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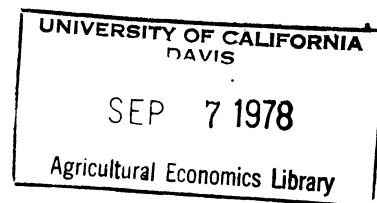
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AN EVALUATION OF SEASONAL RAILROAD RATES
FOR THE OKLAHOMA WHEAT TRANSPORTATION MARKET

Marc A. Johnson and James C. Shouse

ABSTRACT

Harvest-period railroad rate surcharges are applied to a model of the Oklahoma wheat transportation market to test effects of seasonal rail rates upon railroad, truck and truck-barge modes of transport, shippers, construction and use of country elevator and farm storage facilities, wheat flows through terminal elevator locations and the integrity of the rail transit rate structure.

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WHEAT TRANSPORTATION

AN EVALUATION OF SEASONAL RAILROAD RATES
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Marc A. Johnson and James C. Shouse*

The Railroad Revitalization and Regulatory Reform Act of 1976 (RRRRA) was passed to fulfill two broad goals: a) to alleviate immediate railroad industry problems by providing federal assistance to railroads in severe financial and operational distress and b) to promote long-term financial viability of the entire railroad industry by reforming the railroad regulatory system. Reform of railroad rate and ratemaking regulations represents one means of achieving the latter objective. Rate modernization reforms focus upon rate flexibility within minimum and maximum rate bounds, separate pricing for distinct rail services and experimentation with demand-sensitive rates. Effects of implementing one type of demand-sensitive rate in the Oklahoma wheat transportation market are evaluated in this paper.

Demand-sensitive rates are intended to: a) provide incentive to smooth peak-period commodity movements by rescheduling shipments and b) generate additional revenues for railroads (P.L. 94-210, § 202(d)). Peak-period rates are surcharges added to base rates during periods of heavy service demand. These rates serve to ration limited car capacity to higher valued commodity movements while less essential movements are diverted to off-peak periods to avoid the surcharge [3]. Smoothing service demands over time potentially could benefit railroads by enhancing car utilization, reducing car capacity requirements and reducing overtime crew costs during harvest periods.

There are two types of peak-period rates. Seasonal rates set regularly-timed surcharges corresponding to a recurrent seasonal pattern of rail service demand. Other peak-period rates set randomly-timed surcharges triggered at a specified level of service demand. Only effects of planned shipper responses to annually-applied seasonal rates are evaluated here.

Seasonal rates likely would inflict increased costs upon wheat shippers. Country elevator storage typically is sufficient to store only a portion of locally produced wheat; the remaining portion either is sold or moved at harvest time to regional terminal elevators for storage. Storage income provides incentive for local commercial storage facilities to be kept full. Wheat shipments from terminal elevator cities are relatively smooth throughout a typical marketing year. Thus, reductions in peak-period traffic can only be achieved by holding more wheat locally through the harvest period in additional country elevator or farm storage facilities, or assembling wheat at terminal elevators by nonrail modes. Both alternatives represent additional costs to wheat producers. To be effective in smoothing traffic, seasonal surcharges must be greater than the added costs of intertemporal shipment diversion.

Effectiveness of seasonal surcharges in both smoothing rail wheat traffic and increasing railroad revenues requires that general demand for railroad services by wheat shippers be inelastic. New storage capacity must be inexpensive relative to the surcharge the railroads can maintain in the market without severe traffic diversion to other modes. This study evaluates the structure of the Oklahoma wheat transportation market to predict effects of harvest-period rail rate surcharges upon: a) the transportation bill paid by wheat producers, b) the construction of additional local wheat storage facilities, c) the volumes of wheat handled by regional terminal facilities, d) the integrity of the railroad transit

privilege rate structure and e) the market shares, volumes and revenues of truck, barge and railroad transport modes derived from moving Oklahoma wheat. Fulfillment of these objectives will show the effects of seasonal rail rates upon the Oklahoma wheat industry and test the effectiveness of seasonal rates in achieving their intended results.

Theory and Procedure

Seasonal rail rate surcharges represent a seasonal change in relative transportation prices between modes. For seasonal rail rates to produce intended results, railroad demand by wheat shippers must be inelastic over a substantial range of relative price change.

Assuming that volume of farm wheat production will be unaffected by seasonal rail rates, wheat shippers can maximize profits by selecting market and transport mode combinations to maximize site price.¹ Let wheat move to any market j by either truck, truck-barge or railroad modes with effective rates r_m, r_b, r_r , respectively. Effective rates are market-quoted rates plus any discounts from market price associated with delivery by a particular transport mode. In time period t a shipper at location i will ship wheat in a manner to maximize average site price, where site price derived from a particular market-mode combination is

$$P_{ijkt}^s = P_{jt}^m - \min(r_{ijmt}, r_{ijbt}, r_{ijrt})$$

where P_{ijkt}^s is site price received by a shipper at location i when shipping to market j by mode k at time t , $k=m,b,r$, P_{jt}^m is market price at location j at time t and r_{ijkt} are effective transport rates for hauling wheat between locations i and j by mode k at time t .

Shippers at location i will demand quantities of service at time t from mode k , D_{ikt} , depending upon wheat prices at various markets j , relative

transport rates to these markets and total volume of wheat sold during period t , V_t , i.e.,

$$D_{ikt} = D_{ikt} (P_{jt}^m, r_{ijmt}, r_{ijbt}, r_{ijrt} | V_t).$$

Total quantity of service demanded from each mode in a time period is the sum of service quantities demanded by individual shippers located at spatially separated points. Aggregate modal revenues are point-to-point rates weighted by volumes shipped between corresponding points, in each time period.

Measurement of the price elasticity of railroad demand for wheat movement in Oklahoma begins by identifying all country elevator locations as origins i . Annual volumes of grain handled at each of 195 origins were obtained by mail survey; where returns were incomplete, estimates were derived by distributing county wheat production to origin locations in proportion to the size of market area served.² Volumes for 1976 were used due to the even distribution of production over the region.

Wheat may be shipped from each origin in one of three movements. Movement one is composed of wheat sold by producers during the June 1 to July 1 harvest period which is moving to final markets. Typical proportions of annual grain handling volumes sold during harvest at each origin were obtained from survey results. Market-mode alternatives for movement one include: a) trucking to Enid, Oklahoma, for subsequent truck delivery to the Port of Houston, Texas, b) trucking to Ft. Worth, Texas, for subsequent truck delivery to the Port of Houston,³ c) rail movement to Enid on a storage-in-transit rate for subsequent rail shipment to the Port of Houston⁴, d) trucking to the river Port of Catoosa for subsequent barge shipment to eastern flour mills and e) trucking directly to the Port of Houston.

Movement two is composed of the volume of unsold wheat received at country elevators in excess of local storage capacity. This wheat must be moved into terminal elevator storage. Storage facilities at river and Gulf ports do not serve the intertemporal storage function with producer-owned grain. Thus, market-mode alternatives available for movement two are the same as alternatives (a), (b), and (c) for movement one.

Movement three is composed of all wheat sold and moved during the non-harvest period. From any origin, this volume is equivalent to elevator storage capacity less working space, plus wheat received by elevators from farm storage after the harvest period. The five market-mode options listed for movement one are relevant for movement three, although corresponding transport rates may differ between time periods.

Each market-mode alternative for each movement has a corresponding effective transport rate representing the difference between the export wheat bid price at Gulf of Mexico ports and the local site price at each origin. For trucking alternatives through terminal cities of Enid and Ft. Worth and for the truck-barge option, effective transport rates are composed of two parts: a) a distance-related truck rate to the terminal city⁵ and b) the wheat bid spread, for wheat delivered by truck, between Gulf ports and the terminal or river port city.⁶ Truck rates for movements directly from origins to Gulf ports were obtained by interviewing elevator managers in the region. Published Ex Parte 336 export wheat railroad rates were effective during the study. Seasonal railroad rates were introduced either by multiplying rail rates for movements one and two by a factor greater than unity or by multiplying rail rates for movement three by a factor less than unity.

Each origin elevator is assumed to select the transportation alternative

with the lowest effective rate for each of the three movements. Volumes corresponding to these decisions are aggregated to summarize the effects of seasonal rates. The aggregated volumes of each market-mode alternative indicate volumes of wheat handled and stored at terminal facilities at Enid, Ft. Worth and Catoosa. Volumes aggregated over the three modes are used to calculate modal market shares and changes in railroad traffic levels. Transport revenues are calculated as rates times volumes and aggregated by market-mode option and by mode in each time period. The revenue aggregations provide a view of effects of seasonal rates upon railroad revenue, average transport rates paid, total transport bill paid by shippers and economic incentives created by seasonal rates to defer shipments until the nonharvest period. Proportional railroad traffic volume changes resulting from proportional rate changes, holding other rates constant, provide a measure of railroad service demand elasticity for wheat movement in the two time periods.

Results

A base grain flow pattern is developed with estimated 1976 volumes of the three wheat movements at each origin and transport rates effective during May, 1977. This flow pattern, shown in column 1 of Table 1, serves as a reference from which to measure effects of implementing a ten-percent harvest-period rail rate increase upon transport modes, shippers, storage capacity, terminal elevators, and the transit privilege.

Effects on Transport Modes

Since a harvest-period rail rate surcharge affects relative transport rates only during the harvest period, significant effects resulting from application of the surcharge are only expected for harvest-period movements

TABLE 1: Modal Transport Volumes, Revenues and Average Rates for Moving the 1976 Oklahoma Wheat Crop Without and With Ten-Percent Harvest-Period Rail Rate Surcharges

Movement- Mode	Without Surcharge					With Surcharge*				
	Volume (mil. bu.) (1)	% (2)	Revenue (mil. \$) (3)	% (4)	Average Rate (¢/bu) (5)	Volume (mil. bu.) (6)	% (7)	Revenue (mil. \$) (8)	% (9)	Average Rate (¢/bu) (10)
Movement 1										
Truck	2.93	12.3	1.17	12.7	39.9	5.56	23.4 (37.2)	2.25	22.9 (37.3)	40.5 (41.4)
Rail	18.80	79.0	7.31	79.4	38.9	13.83	58.1 (41.1)	5.84	59.5 (41.5)	42.2 (41.6)
Truck-Barge	2.06	8.7	0.73 [#]	7.9	35.4	4.39	18.5 (21.7)	1.72 [#]	17.6 (21.2)	39.1 (40.2)
Total	23.79	100.0	9.21	100.0	38.7	23.78	100.0	9.81	100.0	41.3 (41.2)
Movement 2										
Truck	3.96	9.5	1.63	9.9	41.2	9.64	23.1 (42.2)	4.15	23.3 (42.6)	43.0 (43.1)
Rail	37.72	90.5	14.80	90.1	39.2	32.03	76.9 (57.8)	13.66	76.7 (57.4)	42.6 (42.4)
Total	41.68	100.0	16.43	100.0	39.4	41.67	100.0	17.81	100.0	42.7 (42.7)
Movement 3										
Truck	36.72	44.3	13.13	42.5	35.8	36.03	43.5 (41.7)	12.87	41.6 (39.8)	35.7 (35.7)
Rail	43.87	53.0	17.01	55.0	38.8	44.55	53.8 (54.4)	17.31	55.9 (56.4)	38.9 (38.8)
Truck-Barge	2.26	2.7	0.79 [#]	2.5	35.0	2.26	2.7 (3.9)	0.79 [#]	2.5 (3.8)	35.0 (37.2)
Total	82.85	100.0	30.93	100.0	37.3	82.84	100.0	30.96	100.0	37.4 (37.5)
All Movements										
Truck	43.61	29.4	15.93	28.2	36.5	51.23	34.5 (41.1)	19.27	32.9 (40.2)	37.6 (38.7)
Rail	100.39	67.7	39.12	69.2	39.0	90.41	61.0 (53.2)	36.81	62.8 (54.2)	40.7 (40.2)
Truck-Barge	4.32	2.9	1.52	2.6	35.2	6.65	4.5 (5.7)	2.51	4.3 (5.6)	37.7 (39.1)
Total	148.32	100.0	56.57	100.0	38.1	148.29	100.0	58.59	100.0	39.5 (39.5)

*Truck capacity is limited to 700 trucks in accord with industry estimates; results reported in parentheses are obtained when the truck capacity restriction is removed.

[#]Truck revenue plus river port terminal margin of 27 cents per bushel.

when intertemporal shipment diversions are assumed negligible. Forty-four percent of the 1976 crop was moved during harvest; 16 percent was sold by producers at harvest time and moved to final markets (movement 1) and 28 percent was moved inland terminals for storage (Table 1, column 1). Railroad is clearly the dominant mode in the harvest period carrying 79 percent of marketed wheat and 90 percent of wheat to be stored. Trucking directly to Gulf ports is not permitted during the harvest period. The only country elevators trucking grain to terminal cities are elevators not served by railroads; these elevators truck wheat to Ft. Worth. Wheat trucked to the river port originates in eastern Oklahoma counties where production is sparse. Trucks contribute substantially to post-harvest wheat movement, for trucking directly to Gulf ports is the least costly alternative at numerous origins. Generally, railroads carry more than two-thirds of annual wheat production to markets and trucks account for nearly 30 percent. Only 4.3 million bushels of Oklahoma wheat moves by barge.

Harvest-period rail rates were increased 3, 5, 7 and 10 percent above existing levels. With each successive increase, railroad traffic volume and revenue was lost to other modes. Results of a 10 percent surcharge, with and without a constraint on existing trucking capacity are shown in columns (6) to (10) of Table 1. The 5 million bushels of sold grain diverted from the railroad was evenly split between barge and truck transport. Attractiveness of the truck-barge option spreads to the highest density wheat production areas of Oklahoma. Trucks divert from the railroad 2.6 million bushels of sold wheat and 5.7 million bushels of wheat bound for terminal storage. If truck capacity was unrestricted truck diversions would be 5.9 and 13.6 million bushels for the two movements, respectively.

At existing transportation rate levels, the wheat transportation market is very competitive. Average price elasticity of demand for railroad

service in the movement of marketed wheat at harvest time is -2.6, with truck and truck-barge competition. Average price elasticity of railroad demand for moving wheat to terminal storage is -1.5, with truck competition. The aggregate average harvest-period price elasticity of railroad demand is -1.9. Raising prices in the presence of an elastic demand causes reductions in revenues for railroads. While the surcharge causes a reduction in traffic pressure on railroads at harvest time associated revenue reductions are contrary to the intent of the policy.

Effects on Shippers

Increases in harvest-period rail rates will increase the total transport bill paid by shippers. However, the proportional increase in the total bill will be dampened by the ability of some shippers to divert shipments to other modes and to shift movements to post-harvest periods. Columns 5 and 10 of Table 1 show average modal rates paid on each movement without and with a ten-percent harvest-period rail rate surcharge. The average rate of 41.3 cents per bushel paid on movement one with the 10 percent surcharge is just 6.7 percent above the average base rate of 38.7 cents per bushel.

Summary revenue measures on all shipments represent the effect of a ten percent surcharge upon the transport bill paid by shippers. The total 1976 freight bill rises from \$56.57 million to \$58.59 million, a \$2 million increase. Truck-barge operators receive an additional \$1 million. Truckers receive an additional \$3.3 million while railroads lose \$2.3 million.

Effects on Storage Capacity

Seasonal rail rates can smooth traffic with reduced railroad revenue losses if surcharges create sufficient incentive to divert harvest-period movements to other periods. The transport rate differential created

between the harvest and nonharvest periods may: a) induce producers to sell less wheat at harvest time and store it locally in excess storage space (reduce movement 1), b) induce producers to store more of the wheat destined for terminals in excess local storage space (reduce movement 2) or c) induce producers to build new storage capacity on farms and at elevators (reduce movement 1 and 2). Grain stored in this manner would be shifted to nonharvest transport on movement 3.

Survey results suggest that 14.4 million bushels of farm storage space and 11.4 million bushels of country elevator storage space remained unused after the 1976 harvest. If all producers were induced to withhold wheat sales until after harvest, 15.5 million bushels could be placed in local storage and the remaining 8.3 million bushels would be moved to terminals. (Only 15.5 million bushels of unused space are located at origins of excess grain.) The volume of movement 3 would be increased by 15.5 million bushels. Similarly if seasonal rates induced producers to store on the farm that wheat destined for terminal storage, 10.3 million bushels could be diverted from movement 2 to movement 3.

Similarly, decisions to build new farm or elevator storage capacity depends, in part, upon the value of the rate differential created by the rail rate surcharge. Note in columns 5 and 10 of Table 1 that the average rate differential between movements 1 and 3 increases from 1.4 cents per bushel to 3.9 cents by applying the surcharge. The surcharge is responsible for an average rate differential of 2.5 cents per bushel. Similarly, the surcharge is responsible for an average rate differential between movements 2 and 3 of 3.2 cents per bushel. The perpetuity values of the 2.5 cent and 3.2 cent annual average rate differentials, discounted at eight percent, are 31 cents and 40 cents respectively, far below current storage construction costs. Though it is not possible to predict how effective these rate

differentials will be in inducing intertemporal shipment diversions, it is clear that the surcharge will only contribute to, not cause, these diversions.

Effects on Terminal Cities

Basically, wheat diverted from railroads at harvest time is wheat diverted from Enid to Ft. Worth by truck and to Catoosa by truck-barge combination. The bid price for wheat at Ft. Worth is 20 cents per bushel greater than at Enid which is more than the truck rate differential from most origins. A ten-percent rate surcharge results in a handling volume loss at Enid of 9 million bushels, about 9 percent of Oklahoma wheat handled at Enid in 1976; 6.7 million bushels are diverted to Ft. Worth and 2.3 million bushels to Catoosa. When excess farm storage is used, Enid loses 8.6 million bushels due to the rail rate surcharge.

Effects on the Transit Rate Structure

Since the through transit rate on wheat moving to terminal storage at harvest is set during the harvest period, will two separate rates be cheaper than a single transit rate, by avoiding the surcharge on part of the haul? Let R be the current rail rate from origin to Gulf, r be the current domestic rate to Enid, e be the current export rate from Enid to the Gulf and $(x - 1)$ be the proportional harvest period surcharge. With the surcharge the transit rate becomes $R \cdot x$ and the two-part nontransit rate becomes $(r \cdot x + e)$. These rates are equal for a surcharge equivalent to $x = e / (R - r)$. Currently $e = 39.6$ cents per bushel. The greatest through rate-domestic rate differential, $(R - r)$, for an Oklahoma origin is 26.4 cents, suggesting that the integrity of the transit rate structure only begins to erode with rail rate surcharges in excess of 50 percent.

Conclusions

Seasonal railroad rates for Oklahoma wheat do not achieve intended policy objectives. Extreme price competition for transportation results in traffic and revenue diversions from railroads to other modes in the presence of harvest period rail rate surcharges. A ten-percent surcharge does not yield sufficient incentive to build substantial quantities of new storage space to smooth traffic. Shippers pay more to move grain and flow patterns through terminal cities, with vast investments in storage space, are disrupted.

REFERENCES

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FOOTNOTES

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¹Constant volume, \bar{Q} , leaves profit, Π , merely a function of site price, P^S , i.e.

$$\Pi = P^m \cdot \bar{Q} - \overline{C(Q)} - t \cdot \bar{Q} = (P^m - t) \bar{Q} - \overline{C(Q)}$$

where P^m is market price, t is unit transport rate and $C(Q)$ is production cost.

²Wheat producers were assumed to patronize elevators of nearest road distance.

³All wheat trucked to terminal cities on a flat rate is assumed to move to final markets by truck, for the rail rate exceeds the truck rate from terminal cities to Gulf ports. Though some wheat is sold by inland terminal companies to domestic users, the export market dominates price determination for both domestic and export markets.

⁴Rail service is absent in 23 locations. At twenty other locations transit rates apply only to intermediate storage at Ft. Worth; wheat from these 20 locations is allocated to Ft. Worth terminals.

⁵The rate-distance function for trucking wheat from Oklahoma origins to Enid is [1]:

$$r_{ijm} (\text{¢/bu.}) = 3.1486 + 0.1038 \text{ MILES} - 0.00008134 (\text{MILES})^2$$

$$(0.1727) \quad (0.0036) \quad (0.00001537)$$

$$R^2 = .9834 \quad F = 5117.10 \quad () = \text{standard errors}$$

Truck rates to Ft. Worth:

$$r_{ijm} (\text{¢/bu.}) = 6.4353 + 0.0794 \text{ MILES} - 0.00002248 (\text{MILES})^2$$

$$(0.7998) \quad (0.0067) \quad (0.00001321)$$

$$R^2 = .9702 \quad F = 1108.07$$

These rates were effective during May, 1977.

⁶The bid spreads for Enid and Ft. Worth were derived from data presented in Market News and were effective in May, 1977. The Gulf-river port bid spread is stable at 27 cents per bushel as reported by Johnson and Mennem and confirmed by the port terminal manager.