AE 89020 October 1989

POSTED PRICES AND AUCTIONS IN RAIL GRAIN TRANSPORTATION*

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*Paper presented at a symposium on "Institutional Design for Public Policy Analysis" at the Allied Social Science Association Annual Meeting, December 28-30, 1988, New York, NY, and at the Transportation Research Forum, Williamsburg, VA, October 11, 1989.

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I. INTRODUCTION

There have been important institutional innovations in pricing in the rail grain transportation industry over the past decade. These have been in response to the underlying fundamentals of the market and the competitive environment of the industry. Pricing and commercial practices in this industry are typical of industries which have evolved with less regulation. Prior to the Staggers Rail Act there was temporal rigidity in rail prices. Competing modes, not being regulated, responded to market conditions. However, due to the stickiness in rail prices it was changes in prices of competing modes and output of the railroads, which equilibrated the market. There were several key features of the Staggers Rail Act which affected the nature of competition and pricing institutions. These were provisions for increased price flexibility, encouragement in the use of contracts, and other innovative pricing mechanisms. The industry has evolved from being dominated by a posted price mechanism, to proliferation in the use of bilateral, confidential contracts, and more recently to a proposed auction mechanism for guaranteed service in forward positions (i.e., a forward market). Explicit in each of the latter was an increased emphasis on service guarantees, which effectively result in priority in the allocation of cars. Currently the industry is making use of each of these mechanisms.

It is premature to evaluate the impacts of these alternative pricing mechanisms, or institutions. However, data on early trading in these markets are presented and discussed. The purpose of this paper is to describe the evolution of these pricing mechanisms and to describe the form of competition and the rules governing this competition in a deregulated environment. In section II the institutions affecting pricing prior to and post deregulation are described. In addition data are presented on rail car supply and allocation procedures. Section III provides detailed information on the operations of the auction market of a particular railroad which has developed for pricing and allocation of rail transportation service. Comparisons are made to operations of the auction mechanism to alternative pricing procedures. The final section presents a summary of the evolution and impetuses for these changes. In addition there are many unresolved issues which are discussed.

II. EVOLUTION OF RAIL PRICING IN GRAIN TRANSPORTATION

There has been a very important evolution in the pricing of rail services since the early 1980s. Prior to the Staggers Rail Act' rail pricing was dominated by a tariff based system akin to a posted-price mechanism. This was followed by increased use of contracts which circumvented the posted price mechanism during the mid-1980s. Recently there has been a move by at least one major railroad to eliminate use of contracts on some commodities, and replace the pricing institution with an auction mechanism.[1] The forces which underlie this evolution are described in this section. In addition, the rail car supply problem and traditional allocation mechanisms are discussed. In the next section, a detailed discussion is provided of the grain rate auction mechanism.

PRE-STAGGERS. Prior to 1980 rail rate changes were subjected to a regulatory process which had been in existence since 1887. Even though there was a regulatory procedure, rate levels were subject to pressures from intermodal, intramodal and intermarket (network effects) competition.

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[1]Currently, the Burlington Northern (BN) is the only railroad which is making active use of a formal auction mechanism, and its expansion has been hampered by a pending investigation by the Interstate Commerce Commission (ICC). Other railroads likely are evaluating use of similar innovations, but their implementation are likely on hold pending the ICC investigation.

However, rate bureaus played an important role in intramodal competition. In most grain transportation markets the structure of competition was likely characterized by a dominant firm price leadership model. The railroad, acting through the rate bureaus was the dominant firm, and the competitive fringe consisted of trucks, barge, or truck-barge competition, each of which were exempt from the regulatory process, and individually were incapable of having a perceptible influence on price. The important point is that even though a regulatory process existed for the railroads, competitive pressures still existed and influenced equilibrium in modal competition.

The regulatory process during this period entailed general rate increases applied to regions and commodities. Flag-outs were used for special demand situations and were administered at the regional or commodity level. However, these were used only rarely. Rate changes were submitted by the railroads to the ICC. Formally, a 30 day notice was required of rate changes. If the ICC investigated the rate change there could be a time lag of up to 10 months (9 month period for investigation plus the 30 day notice) between initiation of the rate change and its fruition. The important point for purpose of this paper is the nature of rigidity implied in the regulatory process. At least during the 1970s rarely was a rail rate increase denied, despite protests from shippers. One of the effects of protests from shippers was the deferral of a rate change. Thus, an important impact of the pricing process was the apparent rigidity, or stickiness in the pricing mechanism.

There were four important characteristics of the market environment affecting railroad pricing during the 1970s. One was general inflation which impacted rail costs and thus was used to justify inflationary rate increases. The second was the dramatic increase in grain exports from the U.S., resulting in a rightward shift in the transport demand function during the early to mid-

1970s. Third was the abnormally rapid real increases in fuel prices. The effect of this was to have a negative impact on the supply function of motor carriers which are less fuel efficient than rails and are an important source of competition in many movements. Finally, there was an overall shortage of rail cars relative to demand. Persistent shortages existed during some of the years of the 1970s.

Comparisons of rate levels and changes are difficult due to the relative unavailability of data on competitive modes. However, data were collected on truck and rail rates during the period 1973 to 1983 on grain shipments from North Dakota and are shown in Figure 1.[2] There are two important points demonstrated in Figure 1. First is the rapid escalation in rates on both modes (though not apparent in Figure 1, the rate increases exceed that of overall inflation). The second and important point for this paper is that of the apparent rigidity of rail rates compared to that of truck. This is due likely to the regulatory process affecting railroad pricing, versus the competitive market affecting trucks. In general, due to the relative stickiness in rail rates it was the price of competitive modes which equilibrated the market.[3] In the period following 1980 one can detect that rail rates became less rigid, or more responsive to market conditions. Comparisons following approximately 1983 would be inappropriate due to the proliferation of confidential contracts during that period.

In a recent study of this particular market (Wilson, Wilson and Koo) a model was developed to evaluate the nature of competition during this transition period. Important conclusions from that study are briefly stated.

[2]See Wilson, Wilson and Koo for a complete description of the data.

[3]Similar behavior existed for barge rates relative to rail rates.

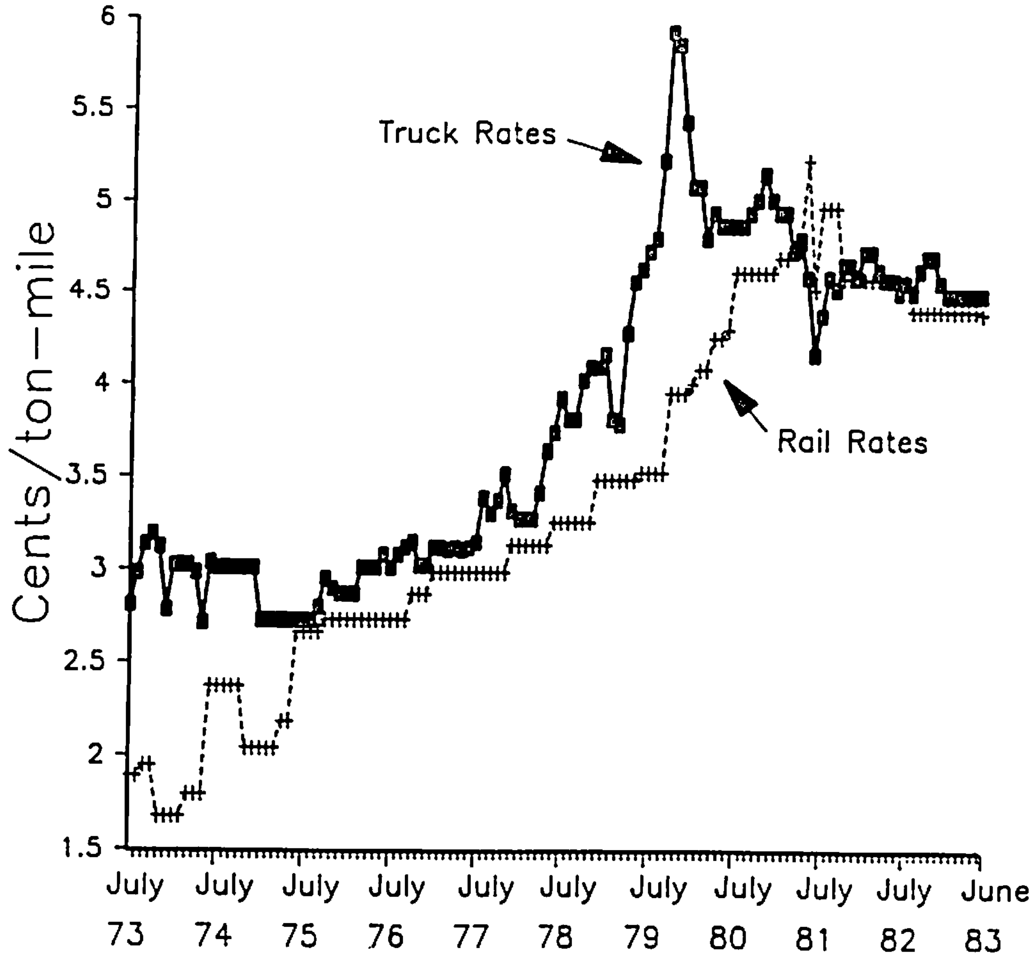

Figure 1. Truck and Rail Rates for Wheat Shipments to Minneapolis/Duluth from North Dakota

First, a crucial variable affecting competition is that of rail car supply. During periods of shortages, the truck demand function shifts rightward and becomes more inelastic (rotates), but the increase in truck demand is moderated by increases in truck rates. Second, the truck supply function is highly elastic, resulting in an elastic residual demand for rail service. Finally, rail pricing was characterized by a dynamic adjustment process in rate changes. In the post-Staggers period the adjustment lag to desired rates was reduced and the effect of output of the competitive mode on rail prices was greater.

PRICING INSTITUTIONS IN THE POST-STAGGERS PERIOD. There are a number of important features of the Staggers Rail Act which have influenced the pricing environment during the last 8 years. These include: elimination of the concept of general rate increases after 1983; development of a zone of rate flexibility which if violated would trigger the regulatory process; allowing rate changes in response to changes in the rail cost recovery index; the powers of rate bureaus were drastically reduced; the notice period for rate increases (decreases) was reduced to 20 (1) days; and contract rate agreements were specifically legalized. In addition, premium charges could be imposed for "special services to improve the utilization of rail equipment."

Rail pricing for grain was not drastically impacted until several years following passage of the Staggers Rail Act. There was a potential lag in implementation of key features of the Staggers Rail Act due, in part, to the management of rail pricing departments. However, a likely more important reason was that in the immediate post-Staggers period the market for grain transportation was similar to that described above, namely strong demand for rail transport. However, by 1982 the market came to be characterized by a reduction in aggregate demand and a decrease in real input prices for both trucks and rails (but proportionately more for the former). The result of these two fundamental phenomena was an increase in relative surplus of rail cars.

The evolution of the above competitive environment had an important impact on the nature of rail pricing in grain. In particular, beginning in about 1983 bilateral contracts between individual shippers and carriers began to proliferate as a pricing institution. Terms of contracts varied across shippers and carriers but in general included rates (usually negotiated relative to a tariff), minimum volume, car supply and service (performance). Administration of the contracts varied across railroads. Some railroads gave the same terms to all parties, whereas others negotiated terms with individual shippers. Terms of the contracts essentially entailed forward contracts for shipping service and were determined through bilateral bargaining. Any potential market power of the railroads was offset to the extent that counter-railing bargaining power of large shippers existed.[4]

Principal impetuses for the use of contracts by carriers was to assure utilization of equipment, whereas shippers sought rate concessions. Table 1 shows the use of contracts on grain and grain products during the 1980s (Baumel, Hanson and Wisner). Use of contracts increased rapidly and reached a peak in 1986 for bulk grain, and have since decreased. A potential reason for the increase from the carrier perspective includes the growing surplus of equipment. From a shipper perspective, contracts were an appealing means of

TABLE 1. NUMBER OF RAILROAD CONTRACTS PER MONTH

Year	Grain	Grain Products
1980-83	46	*
1984	101	35
1985	231	60
1986	244	93
1987	180	101
1988**	136	108

*Included in grain contracts.
**Through May, 1988.

SOURCE: Interstate Commerce Commission and tabulated in Baumel, Hanson and Wisner.

[4]For perspective, a survey of grain shippers in North Dakota indicated that 79% were involved in contracts. The high volume elevators were more frequent users and in general negotiated their own terms. Smaller shippers either were not involved in contracts, or simply sold on a FOB basis taking advantage of the buyers contracts (Zink and Griffin).

reducing rate uncertainty and performance assurance. There are likely three reasons for the decrease following 1986. First, there was a change in the disclosure rules which allegedly reduced the incentive to contract. Second, a sharp increase occurred in grain exports resulting in increased transport demand, and the eventual return to reduced equipment supplies. Finally, the largest grain-hauling railroad in the U.S., the BN, introduced an auction mechanism with service guarantees as an alternative pricing mechanism. This is discussed in detail in Section III.

CAR SUPPLY AND ALLOCATION MECHANISMS. An important impetus to the evolution of institutions affecting rail pricing is that of car supply. Table 2 show the composition of the rail grain fleet in the U.S. from 1978 to 1988. During this period there was a noticeable evolution away from boxcars to jumbo

TABLE 2. NOMINAL SIZE OF RAIL GRAIN FLEET: RAILROAD-OWNED, PRIVATELY-OWNED, AND TOTAL COVERED HOPPER CARS

Year	40' ND Boxcars	---- Jumbo Covered Hopper Cars ---- Railroad	Private	Total
	---------------- 1,000 cars			------------------
1978	85.5	94.6	54.2	148.8
1979	65.5	99.9	61.9	161.8
1980	58.3	106.2	79.7	185.9
1981	43.0	117.1	101.0	218.1
1982	30.9	112.2	108.5	230.7
1983	15.4	120.2	112.7	232.9
1984	11.4	122.3	111.3	233.6
1985	6.8	123.5	114.7	238.2
1986	4.3	123.5	115.5	239.0
1987	3.8	122.4	114.5	236.9
1988	2.8	122.4	114.0	236.4

Source: *Association of American Railroads*

Note: Jumbo covered hopper cars are defined as all covered hopper cars with a load capacity greater than 4,000 cubic feet.

covered hopper cars. The rail grain fleet peaked in 1982. There has been virtually no new construction of grain cars since that time. In practice due to the aging of the fleet it is even possible that the effective operable supply may be decreasing due to increased frequency of mechanical repairs. However, the effect of the decrease in supply may be offset to some extent by improvements in efficiency.

Individual railroads maintain 'surplus/shortage' records for their systems. These are simply the extent that orders for cars differ from supply. Table 3 shows the average weekly surpluses and shortages for the BN. Shortages predominated in the late 1970s, but during the 1980s surpluses prevailed, and actually became relatively large. Rail car demand is impacted by domestic and export demand for grains. The former is relatively stable through time, however, the latter is quite volatile. Following rapid growth

TABLE 3. JUMBO COVERED HOPPER CARS SURPLUS/SHORTAGE STATISTICS (4,000 CUBIC FEET AND OVER)

Year	Surplus	Shortage
1978	10	18,957
1979	1	16,646
1980	3,042	2,149
1981	19,753	16
1982	22,908	133
1983	14,359	127
1984	11,592	318
1985	16,323	839
1986	11,182	1,204
1987	5,283	884

in export demand during the 1970s, the U.S. experienced a large reduction in export demand for grains during the 1980s. The 1985 Farm Bill contained provisions which encouraged sales of government owned grains[5] and mechanisms for use of direct subsidies to expand exports. As a result during the period 1986-1988 there was a drastic increase in demand for transport services. Nationwide up to 15% of the total railcar capacity for grain was being used for these movements (United States Department of Agriculture). The cumulative impact of these developments resulted in an increase in the delay in car placement. During the period September 1987 to February 1988 the average delay was 30 days, but ranged from nil to 70 days depending on region and month.

The traditional mechanism for allocation of rail cars and unit trains was to fill orders on the oldest date wanted, i.e. FIFO. In addition, penalties were not imposed for cancellation of car orders. As a result of these allocation rules there was a tendency for grain traders, in anticipation of increases in demand, to inflate their orders for cars, and if necessary to cancel without penalty. By being the oldest order, they potentially had a competitive advantage in trading. Following tremendous expansions in subsidized grain sales in early 1988 car orders escalated very rapidly, followed by rates on alternative modes. The inflation of car orders hampers rail management in making car allocation and investment decisions. For example, Figure 2 shows the outstanding car orders for grain equipment on the BN system during the period March-April 1988. During the latter part of that period there were over 60,000 cars cancelled within 3 weeks.

[5]Formally owned by the Commodity Credit Corporation (CCC), these grains represented accumulated forfeitures by producers over a number of years.

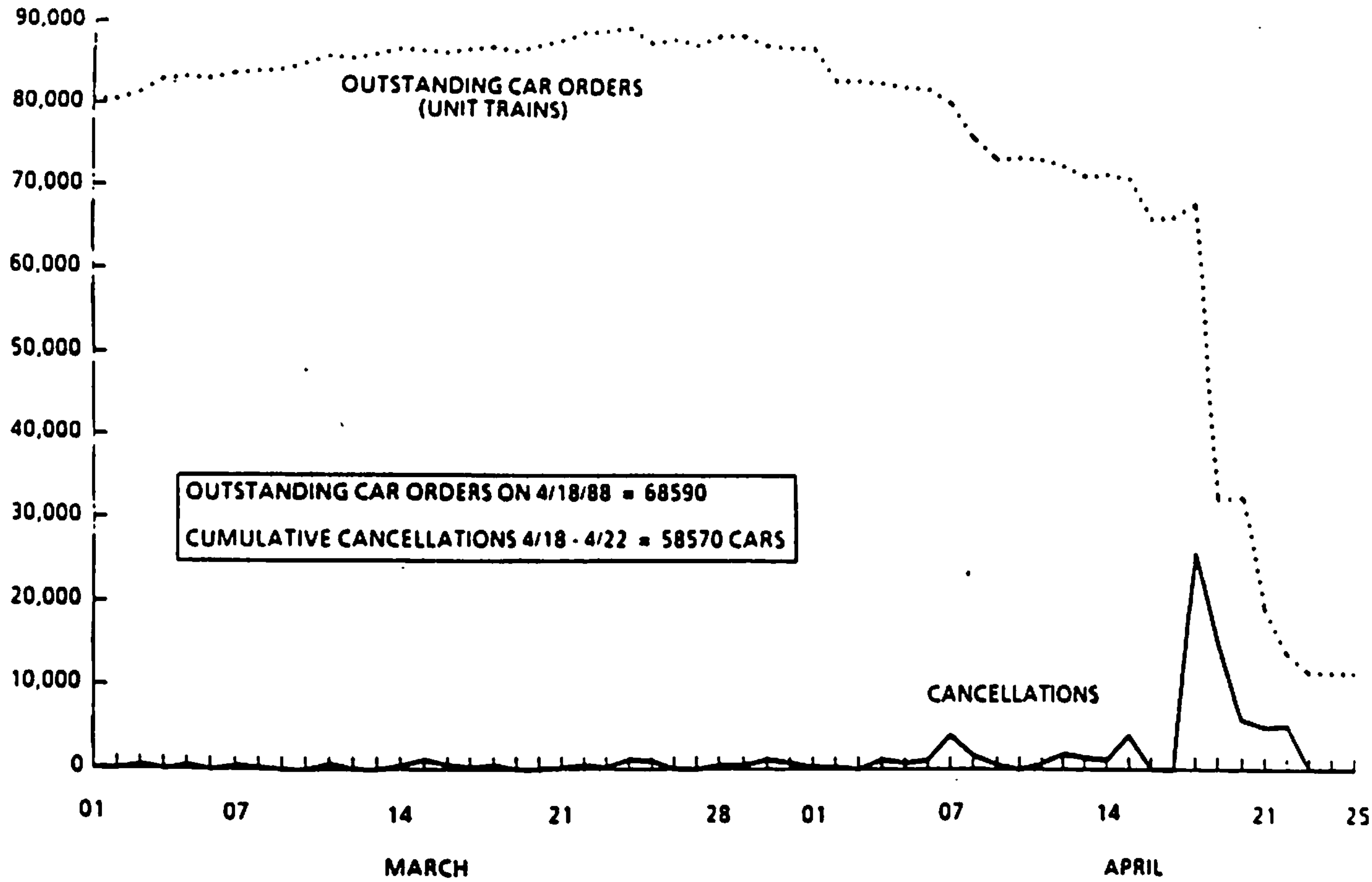

Figure 2. Outstanding Unit-Train Car Orders Versus Cancellations (BN)

III. GRAIN RATE AUCTIONS

In early 1988 the BN Railroad initiated an innovative mechanism for pricing rail grain transportation referred to as the Certificate of Transportation, or COT program. This is a program with guaranteed service and an auction mechanism is used for price determination. The previous section described the evolution of the institutions of rail pricing which have essentially led up to the development of the COT program. In this section the rail grain auction is described in detail. First, the grain marketing industry is briefly described along with key features of the COT program. The COT program is discussed in the context of a mechanism to place a value on priority, ie priority pricing. The third section develops a model which explains the value of COTs and evidence from early trading of COTs is presented. Salient features of the auction are described along with brief comparisons to posted prices and bilateral bargaining, both alternative mechanisms to price determination.[6]

INDUSTRY ORGANIZATION AND RAIL GRAIN RATE AUCTIONS

There are many participants in the grain marketing industry including producers, elevators, commission companies or brokers, exporters and domestic processors. Prices throughout this market system are determined through a system of futures, forward and spot markets. Prices at various points in the market system differ by the cost of handling, conditioning and storage, as well as margins for the market participants. Purchases (sales) by

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[6]The COT program was originally introduced in January 1988 but was suspended in late January due to shipper complaints. Subsequently, shipper complaints led to an investigation by the ICC which is still in process. The program was reinitiated in a revised format (ie taking into consideration shipper comments) in June 1988. Due to the newness of this institutional mechanism it was not possible in this paper to fully evaluate many of the interesting questions related to this pricing institution at this point. Thus, this paper is primarily descriptive of the institution. Finally, though the BN is the only railroad to date which has formally initiated a formal auction mechanism with service guarantees, others are waiting the outcome of the ICC investigation prior to implementing innovative pricing mechanisms. One other railroad, the Union Pacific, has started a related program with service guarantees, but differs from the BN to the extent that prices take the form of a posted tariff, as opposed to an auction mechanism.

participants can be either FOB or CIF which, in fact, becomes a negotiable term. Grain is allocated amongst and between participants and locations in response to price differentials relative to marketing costs (e.g., transportation). Space utility is created by transportation and any time price differentials exceed transport costs, demand is created for shipment. Arbitrage precludes price differentials in excess of transport costs for more than a brief time. It is through these markets that price levels and differentials are established which influence the allocation of grain across uses and destinations.

The COT program was designed as a price discovery mechanism and to accommodate the needs of the grain industry in a deregulated railroad pricing environment. An overall purpose of the mechanism was to establish a forward market for rail transportation in particular corridors. To do so the COTs were designed as negotiable instruments and service guarantees were provided. Important features of the COT program are:

1. Corridors of grain transport were developed by region and type of grain (for example, Northern Wheat east if from Devils Lake, North Dakota to Minneapolis). Origins and destinations different from those of the corridor could also use the COTs at preestablished premiums or discounts relative to the COT value. Thus, the unit of trade was standardized.

2. Up to 40% of the BN rail car fleet could be allocated to the COT auction, the balance being available to non-COT movements. Allocations to individual corridors are determined by historical averages and pre-announced.

3. Forward positions for grain transportation are created and traded in monthly increments. These are as far as 3-6 month forward depending on demand.

4. Weekly auctions are conducted via electronic media for forward positions. These are sealed bid discriminatory auctions with announced minimum bids. Information regarding number of bidders and accepted bids is released following the auction. Multiple units could be sold each day, up to a maximum which is pre-specified.

5. A service guarantee provision is included which takes the form of a payment to the COT holder for failure of the carrier to furnish the equipment.

6. A prepayment fee of about 50% (originally 100%) of the value of the bid is required. This is partial prepayment for the freight and forgone interest is reimbursed. This prepayment could be interpreted as a performance bond, or simply a cancellation fee imposed on the shippers.

7. The COT is negotiable which is intended to facilitate development of a secondary market. The purpose of this is to provide some liquidity should a traders' underlying commodity position change.

In general, the design of the program is to facilitate the development of a forward market for grain transport services. As a result, rates and service are guaranteed for both parties. It is important to note that points 5 an 6 are somewhat revolutionary in the grain transportation industry, but are crucial to the program.[7] One of the features of the Staggers Rail Act which facilitates the introduction of the COT program is that premiums may be imposed for "special services to improve car utilization."

PRICING EFFICIENCY AND CAR ALLOCATION SCHEMES

Spot prices are rarely used in industrial marketing despite their attractiveness in allocation. It is more common to use fixed prices (e.g., posted prices or fixed tariffs) which results in periodic idle capacity, and/or arbitrary allocation during peak period. Priority pricing is designed to resolve these problems.[8] The fact that in most cases the important attribute of reliability (or priority) is unpriced, results in allocational

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[7]Though not pursued here, the rate auction described above has been introduced concurrent with a forward car lease program. The concept is that by having a forward rate market signals will be transmitted which can be used in making forward car lease decisions.

[8]The concept of priority pricing is subtly different from conventional peak-load pricing. The latter is characterized by cyclic and/or stochastic demand and the service is temporarily differentiated between peak and off-peak periods. Prices in each segment are set to level the peak. Peak-load pricing is a special case of spot pricing. For comparison, in priority pricing the delivery condition which is differentiated is the priority of service. Prices differ across customers depending on the priority they choose. Thus, the market is segmented by priority class rather than peak and off-peak.

problems in operation and capacity planning. If capacity (timeliness of service) is unpriced, the value of additional capacity (which improves timeliness of service) is uncertain. As a result allocation and planning decisions are distorted and queuing costs become a part of the implicit price paid by customers.

The COT program is an innovation in transport marketing and can be interpreted as unbundling of the delivery conditions (i.e., priority)[9] from the basic service (transport).[10] As such it is a special form of service differentiation where the differentiation is by priority in car allocation (as discussed above, COTs have a priority over other forms of grain transport). Consequently, the contiguous tariff and contract alternatives form the basis of a menu of service alternatives, which facilitates segmentation of the market into a spectrum of priority classes. The premium reflected for COT rates over non-COT tariff rates is the implicit value of the priority and could be viewed as insurance against a shortage.[11]

Priority pricing involves offering different service quality categories, differentiated by timeliness of service. The unbundled attribute is the probability of receiving timely service. In general, priority pricing is a

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[9]Throughout the remainder of this section use of the term "priority" will refer simply to the priorities in the allocation of rail cars. Priority can also be viewed as 'reliability', which is the quality dimension used in power utilities, or as 'timeliness of car placement', in grain transport. These terms will be used interchangeably throughout this section.

[10]The concepts and analogies presented in this section are taken from the examples of pricing electric utility service (Chao and Wilson).

[11]The COT provisions could also be viewed as an option (as in contingent forward contracts for commodities and financial instruments) where the pre-payment, being non-refundable, is the price of the option. The option then is the right to service with a priority over non-COT trains, which yields certain benefits. If viewed as an option, or insurance, the value of COTs varies through time with the uncertainty in the market and with maturity of the shipping period.

mechanism to induce self-selection. Customers select a priority class and price to minimize expected total cost which is comprised of a demand charge plus the expected cost associated with the shortage or interruption. It is the customer selection which determines the service priority. Service classes can be a continuum of alternatives, or discrete.

An efficient allocation of resources is one which maximizes welfare. In the context of pricing unstorable services (e.g., electric power, or transport), efficiency requires that those customers whose service is deferred are those which would incur the least cost. Simply put, an allocation is efficient if the order of service corresponds with the value of the service across customers.[12] Priority pricing improves efficiency by serving customers in the order that conforms with the cost (implicit or direct) incurred from the shortage or deferral, vis-a-vis random rationing. An efficient rationing scheme then is one in which the resource is allocated according to customer valuation. Previous research has shown that priority service pricing is superior to random rationing on efficiency grounds (Chao and Wilson). One of the benefits of priority pricing is purely informational. By having different prices associated with different service priorities, information on the value of capacity increments that improve reliability is derived. This is an indication of customer willingness to pay for capacity increments that is unavailable in undifferentiated services. Given the signals generated in a priority pricing mechanism, providers of services can improve their decisions on capacity and operation planning which influence timeliness.

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[12]For example, in power generation, the value of uninterrupted service for a hospital is greater than residential air conditioning, or agricultural irrigation. Thus, during periods of excess demand, it would be efficient to interrupt service to the latter two-market segments first. Random rationing would impose greater costs on the former.

The role of pricing by priority is to induce customer self-selection, and in the process transmit information about the value of reliability to providers of the service. There are two general alternatives to achieve efficiency in the allocation of service priorities. One is a spot pricing mechanism. In this case prices are revised continuously in response to supply and demand conditions. However, in many case the uncertainty for buyers and sellers of a spot pricing mechanism are too great. An alternative is a contract mechanism which includes a clause regarding service priority. These have come to be known as 'priority service contracts' and can be viewed as contingent forward contracts. These include an array of prices associated with different delivery priorities. The customer then chooses the one which minimizes the expected total cost as described above. Chao and Wilson have shown that priority service contracts can have the same efficiency gains as those attained in spot markets. However, most of the gains in efficiency are attained with the first three to four priority classes. Both the use of a spot market mechanism, and the priority service contract are motivated by efficiency gains over random rationing. However, there are several differences. A key difference is the time frame. Spot prices are revised continuously, whereas priority service prices are offered as a forward contract. Second, the signals transmitted in a forward contract can be used to improve allocation decisions, whereas spot markets are merely a rationing mechanism. Third, the uncertainty for both buyer and seller are reduced (or eliminated) in priority service contracts as opposed to a spot market.

In the case of grain transportation it is important to devise a mechanism for setting priorities due to the volatility in demand and car shortages (surpluses). In addition, car allocation problems are compounded by inversions in the futures market (i.e., storage market) and in some cases it is exacerbated because of ordering and allocation procedures. In each case railroad management is fraught with allocation decisions and how to establish priorities. Transmission of signals regarding the value of marginal capacity or improved operating efficiency to railroad management has been limited. Similarly, shippers, not being charged for differentiated services, all demand priority service. In general, ad hoc or lesser efficient mechanisms have been used to establish priority.[13]

The COT program is a marketing technique which unbundles service priority, in this case timeliness of car placement, from transport. When combined with other shipping alternatives a menu is formed. These alternatives each have different terms of trade, an important difference which is the service guarantee (or timeliness in car placement, or priority). Self selection is achieved because shippers, being exposed to these alternatives, choose that which minimizes their expected total cost. With the COT program there are three categories of priority for grain car allocation.
These are: 1) Certificate of Transportation trains and cars; 2) cars ordered through a car guarantee provided by contract; and 3) non-COT unit train and single or less then unit train orders. Category 2 refers to contracts with car guarantee provision. However, no such contract currently exists so there are essentially two categories of priority, COT and non-COT. Within the latter orders are filled based on date ordered for placement on a first come first serve basis. Service guarantees and rates differ for these two classes of priorities. In the case of COTs, the rates are determined by the auction mechanism and subject to competitive pressures and commodity market spreads

[13]Lesser efficient as used here would be an allocation in which service priorities across shippers do not coincide with the costs (direct and indirect) associated with deferred car receival.

(discussed below). Rates for non-COT traffic are posted by the railroad, however still being subjected to market pressures. The difference between these reflects the premium for priority service. Given the fundamentals of the market this varies through time, and across market participants. In addition, a negative premium (i.e., a discount) may develop as discussed below due to the obligations implied in a COT.

Important to the gain in efficiency in priority pricing is that there are differences in value of the underlying attribute, i.e., priority or timeliness of service across customers. In self-selection, customers choose that alternative which minimizes the expected total cost where a component of the total cost is that of delays (or interrupted service in the case of a utility). There are a number of important dimensions in which the value of timely service may vary across individuals in the grain industry. One is that storage costs differ across participants depending on location, time of year, size, and whether they own or lease storage space. Values differ also depending on the extent the shipper is oriented as a high throughput elevator, versus one primarily for storage. The former would incur higher costs of car shortages. A third dimension of differences in value is whether the market participant has a commitment or not. A grain exporter for example, with a commitment for a shipment by a particular date has a different value for priority than does for example, a storage elevator during the non-harvest period. Another difference relates to domestic processors. In many cases these processors are located at the point of consumption, and operating efficiency requires a regular supply of raw materials. In absence of service priority opportunities, storage capacity at the point of processing may be larger than necessary but is in anticipation of periodic shortages. Due to the above differences and possibly others, the value of timeliness in shipping varies across shippers.

There are a multitude of different mechanisms for administering a priority pricing system in grain transportation, the COT program being just one very simple alternative.[14] One would be to offer multiple tariffs each with a different rate and service guarantee. Another would be to use bilateral contracts where one element of the contract would be a clause on service priority. Each of these alternatives could achieve the same objectives of the COT program. For perspective, the COT program is a forward contract with a service priority in the form of a car guarantee. It differs from the above two alternatives in four important ways: 1) it is not a privately negotiated bilateral contract; 2) rates for COTS, (i.e., for priority service) are determined by competitive bidding, rather than being prescribed by the BN; 3) the results are publicly disseminated; and 4) all shippers are essentially faced with the same menu of alternatives.

VALUATION OF COTS

There are three important features of COTs from a merchandising perspective. One is that they provide a mechanism to lock-in rates for a particular movement. Second is that guarantees are provided for car supply. As a result of these the risks associated with transport described in the previous section are reduced. The third point is that COTs are negotiable. Consequently, the rights and obligations can be transferred to other parties, either directly or through the development of secondary markets. In these respects COTs differ from other traffic (i.e., tariff or contract). The value

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[14]In the electric utilities various mechanisms are being used to administer priority service. These are partly facilitated by electronic devices for metering usage.

of COTs will vary through time, sometimes at a premium, and sometimes at a discount to non-COT rates. These are in addition to the role of COTs as forward contracts. A general model is developed here to demonstrate the factors which influence COT values.

For demonstration purposes a payoff function is developed for a basis trader.[15] A payoff function is specified first using COTs, and then for a non-COT position. For simplicity it is assumed throughout that when using COTs shipment occurs one period forward, i.e. in time t+1, and thus the opportunity costs of storage are for one period (e.g., one month). If there is a risk of car shortage, it is assumed at the outset that shipment occurs 2 periods forward, i.e. in time t+2. Thus, in this case there are 2 months of storage costs which are incurred. These are not restrictive assumptions but facilitate easy interpretation.

The payoff to a merchant using a COT is defined as:[16]

1) $$\pi_{cot} = B_{t+1,j} - B_{t,i} - T^{COT}_{ij,t+1} - H - S(1)$$

where π is the payoff; $B_{t+1,j}$ is the basis in market j for delivery in time t+1;

$B_{t,i}$ is the basis in market i in time t; $T^{COT}_{ij,t+1}$ is the price of a COT between i and j in t+1; and H is the cost of handling. As used here, S refers to the opportunity cost of storage including interest, infrastructure and deterioration. For simplicity it is assumed that in a COT transaction S is incurred for one period (e.g., one month, or one quarter). It is also

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[15]Basis is defined as the difference between the price at a particular market and the futures price. Given hedging activities of firms, the basis is the relevant variable for developing the payoff function.

[16]The formulation here does not reflect the differential in interest but between that paid by the railroad, the down payment, and the cost of capital to the firm.

important to note that to some extent different participants have different values for S, and therefore the payoff, and calculations below, vary across participants. From equation 1 the value of a COT is:

$$T_{ij,t+1} = B_{t+1,j}^{COT} - B_{t,i} - H - S(1) - \pi_{COT} \tag{2}$$

For a non-COT user, or a market in which COTs do not exist the equivalent payoff function is more complex and includes the risk of not receiving cars, and the existence of alternative markets or modes. This payoff function is defined as:

$$\pi_2 = P_1[B_{t+1,j} - B_{t,i} - \hat{T}_{ij,t+1} - H - S(1)] + P_2[B_{t+2,k} - B_{t,i} - \hat{T}_{ik,t+2} - H - S(2)] \tag{3}$$

where the variables are as previously defined and P_1 refers to the probability of receiving the cars within the time period for which they are ordered e.g. in time period 1; P_2 refers to the probability of receiving cars in the next period (e.g., period 2); the subscript k in the second part of the equation refers to market k or mode k (the dual role of the subscript is for generality purposes). Note that being this is a 2 period model $P_1+P_2=1$. Also, shipments not made under tariff in period 1 due to car delays incur an additional period of storage costs i.e., 2S. Interpretation of this payoff function is that it is the summation of returns, weighted by their probabilities of occurrence, associated with two shipment alternatives.

Using equation 2 and a transformation of 3, the factors influencing the difference in the value of COTs and tariffs can be elaborated. The subscript k refers to an alternative corridor, or market with a corresponding different rate, $\hat{T}_{ik,t+1}$, expected to exist in the next period. Shipment is assumed to occur within the next period, t+1, rather than being deferred as in the general specification. This is a more realistic situation in which the shipper has alternative markets and/or modes to the tariff movement.

Transformation under these assumptions results in:

4) $$\hat{T}_{ij,t+1,} = \frac{-\pi_2}{P_1} + P_1(B_{t+1,j}-B_{t,i}-H-S) + \frac{P_2}{P_1}(B_{t+2,k}-B_{t,i}-H-S-\hat{T}_{ik,t+2})$$

and taking the difference relative to equation 2 results in the difference in value between a COT and the respective non-COT tariff:

5) $$T^{COT}_{ij,t+1}-\hat{T}_{ij,t+1} = \frac{\pi_2}{P_1} - \pi_{cot} + \frac{P_2}{P_1}[(B_{t,i}+H+S+\hat{T}_{ik,t+2})-B_{t+2,k}]$$

In this case aside from the return differential of COT versus non-COT (π_2 is weighted by P_1 to account for risk differentials), the important factors affecting the premium for COTs are: 1) the transport cost and basis if shipped to another market; and/or 2) the transport cost if shipped to the same market under an alternative mode. If the transport cost of the alternative mode increases, the value of the COT relative to tariff increases by a factor of P2/P1. Increases in the basis to an alternative market, $B_{t+2,k}$, reduces the premium for a COT by a factor of P_2/P_1. For example, if the basis to an alternative market increases by 3¢/bu., and the probability of receiving cars is .8, then the value of the COT premium relative to a non-COT tariff would decrease by 3/4¢/bu.

In this situation in which competing markets or modes provide alternatives to rail service under tariff, there are very realistic situations in which COT rates can trade at a discount to tariff. It is important that the COT forces an obligation on the shipper to a particular movement on a particular corridor, and during a particular time period. Thus, in some cases in order to be subjected to this obligation, COTs may trade at a discount to the tariff. COTs will trade at a discount to the tariff rate on a particular movement in the following case:

6) $$\frac{P_2}{P_1}(B_{t,i}+H+S+\hat{T}_{ik,t+2}) - \pi_{cot} < \frac{P2}{P_1} B_{t+2,k} - \frac{\pi_2}{P_1}$$

Ignoring the effects of the payoff differential, several important points can be made. If there is a strong basis in an alternative market ($B_{t+2,k}$), i.e. strong relative to the transport cost to that market ($T_{ik,t+2}$); or if there is a strong basis relative to the rate for the alternative mode(or corridor), then COT rates would trade at a discount relative to its equivalent tariff rate. This is a basic principal of grain marketing in that if alternative markets (or corridors, or modes) are sufficiently attractive relative to the tariff movement (i.e., market j) then in order to obligate the shipper to that movement (i.e., from i to j), the rate must be discounted relative to tariff, because in fact, movement under the tariff would be nil.

In summary, COT values represent the market determined values for rail service at a particular time in the future, and for a particular corridor. As such, COTs involve an obligation both on the part of the railroad and shipper. Factors which influence the value of COTs include the commodity market which establishes premiums and discounts for different delivery periods, storage costs, spreads for different delivery locations (corridors), rates on alternative modes, as well as by the probability of timely car placement under a non-COT tariff movement. The market value of COTs will be disciplined by the commodity market network which is comprised of intermarket and inter- and intramodal competitive pressures. Under certain circumstances COTs can trade at premiums relative to a non-COT tariff movement, and in other cases COTs will have to be valued below the equivalent non-COT tariff movement. Besides these factors influencing COT values, one other is the strategic value of COTs in the competition for grain procurement. In general, this refers to the strategic advantage, or sometimes disadvantage, in inter-firm competition of having COTs.

There has only been limited trading of COTs due to the newness of the program, and due to the learning process of market participants. The data in Table 4 demonstrates the value of COTs relative to non-COT tariff values over the first six months of trading. Some corridors have been sold out (i.e., 100 percent sold), whereas participation in others has been minimal. The results indicate the value of COT bids relative to the tariff. These ranged from a low of 96 percent implying a discount to tariff, to a high of 103 percent reflecting a premium.

TABLE 4. SUMMARY OF COT ACTIVITY BY CORRIDOR IN 1988

Corridor	Total Sold	Cars Committed	Percent Sold	Difference Per Car	COT as a Percent of Tariff 6/20 - 12/15
1	367	19,818	2	$76	103.47
2	66	3,564	2	$24	101.50
3	359	359	100	$36	101.06
4	1,152	1,152	100	$12	101.86
5	175	4,550	4	($14)	99.50
6	54	1,404	4	($70)	96.00
7	152	3,952	4	($40)	98.58
8	0	0	0	0	0
9	500	500	100	($88)	95.59
10	72	72	100	($47)	98.73
11	7	182	4	$63	102.63
12	52	1,352	4	($19)	98.86
13	565	565	100	($19)	99.27
14	1,643	1,634	100	(5)	99.75
Total	5,155	39,104	624	$31	

Shipment period of August, 1988 thru May, 1989.

AUCTIONS, POSTED PRICES AND BILATERAL BARGAINING

COTs are a tariff for a special service which includes obligations for both the shipper and carrier. Fundamental to this exchange is that each party seeks some form of security via the implied contract; i.e., that implied by the terms for the COT. The carrier wants an irreversible commitment for shipment in a future time period to a particular location. Shippers seek the same and in particular the guarantee of cars and rates. The COT formalizes the obligation of each party. Prices for COTs are determined using an auction mechanism. This is merely a mechanism to determine the price of the instrument for forward positions. Alternative mechanisms for the discovery of prices include what will be referred to as posted rates, and bilateral contracts. The purpose of this section is to briefly describe the auction process as a mechanism of price discovery. In addition, comparisons are made to posted rates, and bilateral contracts.

An auction can be defined as "a market institution with an explicit set of rules determining resource allocation and prices on the basis of bids from market participants." (McAffen and McMillan, p. 701.) Auctions are merely a formalized means of organizing trade; i.e., an institutional mechanism. Prices are determined by competitive bidding and in the case of COTs the results are publicly disseminated. One of the objectives of an auction for the seller is to encourage buyers to reveal the value of an item, or service, in this case. While these values reflect the "willingness to pay," these are conditioned by pressures from intermodal, intramodal and intermarket competition, as well as the storage market as developed in the previous section. Though, by definition, an auction has only one seller, rates established by the auction process are subjected to these forms of competition. The essence of the auction problem is that there is asymmetric information (the seller does not know the value of the item or service), especially in the case of forward positions in transport service, and therefore the auction serves the purpose of price discovery. If the seller did know the value he would simply post that price. The COT program is an example of a sealed bid discriminatory auction. Bids are simultaneously submitted and the highest bidders receive the car(s) or train(s) and pays his bid.

Recent advances in game theory have been applied to the analysis of auction mechanisms, in particular, to identify the critical variables which influence the outcome of the auction. In a general first price sealed bid auction the bidder has a profit function:

7) $$\pi_i=(v_i-\beta_i)[F(B^{-1}(\beta_i)]_i^{n-1}$$

where v_i is the value of the service by bidder i, β_i is the bid, and $F[B^{-1}(\beta_i)]^{n-1}{}_i$ is the probability of winning with a bid β_i. This is the probability that all n-1 of the other bidders have valuations such that $B(v_j)<\beta_i$. F is the distribution of valuations. Thus, the expected profit for the bidder is $v_i-\beta_i$ where v_i is the value as discussed in the previous section. An important point is that valuations would normally not be the same for all participants in the market due to differences in expectations, storage costs and capabilities, and alternatives. The probability on the right hand side accounts for the likelihood of receiving the highest bid, or that all other bids are less than B_i.

Embedded in auctions on items with correlated values is the strategic incentive for underbidding to compensate for the "winners curse". In competitive bidding, it is possible that though a bidder may win the bid, he may lose in the overall transaction. In other words, by winning an auction tells you that your estimate of the value, v_i, is biased high relative to those of other bidders. Likewise by losing a bid indicates your valuation is less than that of competitors. Incorporation of the implications of the winners curse in the bidding strategy results in an adjustment in the bid to offset these effects.

An optimal bidding function for the bidder can be derived by maximizing π which results in a differential equation subject to a boundary condition. The results are an optimal bidding equation which is related to v_i, the valuation by bidder i. This forms the basis of a bidding strategy which depends on the probability assessment of others' valuation. In the case of COTs where cars (trains) are allocated to a certain number of bidders, m, over the minimum bid, the bidding strategy is to bid the expectation of the m^{th} highest bidder.

Auction price theory can be used to analyze the impacts of important variables on the outcome of the auction. Important variables include the variance of valuations, information by bidders, and the number of bidders. Each of these affects the competitiveness of the bidding process. A wide distribution in valuations, v_i, results is greater uncertainty and therefore greater profit for the winning bidder. Different bidders inevitably have different information; i.e., there is asymmetry of information, and this favors bidders with the most information.

A crucial variable is the number of bidders in the auction. As the number of bidders (i.e., n) increase, the β_i relative to its true value increase. Note that n is part of the bidders profit equation and affects the probability of a winning bid. As a result the optimal bid is adjusted by this probability. Essentially this means that increases in n results in greater competitive pressures in the bidding process. As n decreases the optimal bid decreases relative to its true value. In the extreme, if n=1, there is only one bidder, and the auction is essentially equivalent to a bilateral monopoly, i.e. bilateral bargaining. In this case the bidder bids the lowest possible valuation, or the reservation price. This is a bilateral negotiation process where the seller sets the reservation price and the bidder never bids more than the reservation price because of the lack of competitive pressures.

An important procedural aspect of auctions is the role and function of a minimum bid, or reservation price. An auction is an optimal selling mechanism so long as it is supplemented by optimal setting of a reservation price. An (optimally set) reservation price plays two important roles. One is to capture some of the informational rents that would otherwise go to the winning bidders. This is especially important in the case of COT auctions in which case the information to bidders may be asymmetric. Second is to preclude collusion amongst bidders which may be a potential problem, especially in repeated auctions. In the case where a small group of bidders compete over successive auctions, the possibility of signaling amongst bidders increases.

There are a number of alternatives in the discovery of prices for forward commitments. Two of these include 'posted rates' and bilateral contracts. These are alternatives to the auction mechanism described above and their operational implications are discussed here briefly. A posted rate basically is a tariff posted by the carrier which comprises a take-it-or-leave-it offer. The problem with this mechanism is that the carrier does not know the value of the service, and it is normally unlikely that rates would be set optimally. As a result there would likely be persistent shortages and surpluses. An alternative would entail continual experimentation in the rate by the carrier in attempts to equilibrate the market. This however is fairly imprecise and would result in rate uncertainty for shippers.[17]

Bilateral contracts were one of the prevailing means of price discovery and car (train) allocation which was practiced in the period of time following the Staggers Rail Act. Discovery of prices and contract terms for bilateral contracts takes the form of bilateral negotiation between each individual shipper and the carrier. There are several important points related to bilateral negotiation of contracts as a mechanism of price discovery and resource allocation. First, information plays a very important role. As discussed above a bilateral negotiation could be viewed as a bilateral auction (n=1) in which the party with the most information is favored. In practice typically the buyer has greater information regarding demand and market conditions for forward positions than does the seller. This is particularly true in the case of the export grain sales, and its effect is intensified as the size of the buyer increases. Thus, at least in principal, large buyers with more information have the potential to benefit more in bilateral negotiations. As the number of bidders in an auction increases, the profit for the informed bidder diminishes. The second point of importance is that in practice in order to provide the benefits of bilateral contracting it is essential to keep the terms confidential. Thus, the information is private, and as opposed to the COT program, market participants do not benefit from the information generated by the public dissemination of auction results for forward contracts.

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[17]Results of empirical studies have demonstrated that posted price mechanisms tended to converge slower than other pricing mechanisms, e.g., oral auctions or negotiated prices (Ketcham, Smith and Williams)

IV. CONCLUSIONS AND IMPLICATIONS

Since deregulation there have been important innovations in pricing of rail grain transportation. These have been in response to fundamental market conditions and the structure of the industry. The sole pricing mechanism prior to deregulation was a tariff, essentially a posted-price. In the early years after deregulation pricing evolved towards a proliferation of bilateral contracts. Terms of trade in these included performance requirements on both parties, as well as price, and were determined through a bilateral bargaining process. In general the fundamentals of this period coincided with slack demand and relative surpluses of equipment. While a number of rail firms continue use of contract rate mechanisms, recently others have introduced, or are considering, mechanisms which provide service guarantees. These are similar to priority pricing of services which have evolved in other industries in the post-regulation era. The most advanced is that of one railroad in which a forward market for grain transport service has been developed. Prices in this market are determined through a sealed-bid discriminatory auction. Contracts are standardized and negotiable, thereby facilitating development of a secondary market. The value of these contracts are determined relative to the standard tariff with deviations depending on spreads in the commodity market for different delivery locations, rates on alternative modes, and the probability of timely car placement for a standard tariff movement. Early trading of these contracts has resulted in prices within plus or minus 4% of the standard tariff.

Numerous issues surround the development of a forward market for grain transport. From a railroad perspective a rate auction can be viewed as a game which begins with a declaration of the number of cars to be allocated to each auction corridor for a given shipment period. Subsequently, there are weekly repeated auctions in which the seller sets a minimum bid. From a shipper perspective bids are formulated relative to the standard tariff, the latter having different terms of trade. Bid functions are derived by maximizing an expected payoff function. However, due to the design of the auction there is a strategic incentive for underbidding. From a regulatory perspective the tendency has likely been desireable to the extent that innovations are being introduced. The fact that these take the form of a priority service pricing mechanism could raise issues related to common carriage. However, given the car supply situation and heterogeneity of demand some type of mechanism must develop which improves allocation of existing capacity, and provide signals to carriers regarding the value of expanded capacity.

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