United States Department of Agriculture

Agricultural Marketing Service

December 2019

Measuring Rail Market Power in Wheat Transportation (Summary)

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This is a summary of “Measuring Rail Market Power in Wheat Transportation: An Econometric Market Level Analysis” by James Nolan and Chi Su, University of Saskatchewan, College of Agriculture and Bioresources, Department of Agricultural and Resource Economics.[1] This paper received funding from USDA’s Agricultural Marketing Service (AMS) through cooperative agreement number 17-TMTSD-SK-0008. The opinions and conclusions expressed are the authors’ and do not necessarily represent the views of USDA or AMS. The full report is available online at https://ageconsearch.umn.edu/record/292343.

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WHAT IS THE ISSUE?

Railroads are a critical transportation mode for the movement of U.S. agricultural commodities. For wheat, rail is often the only viable mode within the agriculturally productive but landlocked Plains region. Intermodal transportation competition in moving wheat is limited by long distances from key production regions and alternative freight transportation (e.g., barge transportation). In addition, the distances to end markets and large shipment volumes often render truck transportation too costly for wheat.

Competition is an important tenet of rail transportation policy in the U.S., and its impacts (and, likewise, the effects of no competition) are well documented in academic literature. [2] At one end of the spectrum, a single (monopoly) railroad exerts market power by increasing rates and restricting output.[3] At the other end of the spectrum, several firms in proximity to each other tend to compete, which results in reduced rates and increased output.

However, the economic literature is not as clear about mid-spectrum cases—for example, the situation of "rail duopolies" where shippers have access to just two major railroads (and no viable alternative modes). Careful analysis can help illuminate the extent to which duopoly railroads will compete with each other (benefiting shippers) or choose not to compete (benefiting themselves and each other).[4]

To shed light on this issue with respect to U.S. wheat transportation, the researchers examined the regional-level market structure in two separate, high-volume wheat transportation corridors served by a rail duopoly. These were (1) wheat moving from North Dakota to Minnesota and (2) wheat moving from Kansas/Oklahoma to Texas. These three origin States—North Dakota, Kansas, and Oklahoma—account for over 40 percent of the Nation's wheat acreage.

This study has several advantages over previous studies that have analyzed rail market power in bulk transportation. It examines the nature of competition at a "corridor level," where most of the previous work has been done at a national level. Moreover, much of the prior research on rail market power relied on estimated railroad (marginal) costs, which are themselves unreliable and, in turn, generate questionable assessments of actual railroad market power. Mindful of this issue, this paper applied three statistical methods to more accurately discern the nature of competition.

At the national level, railroads often appear competitive. Because any exertion of market power by a railroad would most likely occur in local or regional markets, this study focused on two specific regional markets with limited intramodal and intermodal competition—the wheat rail corridors from North Dakota to Minnesota and from Kansas/Oklahoma to Texas, from 2005-2015.

[2] 49 U.S. Code § 10101.Rail transportation policy.

[3] White offers a basic definition of market power: "it expresses the extent to which the firm has discretion over the price that it charges" (2012).

[4] More formally, the theory of industrial organization suggests two firms operating in a duopoly will find themselves in three potential market power scenarios: (1) collusive (not competitive); (2) Cournot (moderate level of competition); or (3) Bertrand (fully competitive). A collusive market structure involves a situation where implicit or explicit operational agreements might be made between the two firms, who then "behave in an essentially monopolistic way" (Bishop, 1960). Cournot competition represents the vast middle ground on the market power spectrum under duopoly. Cournot competition generally prevails when the private costs of the other firm are unknown (Gal-Or, 1986). Finally, under Bertrand competition, both firms are assumed to have acquired knowledge about costs of the other firm (Gal-Or, 1986). This knowledge means that the firms can expect the other to drop market price to the point of zero economic profitability (i.e. marginal cost) in order to maintain their market share.

HOW WAS THE STUDY CONDUCTED?

To assess rail market power for the two wheat corridors, the researchers developed and applied three statistical models to compare market prices to firm costs and observe any markups. In markets with many firms, competition drives price down to marginal cost (the cost of an additional unit), or zero markup. In this scenario, firms earns just enough to stay in business. In contrast, in markets with few firms or even a single firm, price may include a markup that provides excessive profits. Differences between price and (marginal) cost are therefore a proxy for the degree of competition in any given market, where higher markups correspond to less competition and more market power.[5]

The first model used a multi-equation, two-stage least squares (2SLS) specification, a method frequently used in market power research. The value of this model is in accounting for the fact that rail market prices and quantities are determined by both demand and supply simultaneously. The 2SLS model helps to differentiate the demand curve from the supply curve. Moreover, because this model is used frequently by economists, it provides a benchmark to compare to other studies and to the other models developed in the paper.

Although the methodology in the first model has been used to estimate market power across many industries, some researchers have indicated it may generate inconsistent market power estimates across time.[6] Treating the 2SLS as a baseline, the researchers constructed two additional models to examine the issue further.

The second and third models fall within a broader class of statistical models called "latent variable models." With a latent variable model, the goal is to estimate an important variable that is either unobserved or poorly measured. In this case, the latent variable is the level of competition in the market. The two different latent variable models derive from two slightly different underlying constructs about what determines firm behavior and the degree of rail competition in each market.

The construct for the first latent variable model assumes the duopoly firm's choice to cooperate or compete in the market depends on how the other firm makes similar decisions and how it has made such decisions in the past. Economists use game theory to understand these types of interactions. In this theory, both firms maximize total profits if they both choose to cooperate (or not compete) on rates and quantity. Conversely, the firms make the least total profit if they both choose to compete on rates and quantity (noting that this is the best case for the shipper and market efficiency). In theory, each firm would, therefore, like not to compete with the other in order to have higher profits, but this requires them to "trust" (without directly communicating[7,8]) that the other firm is operating with a similar strategy. The "catch" is that each firm has an incentive to compete if it thinks the other firm is not competing, because the competing firm will do better on its own in this situation.

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[5] More technically, the models estimate the slope of the demand curve, which is related to the price markup, since marginal costs can be difficult to estimate directly.

[6] For instance, 2SLS assumes (1) no changes in demand elasticity over different periods and business cycles, and (2) no changes in market structure over the data series.

[7] A classic example of this is known as the "prisoner's dilemma." The story goes something like this: two individuals, A and B, have been apprehended for a crime and are separated by the interrogator (i.e., A and B cannot communicate with each other). If A and B remain silent (cooperate or not compete), each receives 1 year in prison. If A and B both confess, each serves 2 years in prison. If A betrays B while B remains silent (A competes when B cooperates), A goes free and B serves 3 years in prison (and vice versa). The "dilemma" stems from the fact that each has an incentive to compete, which results in the 2-year sentence for each, when the first outcome would be collectively more desirable.

[8] Such a game does not imply actors are explicitly communicating to not compete, only that each may tacitly refrain from "bidding wars."

The predicted outcome in theory for a “game” like this depends on whether the interaction happens just once or if it is repeated over time. In the simple, one-shot model, the predicted outcome is that firms end up competing. However, when the interaction is repeated over time indefinitely, the predicted outcomes are much more complicated and open ended, likely including both periods of cooperation and periods of competition. The complexity of the interactions further motivates the need for careful data analysis.

With this theory in mind, the first of the latent variable models accounts for these kinds of interactions over time and is known as a Hidden Markov Model (HMM). The Markov specification is designed to capture the repeated nature of firms’ choice to compete or not compete through time. To illustrate, a basic Markov model (with no hidden variables) consists of “states” (i.e., “competitive” or “non-competitive”) and probabilities of transition between the states over time. The probability of transitioning to a new state (or staying in the same state) in the next time period depends only on the current state. For example, consider two states of weather, “sunny” and “rainy.” A standard Markov model would allow a forecaster to predict the weather (state) in a future period by observing the frequencies of transitions between the states of sunny and rainy. For instance, it might be that a sunny day precedes a sunny day 85 percent of the time but precedes a rainy day 15 percent of the time. Alternatively, with a rainy day, another rainy day might follow 50 percent of the time or be sunny the other 50 percent. If states of weather were tracked over time, a Markov model could be used to estimate the probability of transition (e.g., from a sunny day to a rainy day) and predict tomorrow’s weather based solely on today’s weather.

In an example germane to this analysis, imagine a hypothetical situation where one knew or could directly observe the state of market structure (i.e., could identify the state of the duopoly market as “competitive” or “non-competitive”). If this were the case—where the states and frequencies between those states are observable—a basic Markov model could be used to estimate the probability of moving to a competitive state from a non-competitive one (or vice versa), or the probability of staying in a competitive state (or a non-competitive state), by examining the frequencies with which those transitions occurred.

The difficulty faced in the example, compared to monitoring the weather, is that market structure cannot be directly observed. Firms privately decide whether they will compete or not, or do something in between, and only the outcomes from their actions can be observed. Continuing the weather example, the firms' decision process is like trying to guess the weather without looking outside, only at whether people are carrying umbrellas or wearing sunglasses. This is why the HMM is required to identify market structure over each time period—because the states are masked or hidden. HMM relies on revealed outcomes (i.e., firm and market data) to infer the actual (hidden) state of market behavior.

The third model is called a finite mixture regression (FMR). The FMR is similar to the HMM model. It is also a latent variable model but, in contrast, drops the Markov time component. The construct for the FMR model focuses on probabilistically grouping the data into three periods of either fully competitive, somewhat competitive, or non-competitive behavior.

Dropping the time element from the model enables the authors to add data on elevator capacity. Elevator capacity data are likely relevant to the rail pricing decision and should be included in the models. However, the data are only a snapshot and are not available over time. The data also are not available for the North Dakota to Minnesota corridor. Given the need to include the data but accepting their limitations, the FMR model was used to compare with the 2SLS and HMM results for the Kansas/Oklahoma corridor only.

WHAT DID THE STUDY FIND?

The nature of a duopoly market is inherently complex, making it difficult to identify whether the two firms are acting competitively or noncompetitively. The duopoly markets examined in this study were true to this pattern, and the results were somewhat mixed. From 2005 to 2015:

- Both rail corridors tended to operate in a limited competitive state, neither fully competitive nor in a state of no competition.
- The wheat rail corridor from Kansas/Oklahoma to Texas was generally more competitive than the corridor from North Dakota to Minnesota.
- The North Dakota corridor was somewhat more competitive than the Kansas/Oklahoma corridor in the 2SLS model, but the results were reversed in the HMM model, as would be expected given the presence of some barge competition.
- The average market conduct parameter—a measure of market power ranging from 0 percent (fully competitive) to 100 percent (fully uncompetitive)—was 36 percent for North Dakota in the 2SLS and 61 percent in the HMM, compared to Kansas/Oklahoma, which averaged 60 and 29 percent, respectively.
- The presence of a possible waterway alternative (the McClellan–Kerr Arkansas River Navigation System) for the Kansas/Oklahoma corridor may be a factor behind the differences observed between corridors.
- It may also partially explain differences within the Kansas/Oklahoma corridor, particularly for the HMM results, which saw a peak in market power between 2008 and 2011 and in 2015. These peaks correspond to reduced levels of wheat handled by the Port of Catoosa, the first port on the navigable portion of the Arkansas River. Port volumes are affected by a variety of factors, such as the availability of local supplies, river conditions, and demand. For example, in 2015, shippers on the Arkansas River faced significant flooding and adverse navigation conditions, which likely impacted the amount of wheat handled by the Port.

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ATTRIBUTION

Preferred citation:
Caffarelli, P. and J. Gastelle. *Measuring Rail Market Power in Wheat Transportation* (Summary). U.S. Department of Agriculture, Agricultural Marketing Service. December 2019. Web. <http://dx.doi.org/10.9752/TS240.12-2019>

Editor:
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