = 0.125$ in producing areas). These parameters yield four estimates, with a range between 0.55% of GDP (minimal specialization, low elasticities) and 3.10% (full specialization, high elasticities). Actually, the impact of different elasticities is small, as they determine only the decline in trade, which is modest and accounts for only a small part of total losses. Most of these latter (the first term in equation 2) accrued to railway companies.

It is worth repeating that these estimates are very crude. Nevertheless, this exercise at least gives some idea as to the magnitude of the losses due to the disintegration of markets between the wars. We are not claiming that the Transportation Act caused the Great Depression, but these are not trivial amounts. Furthermore, these estimates refer to static losses and they thus neglect the dynamic effects. For instance, the dynamic CGE model by Williamson (1974) suggests that a 50% (estimated) reduction in transportation costs from 1870 to 1890 augmented American GDP by up to 20%. On the other hand, there is no evidence that without regulation (and thus with much worse profit prospects) technical progress would not have slowed down or that railroads would have continued to invest enough to maintain stock and track, or that competition would not have caused bankruptcy and perhaps the merger of companies into a single large monopolist. Albro (1971) argues that the denial of a rate increase in 1906 reduced investments below the minimum necessary and the missing investments were to haunt railroads for a long period, being also a motivation for the 1920 Transportation Act (Harbeson 1941). This argument may have held true also for the 1920s and above all for the Great Depression, when companies were hardly profitable and their prospects even bleaker.

7) Conclusion

This paper has demonstrated that important insights can be gained through an investigation of domestic market integration, even for the twentieth century. In the United States, the well known decline of price dispersion for agricultural goods from the late nineteenth to the late twentieth century was interrupted by a period of considerable market disintegration during the interwar period.

We demonstrate that changes in price dispersion were caused by changes in the cost of transportation by rail, only partially offset by substitution to cheaper means of transportation. Until the First World War, the cost of transportation closely followed changes in railroad productivity, but the 1920s mark a major discontinuity, at which point railroads were able to retain a larger part of the productivity gains instead of passing them to their consumers. This break is associated with the 1920 Transportation Act, from which point changes in the regulatory framework and in policy decisions by the ICC explain the movements in the cost of transportation, and thus by implication market integration. We demonstrate that the losses due to the market disintegration due to this regulation between the wars made up a significant proportion of GDP.

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