Impact of Short Line Railroad Abandonment on Wheat Transportation and Handling Costs: A Kansas Case Study

---

Structural changes have occurred in the grain logistics systems of the Great Plains states and the Canadian prairie provinces. One aspect of the structural changes has been an increase in grain trucking and a corresponding decline in short line railroad traffic. In Kansas, grain is the principal commodity market of short lines, so as more grain has been shipped by truck, short lines have lost market share in their most important market, threatening the long run viability of these railroads. Short line railroad abandonment could have several negative impacts on rural communities, so it is important to measure the quantifiable aspects of abandonment.

The objective of this paper is to measure the change in transportation and handling cost of Kansas wheat, resulting from simulated abandonment of short line railroads. Using Arc View Geographic Information System (GIS) software and a truck routing algorithm from Babcock and Bunch (2002), wheat is routed through the Kansas wheat logistics system to achieve minimum transportation and handling costs. This analysis is performed with and without study area short line railroads in the wheat logistics system. The difference in the two scenarios is the impact of short line abandonment on Kansas wheat transportation and handling costs.

Results indicated that there was virtually no difference in the total transportation costs of the wheat logistics system with or without abandonment of short line railroads. Total transport cost for the no-abandonment scenario was $126.6 million, and $124.9 million for the simulated abandonment scenario. While total transportation cost was unaffected by short line abandonment, total wheat handling cost increased $22.4 million as a result of short line abandonment. Thus, total transportation and handling cost was $20.7 million higher in the simulated short line abandonment scenario. It was also estimated that short line abandonment would reduce Kansas farm income by $17.4 million.

by Michael W. Babcock, James L. Bunch, James Sanderson, and Jay Witt

Following passage of the Staggers Rail Act in 1980, US Class I railroads adopted a cost reduction strategy to increase profitability. Part of that strategy was the sale or lease of their rural area branchlines to short line railroads.[1] In the year 2001, Class II and III railroads operated 45,000 miles of track or 31.6% of the US rail system.[2] In Kansas, short lines operated 2,145 miles of track in 2002 which is about 44% of total Kansas railroad mileage.[3] Short lines play a significant role in the transportation systems of many other states as well. Thus, the economic viability of these railroads is an important issue for rural area shippers.

Journal of the Transportation Research Forum. Published in *Transportation Quarterly*,
Vol. 57, No. 4, Fall 2003 (87–103). © 2003 Eno Transportation Foundation, Inc., Washington, DC.

Railroad abandonment in Kansas has increased in recent decades. In the 1970-79 period, 415 miles of rail line were abandoned; in the 1980-89 interval an additional 815 miles, and in the 1990-2000 period, 1,246 miles.[4] In 2001 alone, 335 miles were abandoned.[5] What has changed since 1990 is that a large proportion of abandonment is accounted for by short line railroads. In the 1990-2000 period nearly half of the 1,246 miles were abandoned by short lines.[6] In 2001, 86% of the 335 miles abandoned were accounted for by short lines.[7]

Coincident with increased abandonment of short lines, an increasing amount of Kansas grain tonnage has been diverted from short line railroad shipment to truck shipment. According to the publication *Kansas Grain Transportation* (2001), published by Kansas Agricultural Statistics, the motor carrier share of wheat shipped from Kansas grain elevators increased from 37% in 1990 to 47% in 1999. The corresponding percentages for corn shipped from Kansas grain elevators by truck were 62% in 1990 and 72% in 1999. In 1990, motor carriers accounted for 35% of the sorghum shipments which rose to 56% in 1999. For soybeans, the motor carrier market shares were 35% and 53% for 1990 and 1999, respectively.

Changes have occurred in the Kansas grain transportation system that have contributed to increased trucking of grain. Class I railroads are encouraging the construction of unit-train (100 or more railcars) loading facilities (shuttle train locations) on their main lines. Due to the scale economies of unit trains, Class I railroads offer lower prices to shuttle train shippers. In turn, this enables shuttle train shippers to pay a relatively high price for wheat. According to Rindom, Rosacker, and Wulfkuhle (1997, p. ii), Kansas farmers will truck their grain a much greater distance to obtain a higher grain price at the shuttle train location. Farmers will bypass the local grain elevator and the short line railroad serving it, and truck the grain to the shuttle train facility.

Agriculture has consolidated into fewer, larger farms. With the increased scale of operations, farmer ownership of semitractor trailer trucks has increased.[8] With these trucks, farmers can bypass the local elevator and the short line railroad serving it, and deliver grain directly to more distant markets.

The increasing size of grain railcars threatens to reduce short line railroad grain traffic and increase grain trucking. The new super jumbo covered hopper cars have loaded weights of 286,000 pounds, much larger than most of the short line railroad track is capable of handling. As the percentage of the grain car fleet that can move on short lines declines, grain shippers will have no alternative but to truck their grain to terminal markets.

According to Babcock et al. (1993, p. 80) grain is the principal commodity of most Kansas short lines, and Babcock, Prater, and Russell (1997, p. 12) found that the most important determinant of short line railroad profitability is carloads per mile of track. Thus, increased grain trucking threatens the economic viability of short lines, possibly resulting in further abandonment of these railroads.

Abandonment could have negative effects on rural areas. The price paid to farmers by grain buyers is obtained by subtracting the cost of transportation from the market price. Abandonment would cause grain shippers to switch to more expensive truck transportation, and the more costly freight would result in a lower price paid to farmers for their grain. For example, if the price of wheat at export ports is $3.00 per bushel and the transport cost to the ports is 30-cents per bushel, the net price paid to the farmer is $2.70 per bushel ($3.00 minus 30-cents). If the transport cost to the ports rises to 40-cents per bushel, the farmer receives only $2.60. Of course, the loss of rail service may increase transport cost and reduce profits of other rural rail shippers as well.

In addition to higher transport costs, abandonment would result in a reduction of market options for rural shippers. Markets that are best served by rail (i.e., large volume shipments over long distances) are less available to the rural shipper after abandonment. Abandonment would result in a loss of economic development opportunities for rural communities. Firms that require railroads for inbound and/or outbound transport (i.e., shippers of food, lumber, paper, chemicals, and steel products) would not consider locating in a community that has no rail service. Since railroads are also taxpayers, abandonment would result in a loss of tax revenue needed to fund basic government services. In addition, abandonment would increase the number of trucks on the road system, possibly leading to an increase in the number of highway accidents.

Increased trucking of grain could have other negative impacts. For example, increased road congestion may produce more vehicle accidents and reduce average speeds, resulting in a rise in the opportunity cost of time in transit. The significant increase in heavy truck movements will increase the frequency and magnitude of rutting and cracking of the pavement, causing additional vehicle maintenance costs for passenger vehicle owners.

If additional motor carrier user fees are equal to the increment in truck attributable road damage costs, then other highway users and the state government are no worse off. However, Russell, Babcock, and Mauler (1995, p. 119) found that truck attributable road damage costs increase by a much greater percentage than the increase in grain transported by motor carrier. Therefore, it is unlikely that additional truck user fees will cover the increase in road damage costs. Thus, another impact of short line abandonment is an increase in road damage costs for the state and county governments.

Changes in the grain logistics system discussed above are not unique to Kansas. Similar structural changes in grain transportation have been documented for Texas (Fuller et al. 2001), Iowa (Baumel et al. 1996), North Dakota (UGPTI 2001 and Machalaba 2001), and the Canadian prairie provinces (Nolan et al. 2000). Since the Great Plains states and the Canadian prairie provinces have similar grain logistics systems, the results of this paper have wide geographical scope.

Given the potential negative effects of short line railroad abandonment it is important to measure the quantifiable aspects of abandonment. The objective of this paper is to measure the change in transportation and handling cost of Kansas wheat, resulting from assumed abandonment of short line railroads. This is achieved by computing the minimum transportation and handling costs for moving Kansas wheat from farms, through Kansas country grain elevators, and then through Kansas unit train loading locations to the export terminals at Houston, Texas. Using Arc View Geographic Information System software and a truck routing algorithm from Babcock and Bunch (2002), wheat is routed through the logistics system to achieve minimum total transportation and handling costs. This analysis is performed with and without study area short line railroads in the wheat logistics system. The difference in the two scenarios is the impact of short line abandonment on Kansas wheat transportation and handling costs.

THE STUDY AREA

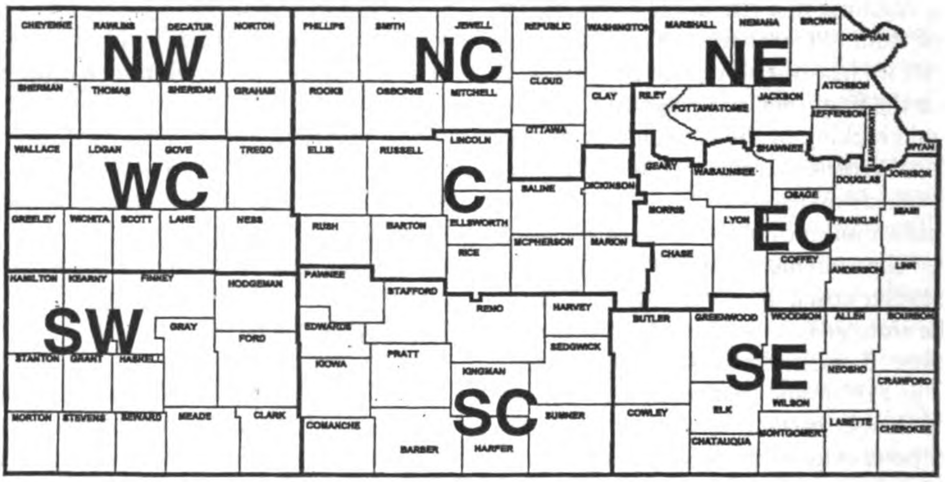
The study area corresponds to the western two-thirds of Kansas encompassing the three central and three western Kansas crop reporting districts (see Figure 1). During the 1998-2001 period the study area accounted for 91.2% of total Kansas wheat production, 79.6% of the state's sorghum production, 80.9% of Kansas corn production, and 38.9% of the soybean output. The study area produced 81.6% of Kansas production of the four crops combined (see Table 1).

Four short line railroads serve the study area—Kansas and Oklahoma Railroad, Kyle Railroad, Cimarron Valley Railroad, and Nebraska, Kansas, and Colorado Railnet. The Kansas Southwestern Railroad began operations in 1991, and the Central Kansas Railroad inaugurated service in 1993. These two railroads merged in June 2000 and became Central Kansas Railway (CKR). The CKR sold its Kansas system to Kansas and Oklahoma Railroad which began operating on June 29, 2001. The Kansas and Oklahoma serves the central part of the study area from Wichita, Kansas, and west to the Colorado border. It also serves south central Kansas and has a line in north central Kansas as well. The Kansas and Oklahoma Railroad has 971 route miles in Kansas and 108 employees.

The Kyle Railroad serves the northern part of the study area with a 482-mile system. The Kyle began operations in 1982 and has 110 full-time employees. The Cimarron Valley Railroad (CV) has 260 route miles with 186 miles in southwest Kansas. The CV was purchased from the Santa Fe Railroad and began operations in February 1996. The CV has 15 full-time employees in Kansas. The Nebraska, Kansas and Colorado Railnet (NKC) serves five Kansas counties in the northwest part of the study area. The railroad has 122 miles in Kansas and 17 miles of trackage rights on the Kyle Railroad. The NKC began operations in December 1996 and has 30 full-time employees.

The study area is also served by two Class I railroads, the Burlington Northern Santa Fe (BNSF) and the Union Pacific System (UP). The BNSF has 1,072 miles of main line track in Kansas and 188-branchline miles. The UP has 1,378 main line miles and 127-branchline miles.

Figure 1: Kansas Crop Reporting Districts



Kansas is divided into nine agricultural statistics districts for convenience in compiling and presenting statistical information on crops and livestock. These nine districts are outlined on the above map. The districts are designated as follows: Northwest (NW), West Central (WC), Southwest (SW), North Central (NC), Central (C), South Central (SC), Northeast (NE), East Central (EC), and Southeast (SE).

Table 1: Study Area Grain Production, 1998 – 2001 (thousands of bushels)

Year	Wheat	Corn	Sorghum	Soybeans	Total
1998	452,488	342,565	206,672	26,277	1,028,002
1999	407,378	359,505	210,216	33,025	1,010,124
2000	311,785	325,745	142,322	23,738	803,590
2001	290,910	297,710	192,135	31,069	811,824
Total	1,426,561	1,325,525	751,345	114,109	3,653,540

Sources: (1998) Kansas Department of Agriculture, Kansas Farm Facts 2000. *(1999 and 2000) Kansas Department of Agriculture,* Kansas Farm Facts *2001.* (2001) *Kansas Department of Agriculture,* Kansas Farm Facts *2002.*

DESCRIPTION OF THE KANSAS WHEAT LOGISTICS SYSTEM

Figure 2 portrays a simplified version of the Kansas wheat logistics system. Wheat is shipped from farms in five axle, 80, 000-pound semitractor trailer trucks (hereafter referred to as semitruck) to country grain elevators, which are usually no more than 10 to 15 miles from the farm origin. Wheat is shipped from country elevators to either shuttle train stations (100-railcar shipping facilities at former country elevator locations) or the terminal elevators at Salina, Wichita, and Hutchinson, Kansas. Wheat moves exclusively by semitruck to shuttle train stations, but movements to Salina, Wichita, and Hutchinson can be semitruck, short line railroad, and Class I railroad. Wheat is then shipped by Class I unit train from the shuttle train facilities and the grain terminal elevators in Salina, Wichita, and Hutchinson to Houston, Texas for export.

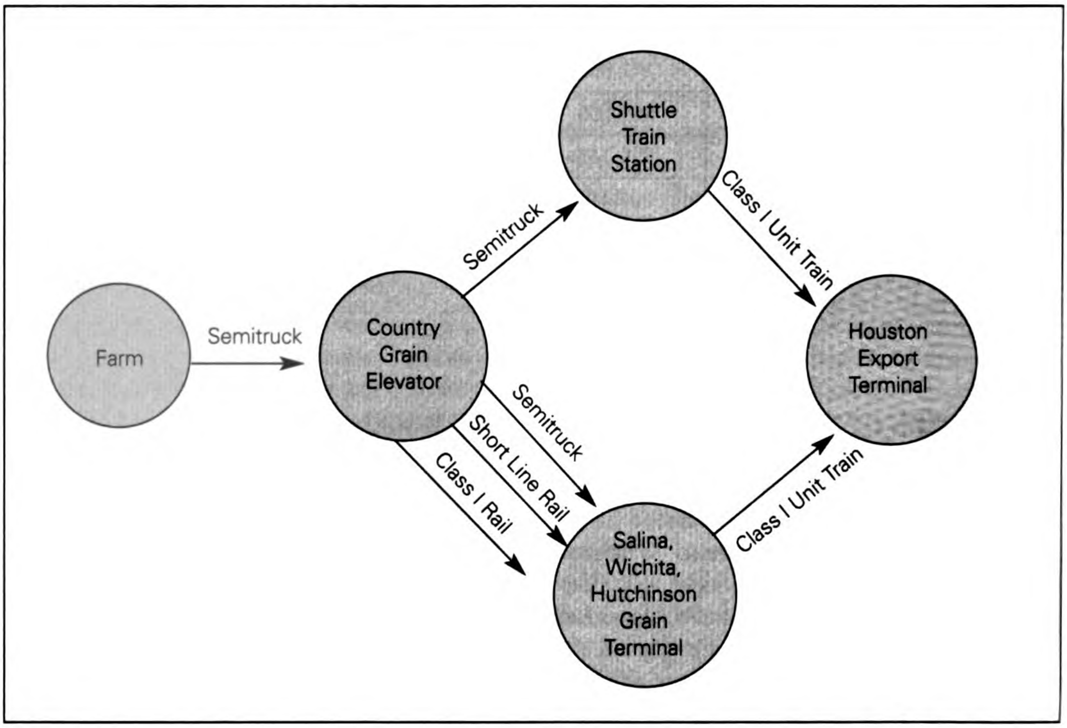
As noted above, this is a simplified version of the wheat logistics system. In some cases, farmers deliver wheat by semitruck directly to shuttle train stations or Salina, Wichita, and Hutchinson grain terminals. This occurs if the farm origins are relatively close to one of these facilities. Also Kansas wheat is shipped to many domestic flour milling locations as well as the Texas Gulf region for export.

THE MODEL

The movement of Kansas wheat is modeled as transshipment network model with individual farms serving as supply nodes, grain elevators and unit train loading facilities serving as transshipment nodes, and the final demand node being the export terminals at Houston, Texas.[9] The county and state road networks, short line railroads, and Class I railroads constitute the arcs which connect these nodes.

Given the magnitude and complexity of the wheat logistics system, the movement of Kansas wheat through the various possible network paths is most clearly analyzed in four distinct steps. Step I involves the collection of wheat from production origins, or farms, into an intermediate storage facility (grain elevator) which can ship wheat to the terminal node represented by Houston in the wheat logistics system model. Since it is not economically feasible for firms to ship wheat by truck from Kansas to Houston, Step I consists of moving wheat from the farm to an elevator that has rail access capable of reaching Houston. Step II involves the handling of wheat at intermediate storage facilities. Step III analyzes the shipment of wheat from Kansas unit train shipping facilities to the network model final demand node represented by the Port of Houston. Step IV is the same as Steps I to III except

Figure 2. Wheat Logistics System



short line railroads are assumed to be abandoned.

Although profit maximization is assumed to be the main goal of all agents (farmers, elevators, transport firms) in the wheat logistics system, costs serve as the most consistent influence on agents' behavior. Profits ultimately decide individual behavior; however, cost minimization is the consistent strategy for maximizing profits, regardless of the type of market involved. Thus, it is assumed that all agents in the system seek to minimize the costs involved in shipping wheat to market. Farmers seek to minimize both the financial and time costs of getting wheat from the field to the grain elevator or unit train facility; grain elevators and unit train shipping facilities operate to minimize the cost of handling wheat and shipping it to various market destinations. The goal of the model is to determine the least cost transport route for Kansas wheat from production origin to final destination utilizing the available transportation network. Kansas wheat is shipped to both domestic and international export markets. The Port of Houston is assumed to approximate the cost of shipping Kansas wheat to the many destinations to which it is normally shipped in a given year. Thus, it is assumed that all agents minimize the costs involved in shipping wheat to market. This relationship is summarized in mathematical form by the following objective function:

$$\text{(1)} \quad \text{Minimize TSC} = \sum_i (H_i + T_i + R_i)X_i$$

Subject to the following constraints:

$H_i, T_i, R_i > 0$

Total Wheat Demanded = Total Wheat Supplied

Actual Wheat Stored at Elevator i ≤ Maximum Storage Capacity of Elevator i

Actual Transport by Truck i ≤ Maximum Transport Capacity of Truck i

Actual Transport by Railcar i ≤ Maximum Transport Capacity of Railcar i

Flow of Wheat into Elevator i = Flow of Wheat out of Elevator i

Where:

TSC is the total wheat logistics system transportation and handling costs

H_i is the sum of all handling costs of unit of wheat i

T_i is the sum of all trucking costs of unit of wheat i

R_i is the sum of all rail costs of unit of wheat i

X_i is the total amount of wheat shipped from Kansas farms to the Port of Houston

Several assumptions were necessary in order to implement the least cost network model. With respect to Step 1, although other methods are available, the methodology selected for determining wheat movements is individual routing choice analysis. With this method, the initial movement of wheat is determined independently by each farmer. A farmer may choose to truck wheat to a country grain elevator, a shuttle train station, or a terminal grain elevator. This choice is based on the wheat price offered by each available destination market and the costs of transporting wheat to that destination. Based on the spatial distribution of farms and potential destinations, the principal determinant in this choice of destination is usually the transportation cost. That is, the difference in wheat prices between destinations tends to be negligible due to low cost market information and high levels of market competition, while each farm is usually closer to one destination than any other potential destination. Thus, farmers are assumed to always choose the least distant, least transport cost destination.

It is also assumed that movement from the farm to the closest storage facility occurs entirely upon the county road system. Although this assumption is not entirely accurate, it is based upon two reasons. First, empirical evidence (Babcock et al., Ch. 3, 2003) suggests that the majority of the trips from the farm to the elevator are traveled on county roads. Second, the majority of farms are positioned adjacent to the county road network and the shortest, least transport cost route to the nearest storage facility lies along that road network.

Three key assumptions were made governing system behavior for the Step II handling aspect of wheat transport. First, vehicle and storage capacities are available in equilibrium quantities such that a capacity constraint never influences wheat movements. The second key assumption for Step II is that a country grain elevator does not ship wheat to another country grain elevator. Instead, country grain elevators ship to unit train facilities because of the large volumes of wheat that must be handled, stored, and shipped to Houston. And finally, input costs and technologies in the study area are assumed to be uniform. Thus, all country elevators have the same characteristics, as do all grain trucks and short line railroads.

Three additional assumptions were made for Steps III and IV of Kansas wheat movement. Houston is the destination for a large portion of Kansas wheat shipments and is used as a proxy for all markets, both domestic and export. A second key assumption is that Kansas wheat must use rail to reach Houston. Although physically possible, the high motor carrier variable (with distance) costs of shipping wheat makes trucking wheat to Houston economically infeasible. Since wheat must reach the Port of Houston by rail, the large economies of scale associated with unit train transport makes rail the least cost mode of transport for every wheat long distance movement. Thus, if rail service is available from an elevator, it will be utilized, and wheat shipments will never change modes of transport once loaded on a rail car.

Structural Elements of the Model

Before analyzing the movement of Kansas wheat, some structural elements of the network model had to be quantified and geospatially referenced. First, the farm locations where wheat is produced were determined. Second, the transshipment nodes (i.e., country grain elevators, shuttle train facilities, and Salina, Wichita, and Hutchinson grain terminals) and the terminal node (Houston) were defined. Next, the road and rail systems available for transporting wheat had to be specified. And finally, system behaviors as defined by the cost functions of storage and transport activities were approximated.

Traditional network models determine grain origins by assuming a study area is evenly divided into homogenous "simulated farms" that generate equal amounts of the grain produced in the county. In the traditional models a study area of the magnitude used in this study would probably be divided into 10 mile x 10 mile squares. While the simulated farm assumption was the best available approximation in the past, tremendous advances in computer technology have recently enabled a much more detailed approximation of reality. Using GIS software and satellite imagery data on land usage in each county, a specific land use map was generated for the entire study area.[10] This land use map represents the actual usage, by category, of all land. Therefore, all cropland was identified for its potential contribution to wheat production. The land usage map of the study area was then divided into legal land sections as defined by the US Public Land Survey System. A potential wheat farm for the model was defined as the typical 1 mile x 1 mile area (640 acres) of a legally defined section. Thus, the entire study area was subdivided into rough 640-acre plots which contained various parcels of cropland and other land uses that were further analyzed to estimate simulated wheat farms in the model. The wheat production for study area farms is determined by dividing the 1998-2001 average wheat produced in a particular county by the total cropland in that county and multiplying this result by the exact amount of cropland in each section in that county. That is:

$$(2)\quad \text{SectionWheat}_i = \text{SectionCropLand}_{i,t}\,[\text{Wheat}_{j,avg} \div \text{CountyCropLand}_{j,t}]$$

Where:

SectionWheat_i is the amount of wheat originating in section i

$\text{SectionCropLand}_{i,t}$ is the land used to produce crops in section i in year t

$\text{Wheat}_{j,avg}$ is the average wheat produced in county j during the 1998-2001 period

$\text{CountyCropLand}_{j,t}$ is the total land in county j used to produce crops in year t

By applying the resulting estimated wheat production for a particular land section to the center point of the simulated farm, the result was a georeferenced set of farms which served to spatially distribute the average county wheat production according to the actual distribution of study area cropland. This approach, therefore, allowed the model to account for geographical variances in both land usage patterns and historic wheat yields, thereby offering a vastly more accurate estimate of origin point locations and wheat production than postulating homogenous 10 mile x 10 mile simulated farms.

The numbers of country grain elevators, shuttle train stations, Salina, Wichita, and Hutchinson grain terminals, and terminal nodes (Houston) were small enough that actual data concerning these entities could be used. Street addresses for facilities licensed to handle and store grain in the State of Kansas were used to identify and georeference the transshipment nodes in the model. The Salina, Wichita, and Hutchinson grain terminals and shuttle train facilities were those identified by Babcock and Bunch (2000). The geographic center of the Port of Houston served as the terminal node for the model.

Having defined all of the nodes in the system, the next step in formulating a model of the wheat logistics system was to define the arcs that serve to connect the different origin, transshipment, and terminal nodes of the network. The actual road system maintained by state and county governments was utilized to define road network arcs. Likewise, those railroads identified and monitored by various agencies in the state of Kansas were utilized for the study.

Having established all of the structural elements of the model, logistics system behavior was approximated by tracing the flow of wheat through the system from origin nodes, through transshipment nodes, and then on to the terminal node utilizing various network arcs. The flow of wheat is believed to move in three distinct phases. Step I (Collection) involves the collection of wheat from farms to an intermediate Kansas storage facility that can ship wheat via rail from the intermediate storage location to the Port of Houston. Step II (Handling) involves the handling of wheat necessary to unload and store the commodity and then load it out from the transshipment nodes. Step III (Distribution) involves the shipment of wheat from Kansas to Houston by rail and Step IV involves the analysis of differences in Steps II and III without short lines in the wheat logistics system. Details of the model can be found in Babcock et al. (2003, Appendix B).

DATA

The model in this study requires much more data than traditional network models. Identifying wheat origin points requires two sets of data. Data describing the location and amount of all cropland in the study area is required. This data is available through the State of Kansas Data Access and Support Center (DASC), an initiative of the state's GIS policy board. Data for the 66 counties in the study area were obtained from DASC and used to form a single land use map of the entire study area. This provides the spatial location of all wheat origins. The amount of wheat produced at each origin point is the subject of the second set of data. The amount of wheat produced per Kansas county in 1998, 1999, 2000, and 2001 is found in *Kansas Farm Facts,* published by the Kansas Agricultural Statistics Service, Kansas Department of Agriculture, 2000, 2001, and 2002 issues. The wheat production for each county is averaged over this four-year period and the county average production is distributed across all wheat origins in the county. The distribution of production is based on a rate of production per square mile so that a 1 mile x 1 mile section that is 100% cropland will produce twice as much wheat as a 1 mile x 1 mile section in the same county that is only 50% cropland.

The system of county and state roads in the study area was provided in digitized form by the Kansas Department of Transportation (KDOT). The locations and storage capacities of country grain elevators and terminal grain elevators were obtained from the *2002 Kansas Official Directory,* published by the Kansas Grain and Feed Association. Shuttle train facility locations were from Babcock and Bunch (2002).[11] Rail systems for Class I (UP and BNSF) and short line railroads were obtained through Kansas rail maps provided by KDOT and the Kansas Corporation Commission.

The key data for generating wheat movements are the various transport costs involved in the wheat logistics system. Truck costs incurred by farmers when transporting wheat from origin points to the nearest destination (Step I) are from the Kansas Department of Agriculture's annual survey of custom wheat cutters published in *2000 Kansas Custom Rates*. Statewide, movements from origin points to the nearest elevator tend to be 12 miles or less and are 12.6-cents per bushel for 12-mile trips. Thus, truck movements from origin points are assumed to cost 1-cent per bushel per mile. To estimate the commercial truck costs (per hundred pounds) for various distances, the study by Mark Berwick (2002) was used.[12] Table 2 contains Berwick's wheat commercial truck costs for various distances.

Elevator charges for loading and unloading wheat by truck and rail are required under Kansas statute to be publicly posted. Based on the reported averages of 345 country grain elevators, truck unload and loadout costs were found to average 9-cents per bushel. The rail loadout cost at country elevators, based on 238 reports, was also found to average 9-cents per bushel. Rail and truck unloading and loadout costs at 12 shuttle train facilities and Salina, Wichita, and Hutchinson terminal elevators were all found to average 7-cents per bushel.

Table 2: Kansas Wheat Commercial Truck Costs for Various Distances*

Distance (Miles)	Cost Per Mile	Cost Per Trip	Cost Per Bushel
25	$1.134	$28.362	$0.030
50	$1.134	$56.725	$0.060
75	$1.134	$85.087	$0.090
100	$1.134	$113.450	$0.120
125	$1.134	$141.812	$0.150
150	$1.134	$170.175	$0.180
175	$1.134	$198.537	$0.210
200	$1.134	$226.900	$0.241
225	$1.134	$255.262	$0.271
250	$1.134	$283.624	$0.301
275	$1.134	$311.987	$0.331
300	$1.134	$340.349	$0.361
325	$1.134	$368.712	$0.391
350	$1.134	$397.074	$0.421
375	$1.134	$425.437	$0.451
400	$1.134	$453.799	$0.481
425	$1.134	$482.162	$0.511
450	$1.134	$510.524	$0.541
475	$1.134	$538.886	$0.571
500	$1.134	$567.249	$0.601

Source: Mark Berwick, Motor Carrier Cost Estimates for Kansas Grain, *Fargo, North Dakota, 2002.*

** Costs are estimated for a five axle semitractor trailer truck operating at a gross vehicle weight (GVW) of 80,000 pounds and hauling 943 bushels of wheat. Costs are based on the assumption of no backhaul or deadhead miles.*

The rail costs of shipping wheat per hundred pounds was obtained from the Uniform Rail Costing System (URCS) Phase III Movement Costing Program which is maintained by the Surface Transportation Board. Unit train (100 cars) costs for movements from Kansas unit train shipping locations to Houston are listed in Table 3. Since no distance related short line cost function exists, the cost function for the least cost Class I railroad (Illinois Central) was used as a proxy.

EMPIRICAL RESULTS

Table 4 contains data comparing wheat traffic, transport costs, and handling costs for the current Kansas wheat logistics system (no-abandonment scenario) to a scenario that assumes abandonment of all short line railroads in the study area (abandonment scenario).

In terms of modal movements, total truck miles more than double in the abandonment scenario from 7.8 million truck miles (no-abandonment case) to 15.9 million. Short line car-miles decline from 3.7 million (no-abandonment scenario) to zero after simulated abandonment. Class I railroad car-miles are unaffected by short line railroad abandonment and amount to 76.4 million in both scenarios. Total ton-miles of wheat traffic are about the same in both scenarios; 9.3 billion (no-abandonment) vs. 9.1 billion (abandonment), a 2% difference.

Total truck transport costs increase from $34.3 million (no-abandonment) to $43.5 million (abandonment), an increase of 26.7% or $9.2 million. Total short line railroad transport costs fall from $10.9 million (no-abandonment) to zero after simulated abandonment. Class I railroad costs are not impacted by short line abandonment and are $81.4 million in both cases.

There is virtually no difference in the total transport costs of the two scenarios as summarized below:

No Abandonment	**Transport Costs**
Trucks	$34.3 million
Short Line Railroads	$10.9 million
Class I Railroads	$81.4 million
Total Costs	$126.6 million

Abandonment	**Transport Costs**
Trucks	$43.5 million
Short Line Railroads	0
Class I Railroads	$81.4 million
Total Costs	$124.9 million

This result is due to a decrease of short line railroad costs of $10.9 million in the abandonment scenario coupled with a $9.2 million increase in truck costs, so transport costs are $1.7 million less in the abandonment scenario. Thus, total transport costs in the abandonment case are about 1% less than the no-abandonment scenario, i.e., virtually identical.

This result may be partly due to the increase in the number of shuttle train locations in recent years that has contributed to the increase in truck wheat shipments over short distances. If this study had been conducted in the early 1990s prior to development of shuttle train facilities, abandonment of study area short lines would have resulted in all the wheat previously shipped by short lines to be moved by truck. If there were no shuttle train facilities, all the abandonment-related truck shipments would have to be transported to the grain terminals at Salina, Wichita, and Hutchinson. Thus, truck wheat shipments would move over a much greater distance than is typical in the current logistics system that includes shuttle train facilities, resulting in higher truck transport costs than those measured in this study.

An alternative hypothesis to explain the failure of transport costs to rise in the abandonment scenario is that Illinois Central

Table 3: Unit Train (100 Cars) Costs of Movements from Kansas Terminals to Houston* (cost per car and total cost)

BNSF Origins

Origin	Miles to Houston	Cost Per Car	Total Cost
Wellington	631	$655.52	$65,552
Wichita	646	$666.40	$66,640
Hutchinson	702	$715.36	$71,536
Abilene	769	$772.48	$77,248
Salina	792	$791.52	$79,152
Wright	814	$807.84	$80,784
Dodge City	822	$816.00	$81,600
Concordia	824	$818.72	$81,872
Garden City	872	$856.80	$85,680

UP Origins

Origin	Miles to Houston	Cost Per Car	Total Cost
Wichita	642	$710.22	$71,022
Hutchinson	692	$752.78	$75,278
Salina	737	$787.36	$78,736
Abilene	738	$790.02	$79,002
Haviland	770	$816.62	$81,662
Plains	799	$840.56	$84,056
Ogallah	864	$893.76	$89,376
Wakeeney	873	$901.74	$90,174
Colby	940	$957.60	$95,760
Sharon Springs	981	$989.52	$98,952

Source: Office of Economics, Environmental Analysis, and Administration, Surface Transportation Board, Uniform Railroad Costing System Phase III Movement Costing Program, 1996.

** URCS Inputs: Shipment type was originated and terminated; car type was covered hopper; number of cars was 100; car ownership was rail owned; commodity was grain; tons per car was 100; movement type was unit train; and empty/loaded ratio was 1.0.*

Railroad costs (proxy for short line cost) are higher than study area short line costs.

While total transport costs are not affected by simulated abandonment of short lines, the same is not true for handling costs. Total handling costs increase from $74.7 million in the no-abandonment case to $97.1 million (abandonment scenario), a rise of $22.4 million or nearly 30%. This is because wheat has to be handled twice if elevators on short line railroads have to truck their wheat to a shuttle train station or a grain terminal in Salina, Wichita, or Hutchinson. Thus, when wheat arrives by truck from the farm, an unload cost is incurred, and a load-out cost is assessed when the wheat is subsequently

Table 4: Comparison of Wheat Traffic, Transport Costs, and Handling Costs (no-abandonment and abandonment scenarios)

Variable	No Abandonment	Abandonment	Difference	% Change
Bushels	365,533,000	365,533,000	0	0.0%
Total Ton-Miles	9,284,523,972	9,098,231,759	-186,292,213	-2.0%
Total Truck-Miles	7,771,552	15,850,420	8,078,868	104.0%
Short Line Car-Miles	3,665,988	0	-3,665,988	-100.0%
Class I Car-Miles	76,438,797	76,438,797	0	0.0%
Total Truck Transport Costs	$34,336,869	$43,498,306	$9,161,437	26.7%
Total Short Line Transport Costs	$10,863,532	$0	-$10,863,532	-100.0%
Total Class I Transport Costs	$81,390,227	$81,390,227	$0	0.0%
Total Handling Costs	$74,769,192	$97,132,794	$22,363,602	29.9%
Total Transport & Handling Costs	$201,359,820	$222,021,327	$20,661,507	10.3%
Cost Per Bushel	$0.551	$0.607	$0.056	10.2%
Cost Per Ton-Mile	$0.022	$0.024	$0.002	9.1%

loaded into trucks. The wheat is then trucked to a unit-train facility where another unload cost is assessed, and a subsequent load-out cost when the wheat is loaded into railcars for shipment to Houston. If wheat is shipped by short line railroad from these elevators this second handling at unit train shipping locations is avoided.

The total transport and handling costs of the no-abandonment scenario are $201.4 million as opposed to $222 million in the simulated abandonment case. If all four short line railroads in the study area were abandoned, wheat transport and handling costs would be $20.7 million higher than the current system that includes short lines.

Total transport and handling cost per bushel of wheat increases from $0.551 (no-abandonment) to $0.607 (abandonment), an increment per bushel of $0.056 or 10.2%. According to Koo (1985), as much as 85% of an increase in transportation and handling costs is borne by the grain producer. If this is the case, Kansas farm income would fall $17.4 million if short lines are abandoned (365.5 million bushels of wheat multiplied by $0.056 multiplied by 0.85 = $17.4 million).[13]

CONCLUSION

Structural changes are occurring in the Kansas wheat logistics system that have had the effect of shifting wheat traffic from short line railroads to motor carriers. Several factors have contributed to this trend including the construction of shuttle train stations on Class I railroads, increasing farm size, and the trend to larger railcars. These changes have resulted in Kansas short lines losing market share in their principal commodity market, threatening the long run viability of these railroads. Similar structural changes in the wheat logistics system have occurred throughout the Great Plains region and the

Canadian prairie provinces.

Rural communities could be negatively affected in a variety of areas if short line railroads are abandoned. These negative impacts include lower grain prices received by farmers, higher transportation costs and lower profits for rural area rail shippers, loss of market options for shippers, lost economic development opportunities, loss of local tax base needed to fund basic government services, potential increase in highway accidents due to increased truck traffic, and increased road damage costs on county roads and state highways. Therefore, it is important to measure quantifiable impacts of short line railroad abandonment. This study measured the change in wheat transportation and handling costs as a result of abandonment of four short lines currently serving the western two-thirds of Kansas.

Using a network model, Arc View Geographic Information System software, and a truck routing algorithm from Babcock and Bunch (2002), this study computed the minimum transportation and handling costs of moving Kansas wheat from farms, through Kansas country grain elevators, and then through Kansas unit train locations to the export terminals at Houston, Texas. The analysis was performed with and without study area short line railroads in the wheat logistics system. The difference in the two scenarios is the impact of short line railroad abandonment on Kansas wheat transportation and handling costs.

Results indicated that there was virtually no difference in the total transportation costs of the wheat logistics system with or without abandonment of short line railroads. Total transport cost for the no-abandonment scenario was $126.6 million, and $124.9 million for the simulated abandonment scenario. This result is attributable to the increase in truck costs in the abandonment scenario being about the same as the decrease in short line railroad costs. While total transportation cost was unaffected by short line abandonment, total wheat handling cost increased $22.4 million as a result of short line abandonment. Thus, total transportation and handling cost was $20.7 million higher in the simulated short line abandonment scenario. It was estimated that short line abandonment would reduce Kansas farm income by $17.4 million.

State and federal financial assistance to short line railroads would be an efficient use of resources if short line rail transportation results in external benefits. This is the case since the market always underallocates resources to markets with external benefits. There is some evidence that short line externalities are substantial. According to Babcock et al. (2003) abandonment of all the short lines in the study area would increase Kansas road damage costs by $57.8 million. Other potential external benefits of short line rail transport are highway safety benefits (due to reduced number of large trucks on the highway system) and environmental benefits due to lower emissions. Further research is needed to measure the value of these external benefits from a national perspective.

Endnotes

1. In this study, short line railroads are defined as including Class II and III railroads as defined by the Surface Transportation Board. In 2001, Class II railroads were classified as railroads with operating revenue of $21.3 to $266.6 million and Class III railroads were those with less than $21.3 million of operating revenue (*Association of American Railroads* 2002, p. 3).

2. See *Association of American Railroads* (2002, p. 3).

3. Kansas Department of Transportation (2002), p. 35).

4. Kansas Department of Transportation (2002, pp. 82-85).

5. Kansas Department of Transportation (2002, p. 85).

6. Kansas Department of Transportation (2002, pp. 84-85).

7. Kansas Department of Transportation (2002, p. 85).

8. Babcock and Bunch (2002, pp. 34-35).

9. Texas Gulf ports, of which Houston is the largest, is the largest single destination of Kansas wheat, accounting for about 50% of the shipments (*Kansas Agricultural Statistics* (2001, pp. 13 and 15), and *Kansas Agricultural Statistics* (2002, pp. 13 and 15).

10. The land use map was supplied to the research project by Kimball Mapping of Manhattan, Kansas.

11. The study area shuttle train loading stations on the BNSF are located at Wright, Garden City, Concordia, Wellington, Abilene, and Dodge City, Kansas. The shuttle train loading facilities in the study area on the UP are at Haviland, Wakeeney, Ogallah, Sharon Springs, Colby, Abilene, and Plains, Kansas.

12. In analyzing wheat trucking costs from country elevators to unit train shipping facilities, crossover distances (distances at which rail and truck costs are identical) were calculated for two types of railroad movement. One was originated-terminated (OT) movements and the other was originated-delivered (OD) movement. In the OT case, shipments are originated and terminated on the same railroad, whereas for OD movements, shipments are originated on one railroad and delivered to another railroad.

Truck costs were calculated for two scenarios. One assumed that trucks have no waiting time to load and unload wheat shipments while the other assumed that each truck shipment has a one-hour wait time valued at $10 per hour.

Crossover distances were calculated for four alternatives for the short line railroad proxy (Illinois Central Railroad) using URCS costing. The crossover distance for the four alternatives are as follows:

Alternative	Crossover Distance (Miles)
OT Movement, No-Wait Truck	70
OD Movement, No-Wait Truck	60
OT Movement, Wait Truck	60
OD Movement, Wait Truck	40

The crossover distance of 40 miles was determined to be unrealistic since a survey of shuttle train facility managers (Babcock and Bunch 2002) discovered that the typical market area radius of these facilities is 60 to 70 miles. The crossover distances for the other three alternatives are insensitive to the rail and truck movement types (i.e., 60 to 70 miles).

13. The actual impact of short line railroad abandonment on Kansas farm income would likely be different from that estimated in this study. Actual shifts in farm income are determined by changes in rail and truck prices rather than the rail and truck costs used in this study. Also farmers probably have benefited from the gains in wheat handling and transportation efficiency of shuttle train operation that didn't exist prior to creation of these facilities.

References

Association of American Railroads. *Railroad Facts, 2002 Edition.* Washington, DC, 2002.

Babcock, Michael W., E.R. Russell, M. Prater, and J. Morrill. *State Short Line Railroads and the Rural Economy.* Topeka, Kansas, Kansas Department of Transportation, 1993.

Babcock, Michael W., M. Prater, and E.R. Russell. *Long Term Profitability of Grain Dependent Short Line Railroads in the Midwest.* Topeka, Kansas, Kansas Department of Transportation, 1997.

Babcock, Michael W., and James L. Bunch. *Impact of Kansas Grain Transportation on Kansas Highway Damage Costs.* Topeka, Kansas, Kansas Department of Transportation, 2002.

Babcock, Michael W., J.L. Bunch, J. Sanderson, and J.Witt. *Economic Impacts of Railroad Abandonment on Rural Kansas Communities.* Topeka, Kansas, Kansas Department of Transportation, 2003.

Baumel, C.P., J.P. Gervais, H. Hommes, and C. O'Riley. *The Iowa Grain Flow Survey: Where and How Iowa Grain Producers and Country Elevators Ship Corn and Soybeans.* Ames, Iowa, Iowa State University, 1996.

Berwick, Mark. *Motor Carrier Cost Estimates for Kansas Grain.* Fargo, North Dakota, May 2002.

Fuller, Stephen, T.H. Yu, D. Collier, J. Jamieson, and R. Harrison. *Texas Grain Transportation Study.* Austin, Texas, Center for Transportation Research, The University of Texas at Austin, and Department of Agricultural Economics, Texas A&M University, 2001.

Kansas Agricultural Statistics Service, Kansas State Board of Agriculture. *Kansas Grain Marketing and Transportation.* Topeka, Kansas, 1991.

Kansas Agricultural Statistics Service, Kansas State Board of Agriculture. *Kansas Grain Transportation.* Topeka, Kansas, 2001.

Kansas Agricultural Statistics Service, Kansas State Board of Agriculture. *Kansas Grain Transportation.* Topeka, Kansas, 2002.

Kansas Agricultural Statistics Service, Kansas State Board of Agriculture. *Kansas Farm Facts.* Topeka, Kansas, 2000, 2001, and 2002.

Kansas Agricultural Statistics Service, Kansas State Board of Agriculture. *2000 Kansas Custom Rates.* Topeka, Kansas, January 2001, p. 10.

Kansas Department of Transportation, Division of Planning and Development, Office of Rail Affairs. *Kansas Rail Plan Update 2001-2002.* Topeka, Kansas, 2002.

Kansas Grain and Feed Association. *2002 Kansas Official Directory.* Topeka, Kansas, 2002.

Koo, Won W. "Tariffs and Transportation Costs on U.S. Wheat Exports: A Quadratic Programming Approach." In *Transportation Models for Agricultural Products,* edited by Won W. Koo and Donald W. Larson, Boulder, CO: Westview Press, (1985): 105-123.

Machalaba, Daniel. "High Speed Grain Terminals Bode Change for Rural U.S." *The Wall Street Journal,* December 26, 2001, Section B1, p. 2.

Nolan, J., M. Khakbazan, R. Gray, and M. Fulton. *Economic Issues Surrounding the Viability of Short Line Railways in the Canadian Prairies.* Saskatoon, Saskatchewan, Department of Agricultural Economics, University of Saskatchewan, 2000.

Office of Economics, Environmental Analysis, and Administration, Surface Transportation Board. *Uniform Railroad Costing System Phase III Movement Costing Program.* Washington, DC, 1996.

Rindom, S.J., J.J. Rosacker, and M. Wulfkuhle. *The Transportation Impact of Grain Subterminals in Kansas.* Topeka, Kansas, Kansas Department of Transportation, Bureau of Rail Affairs, 1997.

Russell, Eugene R., M.W. Babcock, and C.E. Mauler. "Study of the Impact of Rail Abandonment on Local Roads and Streets." *Conference Proceedings, Sixth International Conference on Low Volume Roads, Volume I* (1995): 110-119.

Upper Great Plains Transportation Institute. "Strategic Transportation Analysis Study Show Results." *UGPTI Insights*. Fargo, North Dakota, Upper Great Plains Transportation Institute, North Dakota State University (Fall 2001): 4-6.

Acknowledgments

The research on which this paper is based was funded by the Kansas Department of Transportation (KDOT), Kansas Transportation Research, and the New Developments (K-TRAN) research program. The contents of the paper reflect the views of the authors who are solely responsible for the facts and accuracy of the analysis.

__Michael W. Babcock__ is a professor of economics at Kansas State University (KSU). In his 30-year career at KSU, he has published 70 articles in professional journals, along with numerous monographs and technical reports, and his research has been cited in more than 70 books, the transportation press, and professional journals. He has presented 70 papers at professional meetings, and he was principal investigator or co-investigator on 28 federal and state government research grants worth a total of more than $1.8 million. Babcock is recognized as a leading national and international authority in three research areas including short line railroad transportation; agricultural transportation; and impact of public policy on transportation market shares.

He has received numerous national awards for his transportation research. He has been recognized five times by the Transportation Research Forum for outstanding research in transportation economics. In addition, Babcock has received the Edgar S. Bagley Award four times from the KSU Department of Economics for outstanding achievement in transportation economics research. In 1999 he was awarded the ISBR Senior Faculty Award for Research Excellence in the Social and Behavioral Sciences from KSU. Babcock has served as an advisor to Kansas Governor Graves on transportation policy and contributed testimony to congressional hearings on transportation issues.

__James Lee Bunch__ is the Real Property Master Planner for the Kansas Army National Guard. A former Artillery Officer in the United States Army, he has eight years of operational management experience utilizing multimodal transportation systems. He is coauthor of the Kansas Department of Transportation study titled "Impact of Kansas Grain Transportation on Kansas Highway Damage Costs," published in April 2002, and holds a Bachelors of Science degree from the United States Military Academy and a Master of Arts in Information Management from Webster University.

__James Sanderson__ received a B.A. degree in Business Administration in 1994 from Kansas Wesleyan University, and a M.B.A. degree in 1997 from Kansas State University. He is currently a Ph.D. student in Economics at Kansas State University.

__Jay Witt__ received a B.S. degree in Economics and Philosophy from Kansas State University in 1999, and, earlier this year, an M.S. degree in Economics, also from Kansas State University. He is currently pursuing a juris *doctorate degree from the University of Kansas.*