Determinants of Price in Sales of Railroad Rights-of-Way
to Public Transportation Agencies

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By L. Shughart, A. Matsuda, and M. Hasan

Charles River Associates
200 Clarendon St., T-33
Boston, MA 02116
www.crai.com
ABSTRACT: Since the United States government deregulated railroads in 1980, a number of privately held, domestic freight railroad rights-of-way have been sold to public agencies for continued or planned use as dedicated passenger corridors, including commuter rail, transit, or high-speed rail. In some cases, these corridors continue to operate for mixed-use freight and passenger transport. This paper describes our attempt to build a generalized model accounting for the wide range of observed prices for these rights-of-way transactions. Transaction price may be explained by a variety of detailed factors, grouped into categories such as the physical attributes of the corridors, the corridors’ context and surroundings, and the economic context of the transactions. This study summarizes relevant transactions from the last 25 years and identifies factors potentially affecting transaction value. Using data from these sales, we develop a model to isolate and quantify the effect of some of the candidate factors on rail corridor right-of-way transaction values.

Introduction

Since the United States government deregulated railroads in 1980, a number of privately held, freight railroad rights-of-way in the United States have been sold to public agencies for continued or planned use as dedicated passenger corridors, including commuter rail, transit, or high-speed rail. In some cases, these corridors continue to operate for mixed-use freight and passenger transport. A quick review of such transactions reveals that the prices paid for these rights-of-way can range from $0.3 million to almost $6.3 million per mile.\(^1\) Naturally, the broad range of prices that we observe raises questions about the factors driving transaction value. A better understanding of the determinants of rights-of-way prices would assist both public agencies planning new services and railroads contemplating sales of rights-of-way. This paper describes our attempt to build a generalized model accounting for the wide range of observed prices for these rights-of-way transactions.

Transaction price may be explained by a variety of detailed factors, grouped into categories such as the physical attributes of the corridor, the opportunity costs to the seller, the rules governing the ongoing relationship between corridor owners and tenant operators, regional economic statistics, and the financial structure of the transaction. This study summarizes relevant transactions from the last 25 years, and identifies factors potentially affecting transaction value.

\(^1\) These prices are expressed in 2004 dollars using the Producer Price Index for line-haul railroads. See footnote 18.
Using data from these sales, we develop a model to isolate and quantify the effect of some of the candidate factors on rail corridor right-of-way transaction values.

Past work that may be relevant to this topic has focused on the qualitative evaluation of utility and transportation corridors, the valuation of entire railroad companies, and the impact of transit development on surrounding real estate values. To the best of our knowledge, and based on our review of the available literature, our study is the first formal attempt to explain, econometrically, the influences on prices for specific rail corridor rights-of-way for transactions involving a private seller and a public buyer.

This work will have direct relevance in providing first-order value estimations for potential, similar conveyances of North American railroad corridors. Outside North America, an increasing number of publicly owned railroad rights-of-way have undergone restructuring ranging from full privatization to public-private partnerships to the tendering of multiple operating concessions. This study is also relevant to international transactions in that the same inventory of price drivers no-doubt influence similar transactions outside of North America.

In the next section, we review published articles related to corridor valuation. Following the literature review, we describe the data underlying our valuation model. First, we list the various determinants of transaction value and the criteria used to assemble our database of corridor transaction cases. Second, we summarize the historical facts associated with each of the transaction cases in our database. We devote the final section of the paper to describing our model structure and the implications of the model results. We conclude with a discussion of potential applications of this work and suggestions for future enhancements to the model.

**Literature Review**

Our review of the literature on rail corridor valuation uncovers a number of articles dealing with the nature of corridors, corridor uses, ownership, and the art of appraising corridors. Based on our review of the available literature, we understand that there has been no systematic attempt to econometrically explain the drivers of price across a series of corridor rights-of-way transactions.
Cervero employs an econometric analysis to analyze urban rail-related development programs and the resulting impacts on site rents.\(^2\) Using multiple regression analysis for isolating the effects of rail transit from other factors, he quantifies the changes in property values and local real estate market conditions attributable to the presence of rail transit. However, his study does not specifically address railway corridor valuation.

During the 1970s the concept of net liquidation value, which includes the premise that the highest and best use of rail rights-of-way is for non-rail purposes, dominated the area of rail right-of-way valuation. Many eastern railroad companies were in bankruptcy at that time. To preserve a semblance of rail service across these companies, the United States Congress enacted the Regional Rail Reorganization Act of 1973, created Conrail, and required the bankrupt railroads to transfer their properties, including rights-of-way, to the new entity. “The Rail Act” also set up a special court and charged it with the mission of awarding constitutionally adequate compensation to the owners of the transferred properties. The rights-of-way of many bankrupt railroads were conveyed to Conrail, and later, in 1976, to Amtrak, using legislatively and administratively defined concepts rather than market value concepts. The special court was required to explore the basic valuation issues regarding the transfer of rights-of-way by the Penn Central, Erie Lackawanna, Reading, Lehigh Valley, Central of New Jersey, Ann Arbor, and other railroads. Perlik \textit{et al.} briefly outlines the theories of the valuation of rights-of-way produced by this exhaustive inquiry conducted by the special court.\(^3\)

Most of the available articles describe qualitative methodologies of valuation for different kinds of corridors: corridors where operations are continued versus abandoned corridors versus corridors with alternate uses. A good overall discussion covering a variety of issues relating to railroad right-of-way valuation can be found in Beetle, where he describes the definition and


measurement of economic value associated with the use of railroad rights-of-way. The article summarizes the general principles of valuation, types of valuation issues that may arise, the range of complexities each issue can present, and some of the perspectives that can assist in dealing with the various issues.

In the 1970s, when corridor appraisal methods were still in their infancy, Dolman et al. described three corridor appraisal methodologies. These include the at-the-fence (ATF) value; the value for non-corridor use, which he views as the lower limit; and the value for corridor use, which he views as the upper limit.

During the 1980s, Clifford A. Zoll published a series of articles describing appraisal methods of rail corridors with actual transaction examples. His earliest publication presents an analysis of actual sales in an effort to set forth factual data that may be useful in appraising and marketing rail corridors. In another article, Zoll analyzes seller and buyer motives and the resulting three markets for rail corridors. He uses examples to examine the distinguishing factors in corridor sales, specifically reviewing the relationship of sale price to ATF value as a guide for developing fair market unit price. In follow-up articles, Zoll details the step-by-step procedures of valuation of land for railway corridors, and again uses a cost approach in the valuation of railway corridor land based upon sales comparisons.

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8 Ibid.
Ackelson et al. suggests using the ATF value and net liquidation value as the upper and lower limits, respectively, for corridor valuations.\(^{11}\)

Valentine points out that appraising a transportation corridor requires understanding definitions of certain fundamental terminology, being aware of potential corridor uses, knowing which interest was to be appraised, determining the purpose of the appraisal, defining the subject area, and arriving at its highest and best use.\(^{12}\) Valentine first suggests that a corridor might be worth more or less by dividing it into several parcels for liquidation. He describes six appraisal methods: replacement cost less depreciation, corridor value, sales comparison, ATF value, net liquidation value, and going-concern value.

Seymour suggests that the cost and income approaches of corridor appraisal do not work and recommends the use of the sales comparison approach.\(^{13}\) Seymour also concludes that estimates of corridor values using the ATF value, in conjunction with an enhancement-factor-methodology, appear consistent with market actions.

Attention has also been given to the valuation of abandoned railroad rights-of-way. Blackard provides a detailed description of the appraisal of abandoned railroad rights-of-way, placing special emphasis on three items in the appraisal: the type of title owned by the railroad, the highest and best use of the property, and the approaches to value to be used.\(^{14}\)

In Ontario, Canada, an inter-ministerial committee reviewed some 2,800 kilometers of abandoned rail corridors. The committee recommended acquisition of those corridors deemed to be in public interest. Gorys et al. describe the process by which one such line was acquired.\(^{15}\)

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They detail the issues associated with abandoned rail rights-of-way, outline the committee’s activities, and identify how the appraised value for the rail properties was ascertained.

Antonides describes three methods for estimating the net salvage value of abandoned rail corridors under the Canada Transportation Act process. These methods consist of the direct comparison approach to value, the application of a discount factor to the ATF value, and the completion of a detailed “breakup analysis” of the corridor.

In 2003, the authors had occasion to assist the Province of British Columbia in the restructuring of BC Rail in which Canadian National acquired the former company’s operations. As part of the exercise, the authors developed an econometric valuation model of short line and regional railroad sales. The amount paid for a railroad property was determined by the cost function of the operations, the revenue generated by the operations, and the selling company’s operating ratio in the year prior to the sale. The sales examined in the BC Rail study were different from the cases described in this paper in that the short line and regional railroads were sold as going-concern freight operations. However, the importance of a selling railroad’s financial health, as measured by operating ratio in the year prior to a transaction, may be relevant to this study.

In the sections that follow, we build on this body of past work by describing our approach to developing an appropriate set of potential price factors, building a database of historical rail corridor transactions and their key quantifiable attributes, and constructing a cross-sectional econometric model to account for the values ascribed to such transactions.

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Determinants of Transaction Value

*Transaction Price* serves as the endogenous variable, which we adjust for inflation by converting values to 1984 dollars using the Producer Price Index for line-haul railroads.\(^\text{18}\) We also calculate the price per corridor mile for each transaction as a possible substitute for the dependent variable.

The value of a particular rail corridor is likely to be determined by a variety of factors, some of which include the physical attributes of the corridor or the description of the acquired assets. Other factors describe the characteristics of the corridor’s surroundings such as the socioeconomic attributes of the geography immediately adjacent to the corridor as well as the characteristics of the region served by the corridor. Value may also be a function of the terms of a transaction including the financing structures employed, the rules governing the ongoing relationship between the corridor owner and seller in those cases where the corridor will serve both passenger and freight trains, and the duration of the contract or lease.

Expected changes in the real estate market and the general economic trends may also enhance or depress a transaction price. Consequently, in defining a specific set of variables to consider in our model, we attempt to examine statistics representative of conditions at the time of the sale, as well as participants’ forecasts and expectations.

Finally, buyer and seller characteristics may be important drivers of transaction value. In some cases, the seller may be anxious to sell a property to offset a downturn in operating income, or to forego a capital renewal. In other cases, the seller may not have duplicate routes that are near substitutes, or the alternative routes may require significant capital improvement to absorb the traffic diverted from the route to be sold. Likewise, certain buyer characteristics will determine the purchaser’s willingness and ability to pay. Examples of buyer characteristics that may affect transaction value include the size and financial health of the public agency making the purchase and the degree of public support for the endeavor.

In addition, both the buyer’s and seller’s evaluation of a transaction will reflect future expectations. For example, the seller may view the corridor as a critical ingredient to accessing potential new markets in the future. The buyer may seek to introduce passenger train service as a way to remediate forecasted traffic congestion in the region or as part of a larger economic redevelopment effort.

Analysts often use bargaining models to capture the effects of buyer and seller characteristics on the value of transactions. However, the uniqueness of freight railroad rights-of-way prevents us from using bargaining theory in this study. Bargaining theory assumes that both the buyer and seller have a good understanding of their respective utility functions; government buyers’ utility functions are particularly difficult to define in that the utility resulting from a transaction is largely manifested by the value of the commodity as a public good at some future point in time. The scope of this paper does not encompass estimating the user and nonuser benefits of some future public transportation corridor as would be required by a bargaining theory approach.

Bargaining theory also relies on the premise that buyers and sellers comprehend the true value created by the transaction and the market price for the commodity. We assert that public agencies and freight railroads involved in right-of-way sales are not confident in their understandings of the value propositions, and that the market value of the assets cannot be clearly observed as the market is not defined by competitive dynamics. The list of options for a public agency—purchase the corridor, risk having it sold for alternative uses, or risk having it broken up and sold as real estate—is not a particularly robust set of choice alternatives, especially when a desired corridor is unique in its location and regional connectivity. Additionally, a selling freight railroad may perceive that alternative private purchasers are not willing to pay as much for the corridor as a public transportation entity would pay. Private buyers such as communications and utility companies have a broader range of options such as choosing corridors that route around urban centers or accessing rail corridors as tenants in mixed-use situations, thus lowering overall cost.

Consequently, while we recognize the potential influence of buyer and seller characteristics and the value of bargaining theory in evaluating certain types of transactions, we restrict our
approach to developing a linear, multivariate regression model. The overall objective of this paper is to identify and quantify the importance of the candidate factors described in the following lists to better inform future buyers and sellers.

**Corridor Physical Attributes**

Many of the transactions we examine comprise a collection of properties and assets. In this paper, we use the term “corridor” to refer to this general collection of assets in the transaction. Within each corridor, some sections may have no track, one track, or multiple tracks. Consequently, we differentiate between “track miles” and “route miles” for purchased track. Some of the transactions include the purchase of “trackage rights” whereby the selling railroad grants the purchasing agency permission to operate passenger trains on tracks retained by the freight railroad and connected either to tracks that the agency is purchasing or to tracks on which the agency already has trackage rights. We define these attributes and the related variables below.

*Corridor Length* is an obvious physical attribute that will determine the sale price of property. While most real estate deals consider such attributes as land area, frontage, and zoning, corridors are typically measured in length and width. One would expect longer corridors to be more valuable than shorter corridors, on both an absolute and a per-mile basis. Corridor length comprises segments of purchased route, purchased open corridor, and trackage rights.

*Corridor Width*, together with corridor length, determines the land area encompassed in a transaction. While a corridor 100 miles long and 50 feet wide has the same land area as a corridor 50 miles long and 100 feet wide, the two parcels would be valued differently. A wider right-of-way provides more flexibility for future track expansion. In very busy corridors, it is typically desirable to assign freight and passenger operations to different tracks. Some rights-of-way are wide enough for the construction of passenger stations and/or platforms. Finally, wider spaces enable maintenance-of-way teams to construct proper drainage facilities, access roads, and support infrastructure for overpasses.

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19 Data for exact corridor width are not available for all track segments for all transactions. When the data are absent, we use a default value of 100 feet.
**Purchased Acres** represents the land associated with purchased routes (*Corridor Acres*) as well as non-corridor land also purchased in the transactions (*Out-Parcel Acres*). A number of the transactions in the dataset include out-parcels, some of which may have been used for storage space, terminals, and other ancillary uses.\(^{20}\) Out-parcels may be adjacent to the main corridor and may be used for parking lots, stations, and green space, or land-banked for future development.

*Number of Tracks* can be thought of as the measure of improvement on the corridor. Track infrastructure is a relatively expensive asset. New crossties cost approximately $50 each to install, or about $175,000 per mile. New rail can cost in excess of $100,000 per mile. Including the cost of ballast, surfacing, switches, and signals, one mile of new track can easily exceed $500,000 in cost. Double track and sidings provide increased operating flexibility and increased throughput capacity by enabling trains to meet and pass one another. A particular corridor may not be entirely single-track or entirely double-track. In those cases where track and route were previously abandoned and the purchasing agency is only acquiring the right-of-way, the number of tracks is set to zero. Data for the number of tracks are listed uniquely for routes that the public agency is purchasing and routes for which the agency is purchasing trackage rights.

*Purchased Route Miles* is the route mileage of the corridor segments of which the purchasing agency takes ownership as a result of the transaction. We assume that when the track is purchased, the underlying real estate of the right-of-way is included.

*Trackage Route Miles* is the route mileage of the corridor segments over which the purchasing agency gains the right to operate.

In a transaction, *Continued Freight Rights* may be granted to a selling railroad by the purchasing agency. In observations where some of the corridor is purchased, we list a zero or one for continued freight rights to account for the potential influence on transaction price. In cases

\(^{20}\) As discussed later in the paper, the prices of some multiple-corridor transactions can be divided into identifiable components. However, data for certain variables are not consistently available for these “sub-transactions.” As such, we distribute out-parcel acreage and values for other variables as needed to the sub-transactions on a weighted basis using corridor miles.
where a corridor contains multiple routes and where the agency does not grant rights universally within the set of purchased routes, we list the value corresponding to the majority of the route miles for the corridor. Continuing freight rights pose a burden on the purchasing agency in that the new passenger operator must allocate track time to tenant freight trains, constraining the available time to run passenger trains and perform track maintenance. In addition, the presence of freight trains may raise the risk profile of the passenger operation, require additional training and staffing, and increase track deterioration because of the heavier loads. On the other hand, the public agency benefits, as the freight operators will likely provide compensation either by discounting the initial purchase price or by offering a per-car usage fee. The offsetting revenue to the agency may cause this variable to have a positive effect on transaction price.

Track condition is likely to affect the value of any rail corridor. To represent track condition, we obtain values of Traffic Density for routes handling traffic at the time of transaction. These values are extracted from the National Transportation Atlas Database (NTAD), which contains information on all railroad routes in the United States, including a density attribute ranging between 0 and 7.\(^{21}\)

The signal condition of track can vary from having state-of-the-art systems in place to not being signaled at all. In our dataset, we include the binary variable Purchased Signals.\(^{22}\) A zero represents a non-signaled corridor and a one represents a corridor with any type of operational signal system.\(^{23}\) While advanced signaling of a corridor may enable faster start-up of passenger operations, signaling systems also significantly raise the ongoing maintenance costs of the route. The signals themselves require sophisticated labor and expensive parts. In addition, the existence of a signaling system complicates routine maintenance of track and highway-crossing.

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\(^{21}\) Data availability considerations require us to use density levels as determined by the number of gross ton-miles per mile in the 2002 NTAD. We use this version of NTAD as a data source for other variables as explained in this section. See http://www.bts.gov/programs/geographic_information_services/download_sites/ntad02/metadata/Rail100k.htm.

\(^{22}\) We would expect the signal condition of purchased trackage rights track to influence transaction price as well. However, as the trackage rights routes included in the transactions in our dataset are all signaled, we do not include signalized trackage rights track as an explanatory variable in addition to trackage rights track.

\(^{23}\) For corridors in which track is purchased, we use NTAD’s signal attribute flags. MAN, TTO, and no signaling yield a zero value for the signal variables, whereas CTC, ABS, ACS, ATS, and ATC all yield a value of one.
protection circuitry, and requires additional communications and power infrastructure. Thus, the effect of a signal system on transaction price may be positive or negative.

In our research efforts, we attempted to quantify other corridor and transaction attributes, such as the number of “equivalent” alternate routes for the selling railroad; the condition of track as represented by the type of passenger service previously permitted; the number of rail bridges, highway/rail fly-overs below standard height, and highway/rail grade crossings; the ongoing track maintenance agreement between the railroad and the public agency; the capital upgrade agreement; and the length and type of the transaction agreement. Data for these attributes were not available for each observation, nor were the available data sufficiently detailed. We anticipate that these corridor and transaction characteristics may have some impact on transaction price. For example, a selling railroad may often be motivated to sell a line segment to preclude spending significant capital dollars on rebuilding a bridge.\textsuperscript{24} For the analysis represented in this paper, we restrict the scope of physical corridor attribute factors to include only those variables, and any appropriate combinations and derivations, explicitly listed in the preceding paragraphs.

**Corridor Context and Surroundings**

In addition to the dimensional and operational characteristics of a corridor, the geography and surroundings of any given track will affect its value. Some corridors may lie in urban areas of high population density where demand for existing and non-existing public transportation is significant. Others may run through areas where adjacent real estate is unusually high and where there are numerous non-transportation uses for the corridors. We attempt to capture these “external” factors with the variables discussed in this section.

*Population Density* is calculated using the 2000 census data at the census tract level (high).\textsuperscript{25} We use a geographic information system platform to define a geographic band extending one mile around each of the corridors. In effect, we calculate the average population per square mile of a two-mile-wide area extending one mile beyond each end of a corridor’s endpoints.

\textsuperscript{24} Interview with Jim Derwin, former CSXT Assistant Vice President Plant Rationalization (retired), July 13, 2004.

\textsuperscript{25} Interview with Jim Derwin, former CSXT Assistant Vice President Plant Rationalization (retired), July 13, 2004.
Exhibit 1 shows an example of a corridor with the two-mile-wide area shaded. Each dot represents 250 residents.

Exhibit 1. Population Band

Relative Value of Real Estate is calculated using median home prices provided by the 2000 census. Using a similar process to the one for deriving population density, we calculate a weighted (by square miles) average median home price for one-mile geographic bands around each corridor. We also convert the values into 1984 dollars, using the Consumer Price Index for housing. We understand that this variable for real estate value has some limitations, as it represents the price of the real estate beneath a home and the physical structure of the home itself. For example, while the value of a home’s structure varies somewhat predictably with the quality of the building materials, the fluctuations in the corresponding materials markets, and the dimensions of the home, the value of the underlying real estate may vary quite wildly in

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25 These data were extracted from census databases utilized by Caliper software packages.
26 This corridor corresponds to the first observation in the dataset, included as Exhibit 3.
comparison, as a result of more elusive factors. Thus, we may be limited in knowing whether the
effect of a one-unit increase/decrease in the real estate variable is more closely linked to changes
in the value of the land than to changes in the building costs of the structure.

**Economic Context**

There may be economic pressures influencing the decision-making processes of transaction
participants. For example, during times when a railroad company is not performing well
financially, shedding under- or non-utilized assets is a quick way to generate cash while at the
same time reducing maintenance liabilities. Strained financial conditions generally may result
from a company’s operational problems or marketing dynamics, or from macroeconomic
downturns unrelated to specific company decisions. We predict that during periods of financial
hardship, railroad companies may be willing to accept a lower price in a transaction relative to
what might be realized for the same corridor during periods of strong financial performance.

Other economic contextual variables possibly affecting a transaction correspond to the relative
difficulty or ease that the buyer has in securing financing, the relative health of the public
agency’s budget, and the expectations for revenues from both continued freight operations and/or
new passenger operations. For the purposes of this paper, we restrict the set of factors
representing economic context to only those variables presented here.

Quarterly GDP growth provides some indication of the direction of economic growth in the
United States. We include in our dataset a variable representing five-quarter *Rolling GDP
Growth*, calculated by averaging the GDP growth values for the transaction quarter and the four
previous quarters.28

*Operating Ratio* for railroads is defined as \((\text{Operating Revenue} - \text{Operating Income}) \div \text{Operating Revenue}\). Operating ratios at or below 80 percent typically indicate that a railroad is in good
financial health. With a lower ratio, a railroad can devote more resources to maintaining tracks

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28 Specific dates (month and day) are unavailable for some transactions. In these cases, we use a default date of the
third quarter in the year listed.
and developing new business opportunities. We include data for this variable for the transaction year as well as for one year before.

Exhibit 2 summarizes the variables we consider in developing our model, any relationships they have to one another, the general source of the data, and the taxonomy we define for structuring our model.

Exhibit 2. Summary of Transaction Attributes Considered in Model Development

<table>
<thead>
<tr>
<th>Attribute / Variable</th>
<th>Label</th>
<th>Definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Corridor Physical Attributes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transaction price *</td>
<td>price</td>
<td>Transaction price in $ millions (1984 dollars)</td>
<td>Multiple **</td>
</tr>
<tr>
<td>Corridor length</td>
<td>length</td>
<td>Length of the corridor(s) in miles</td>
<td>Multiple</td>
</tr>
<tr>
<td>Corridor width</td>
<td>width</td>
<td>Average width of the corridor(s) in miles</td>
<td>Multiple, industry average</td>
</tr>
<tr>
<td>Purchased corridor acres</td>
<td>p_corr_acres</td>
<td>Purchased right-of-way acres</td>
<td>Multiple</td>
</tr>
<tr>
<td>Purchased out-parcel acres</td>
<td>p_out_acres</td>
<td>Purchased out-parcel acres</td>
<td>Multiple</td>
</tr>
<tr>
<td>Number of purchased tracks</td>
<td>p_num_tracks</td>
<td>Average number of tracks on the purchased routes</td>
<td>Multiple, NTAD</td>
</tr>
<tr>
<td>Number of trackage rights tracks</td>
<td>t_num_tracks</td>
<td>Average number of tracks on the trackage rights routes</td>
<td>Multiple, NTAD</td>
</tr>
<tr>
<td>Purchased route miles</td>
<td>p_route</td>
<td>Length of purchased track in route miles</td>
<td>Multiple, NTAD</td>
</tr>
<tr>
<td>Trackage route miles</td>
<td>t_route</td>
<td>Length of trackage rights track in route miles</td>
<td>Multiple, NTAD</td>
</tr>
<tr>
<td>Continued freight rights</td>
<td>rights</td>
<td>Binary index for continued freight rights on purchased track</td>
<td>Multiple</td>
</tr>
<tr>
<td>Traffic density</td>
<td>density</td>
<td>Index for gross ton miles per mile for purchased and trackage rights track</td>
<td>Multiple, NTAD</td>
</tr>
<tr>
<td>Purchased signals</td>
<td>p_signal</td>
<td>Binary index for signaled purchased track</td>
<td>NTAD</td>
</tr>
<tr>
<td><strong>Corridor Context and Surroundings</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population density per acre</td>
<td>pop</td>
<td>Weighted average population density of a one-mile band around the corridor(s)</td>
<td>CRA using 2000 census</td>
</tr>
<tr>
<td>Relative value of homes</td>
<td>home</td>
<td>Weighted average median value of owner-occupied homes within a one-mile band around the corridor(s) in $ millions (1984 dollars)</td>
<td>CRA using 2000 census</td>
</tr>
<tr>
<td><strong>Economic Context</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating ratio</td>
<td>op_ratio</td>
<td>Annual operating ratio of the selling railroad for the transaction year</td>
<td>Multiple</td>
</tr>
<tr>
<td>Operating ratio of previous year</td>
<td>op_ratio_prev</td>
<td>Annual operating ratio of the selling railroad for the year prior to the transaction</td>
<td>Multiple</td>
</tr>
<tr>
<td>Rolling GDP growth</td>
<td>gdp_r_5</td>
<td>Average growth in GDP of the transaction quarter and the four previous quarters</td>
<td>CRA using BEA National Economic Accounts</td>
</tr>
<tr>
<td><strong>Combined</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transaction price per mile ***</td>
<td>price_mile</td>
<td>= price / length</td>
<td></td>
</tr>
<tr>
<td>Total purchased acres</td>
<td>p_tot_acres</td>
<td>= p_corr_acres + p_out_acres</td>
<td></td>
</tr>
<tr>
<td>Purchased route corridor area</td>
<td>p_route_area</td>
<td>= p_route * width;</td>
<td></td>
</tr>
<tr>
<td>Purchased track miles</td>
<td>p_track</td>
<td>= p_route * p_num_tracks</td>
<td></td>
</tr>
<tr>
<td>Purchased track rights miles</td>
<td>p_track_rights</td>
<td>= p_track * rights</td>
<td></td>
</tr>
<tr>
<td>Purchased route density miles</td>
<td>p_route_density</td>
<td>= p_route * density</td>
<td></td>
</tr>
<tr>
<td>Purchased signaled route miles</td>
<td>p_route_sig</td>
<td>= p_route * p_signal</td>
<td></td>
</tr>
<tr>
<td>Purchased route population index</td>
<td>p_route_pop</td>
<td>= p_route * pop</td>
<td></td>
</tr>
<tr>
<td>Purchased route home value index</td>
<td>p_route_home</td>
<td>= p_route * home</td>
<td></td>
</tr>
<tr>
<td>Purchased open corridor miles</td>
<td>p_open</td>
<td>= length - p_route - t_route</td>
<td></td>
</tr>
<tr>
<td>Purchased open corridor area</td>
<td>p_open_area</td>
<td>= p_open * width;</td>
<td></td>
</tr>
<tr>
<td>Purchased open corridor population index</td>
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<td>p_out_acres_home</td>
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<td></td>
</tr>
</tbody>
</table>

* Endogenous variable.
** Includes media reports, interviews, and fact sheets.
*** Possible substitute for endogenous variable.
Transaction Summaries

The following summaries describe each of the historical transactions included in our database. We restrict our initial view to approximately 30 transactions that we identified as occurring since deregulation in 1980 and involving a Class I railroad and a public agency. The descriptions below represent those transactions for which we can substantiate and quantify relevant attributes. While our sample space is quite sparse, numbering 21 observations, it does represent approximately two-thirds of the entire population of these sorts of transactions. Some observations in our dataset come from the same formal transaction, as in certain cases we are able to identify a unique “sub-transaction” and a corresponding price. Transactions are listed chronologically within three broad geographic regions.

Western United States

Southern Pacific to Northwestern Pacific Railroad Authority—1990, 1996
To preserve the rail route between San Rafael and Willits via Novato in northern California, the Northwestern Pacific Railroad Authority acquired 11.25 miles of track from Southern Pacific (SP) between San Rafael and Novato for $10.1 million in 1990. Later, in April of 1996, the authority purchased 116 miles of SP track. The authority acted for a group of public agencies comprising the Golden Gate Bridge Highway and Transportation District, Marin County, and the North Coast Railroad Authority. The two purchases laid the foundation for public control of the rail route between Eureka and SP’s line east of San Francisco, preserving the route for potential future passenger and freight traffic. At the time of the transactions, SP was not running freight trains on either of the purchased segments.

Southern Pacific to Los Angeles County Transportation Commission—1990
In October of 1990, the Los Angeles County Transportation Commission (LACTC) and SP announced an agreement for the sale of 175 miles of rights-of-way in the San Bernardino, Santa Monica, and Paramount areas of the greater Los Angeles region. The purchase price was $450 million, of which $245 million paid “for the railroad corridors and $205 million … [for]

30 Ibid.
station sites, maintenance yards and trackage rights.” The transaction involved routes through Los Angeles, San Bernardino, Santa Monica, Burbank, Paramount, and the northern part of the San Fernando Valley.31

Atchison Topeka & Santa Fe to San Diego Metropolitan Transit Development Board—1991
San Diego’s Metropolitan Transit Development Board (MTDB) purchased 3.15 miles of Atchison Topeka & Santa Fe Railway Company (ATSF) right-of-way land on November 20, 1991. MTDB paid $17.5 million for a 40-foot-wide corridor just south of the San Diego River and a 1.77-acre parcel of land. The short segment of track was secured to enable future light rail service between San Diego’s Old Town and downtown areas. As part of the contract, MTDB agreed to shift the ATSF tracks to make room for the future light rail tracks, and to extend other ATSF track to accommodate commuter rail use.32

Southern Pacific to Peninsula Corridor Joint Powers Board—1992
SP transferred 51.4 miles of track and corridor land, along with 25.4 miles of trackage rights, to the Peninsula Corridor Joint Powers Board (JPB) on January 15, 1992. The JPB comprises representatives of SamTrans and the counties of San Francisco and Santa Clara. The rights-of-way extend from San Francisco to Gilroy in the south via San Jose, and were purchased to enable the expansion of the CalTrain commuter service through San Francisco and San Mateo counties. The total transaction price was approximately $220 million, $8 million of which can be attributed to the purchase of the trackage rights between San Jose and Gilroy. The transaction also included structures used to operate the existing CalTrain service.33

Atchison Topeka & Santa Fe to Southern California Regional Rail Authority—1992
In June of 1992, the Southern California Regional Rail Authority (SCRRA) and the ATSF agreed on the transfer of 253 miles of rights-of-way, trackage rights, and additional property. The SCRRA paid approximately $410 million for 171 miles of track and right-of-way, 82.0 miles of trackage rights, and a share of 370 acres of non-corridor land, the balance of which

was acquired by San Diego’s transportation agencies. The transaction corridors and properties spanned the counties of Los Angeles, Orange, Riverside, and San Bernardino, representing four of the five member-counties of the SCRRA, Ventura County being the fifth. The overarching goal of the purchase was to provide for a “comprehensive commuter rail network” to ease auto congestion and improve air quality.34

*Atchison Topeka & Santa Fe to San Diego Public Agencies—1992*

Also in June of 1992, ATSF agreed to sell 82 miles of track and right-of-way corridors to three San Diego public agencies: the North County Transit District, the San Diego Association of Governments, and the Metropolitan Transit Development Board. The transaction included ATSF’s Escondido Subdivision and the section of the San Diego Subdivision within San Diego County, which sold for approximately $90 million. As with the SCRRA’s purchase of similar track and rights in Los Angeles and the surrounding counties, the routes acquired in this transaction were part of a larger plan to offer passenger rail service as an alternative to highway travel.35

**Southern Pacific to Los Angeles County Transportation Commission—1992**

The Los Angeles County Transportation Commission (LACTC) announced an agreement on September 24, 1992 to acquire portions of Southern Pacific’s line from Los Angeles to points north in Palmdale and Burbank. The 67-mile Saugus Line and the Canoga Park and Burbank sections of the Burbank Branch (approximately 8 miles) were included in the agreement, along with two non-operating parcels of land and other additional properties, for a purchase price of $67.8 million. The track was acquired to expand the then-new commuter rail service for the Los Angeles area.36

---

35 Ibid.
Union Pacific to Sacramento Regional Transit District—2000

In the early part of 2000, the Sacramento Regional Transit District (RTD) purchased a right-of-way corridor from Union Pacific (UP) as part of a planned extension to its existing light rail system. The corridor extended for 6.3 miles from Broadway in downtown Sacramento south to Meadowview Road, and consisted of land and some existing structures adjacent to UP’s track on the west side. Funded by state and local grants, the purchase amounted to $8.4 million with the RTD’s commitment to maintain signals on the west side of the UP track and relocate certain UP track segments.37

Union Pacific to Utah Transit Authority—2002

In 2002, Utah Transit Authority (UTA) secured 175 miles of railroad rights-of-way along Utah’s Wasatch Front from Union Pacific (UP). UTA paid $185 million for the track and corridor adjacent to UP’s main line from Brigham City in northern Utah to Payson, south of Provo. The long-term plan associated with the purchase is the construction of a commuter rail line traversing the entire route. The transaction also included UP’s regional maintenance facility and two intermodal terminals.38

Burlington Northern Santa Fe to Sound Transit (Seattle)—2003

Seattle’s Sound Transit (Sounder) purchased from Burlington Northern Santa Fe (BNSF) 21 miles of right-of-way and track south of Seattle for $32 million in December of 2003. Operating light freight service at the time of the transaction, BNSF retained a “perpetual freight easement” on the route, which constitutes the former BNSF Lakeview Subdivision connecting Tacoma and Roy. The purchase gives Sounder track needed to build a commuter rail system for the region, but the condition of the acquired route is such that Sounder will need to replace completely the track and ties if passenger rail services are to be offered.39

37 “Sacramento continues light rail purchases,” Mass Transit, March 1, 2000, p. 84.
   Interview with M. Schlenker, BNSF, July 9, 2004.
Central United States

Southern/Union Pacific to Dallas Area Rapid Transit—1988, 1989

In the first half of 1988, Southern Pacific sold 34 miles of right-of-way to Dallas Area Rapid Transit (DART) for $56.9 million. Later, in October of 1989, the DART board of directors approved an agreement with Union Pacific for the purchase of 31.5 miles of rights-of-way and 41.5 miles of operating rights. For $39 million, the agreement provided DART with a number of radial routes from downtown Dallas to outlying areas, including Fort Worth. The two acquisitions were part of larger plans to build a Dallas-area light rail and commuter rail system.40

Union Pacific to Texas DOT—1992

The Texas Department of Transportation (TxDOT) purchased Union Pacific’s Katy rail corridor and tracks for $78 million in December of 1992. The corridor was 27.9 miles long, averaged 100 feet in width, and connected downtown Houston with the Houston suburb of Katy. At the time, potential uses for the route included commuter rail and light rail, along with added capacity for the adjacent highway system.41

Southern Pacific to Houston’s Metropolitan Transit Authority—1993

After agreeing to purchase over 100 miles of Southern Pacific right-of-way in December of 1992, the Metropolitan Transit Authority of Houston (Metro) acquired 58 miles of right-of-way along the Westpark Corridor for $45 million. The purchase was the first step in securing a line for planned commuter rail service, although the remaining rights-of-way associated with the original agreement have not been purchased as the commuter rail plans were put on hold shortly after the 58-mile acquisition.42

40 “DART receives almost 80 percent of operating rights/rights-of-way for rail operation with Union Pacific agreement,” Southwest Newswire, October 25, 1989.


Eastern United States

CSXT to State of Florida—1988
For Tri-Rail’s route between Miami and West Palm Beach, the state of Florida purchased 81 miles of railroad right-of-way from CSX Transportation (CSXT) for $264 million in 1988. The route was mostly single track, and CSXT “retained freight operating rights and dispatching control.” In addition to funding the transaction, the state of Florida set aside $18 million to help rehabilitate the purchased track.43

Conrail to Southeastern Pennsylvania Transportation Authority—1995
On March 23, 1995, the Board of the Southeastern Pennsylvania Transportation Authority (SEPTA) approved the purchase of 1.6 miles of Conrail right-of-way for $8.5 million. The right-of-way consists of most of the old Reading Railroad City Branch, which was unused at the time of purchase, and will help to preserve a route through Philadelphia for future transit use.44

CSXT to Triangle Transit Authority—2003
In June of 2003, Triangle Transit Authority (TTA) in North Carolina acquired 52 acres of land from CSXT. The land, adjacent to CSXT’s existing right-of-way, was purchased with the stipulation that TTA’s tracks be at least 26 feet from the CSXT track. For $24.5 million, TTA secured the needed right-of-way for its planned 35-mile rail line from downtown Raleigh to Spring Forest Road in the north. The new route is expected to open in 2010.45

Norfolk Southern to Charlotte Area Transit System—2004
Earlier this year, the Charlotte Area Transit System (CATS) purchased six miles of Norfolk Southern right-of-way for $14.75 million. The transaction helped to secure a portion of the

property needed for CATS’s planned light rail service for Charlotte and areas south. Although the acquired corridor was signaled, there was no track on the route.\textsuperscript{46}

Exhibit 3 summarizes these transactions and their attributes.

\textsuperscript{46}“CATS buys light rail access,” \textit{Mass Transit}, February 2004, p. 45.
## Exhibit 3. Summary of Historical Rail Corridor Transactions and Attributes

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<td>ATSF</td>
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<td>9</td>
<td>1992</td>
<td>CA</td>
<td>Los Angeles</td>
<td>Southern California Regional Rail Authority</td>
<td>ATSF</td>
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</tbody>
</table>

### Table 1: Summary of Historical Rail Corridor Transactions and Attributes

| obs | year | state | region | buyer | seller | price | length | width | p. corr. acres | p. out. acres | p. mem. tracks | t. mem. tracks | p. route | t. route | rights | density | p. signal | p. gauge | p. home | t. route |
|-----|------|-------|--------|-------|--------|-------|--------|-------|---------------|---------------|---------------|---------------|---------------|----------|---------|---------|---------|----------|---------|---------|---------|---------|
| 1   | 1990 | CA    | San Rafael | Southern Pacific | Southern Pacific | 110.0 | 100.0 | 140.6 | 0.0 | 1.0 | 0.0 | 110.0 | 0.0 | 0 | 0 | 1.42 | 0.00 | 98.36 |
| 2   | 1990 | North of SF | Southern Pacific | Southern Pacific | 24.2 | 110.0 | 140.6 | 0.0 | 1.0 | 0.0 | 110.0 | 0.0 | 0 | 0 | 1.42 | 0.00 | 98.36 |
| 3   | 1990 | Los Angeles | Southern California Regional Rail Authority | Southern California Regional Rail Authority | 415.0 | 175.0 | 150.0 | 100.0 | 0.0 | 1.0 | 0.0 | 100.0 | 0.0 | 0 | 0 | 10.85 | 0.13 | 101.00 |
| 4   | 1991 | CA    | San Rafael | Southern Pacific | Southern Pacific | 36.4 | 35.5 | 75.0 | 150.0 | 0.0 | 1.0 | 0.0 | 150.0 | 0.0 | 0 | 0 | 7.19 | 0.04 | 98.17 |
| 5   | 1991 | CA    | San Diego | San Diego Metropolitan Transit Development Board | ATSF | 54.2 | 54.2 | 100.0 | 100.0 | 0.0 | 1.0 | 0.0 | 100.0 | 0.0 | 0 | 0 | 11.4 | 0.00 | 100.00 |
| 6   | 1992 | CA    | Baton Rouge | Union Pacific | Union Pacific | 25.0 | 25.0 | 100.0 | 100.0 | 0.0 | 1.0 | 0.0 | 100.0 | 0.0 | 0 | 0 | 11.14 | 0.13 | 100.00 |
| 7   | 1992 | CA    | Sacramento | Sacramento Regional Transit District | Union Pacific | 173.0 | 173.0 | 100.0 | 100.0 | 0.0 | 1.0 | 0.0 | 100.0 | 0.0 | 0 | 0 | 7.52 | 0.05 | 101.33 |
| 8   | 1992 | CA    | Sacramento | Sacramento Regional Transit District | Union Pacific | 173.0 | 173.0 | 100.0 | 100.0 | 0.0 | 1.0 | 0.0 | 100.0 | 0.0 | 0 | 0 | 7.52 | 0.05 | 101.33 |
| 9   | 1992 | CA    | Sacramento | Sacramento Regional Transit District | Union Pacific | 173.0 | 173.0 | 100.0 | 100.0 | 0.0 | 1.0 | 0.0 | 100.0 | 0.0 | 0 | 0 | 7.52 | 0.05 | 101.33 |
| 10  | 1992 | CA    | Sacramento | Sacramento Regional Transit District | Union Pacific | 173.0 | 173.0 | 100.0 | 100.0 | 0.0 | 1.0 | 0.0 | 100.0 | 0.0 | 0 | 0 | 7.52 | 0.05 | 101.33 |

### Table 2: Summary of Historical Rail Corridor Transactions and Attributes

| obs | year | state | region | buyer | seller | price | length | width | p. corr. acres | p. out. acres | p. mem. tracks | t. mem. tracks | p. route | t. route | rights | density | p. signal | p. gauge | p. home | t. route |
|-----|------|-------|--------|-------|--------|-------|--------|-------|---------------|---------------|---------------|---------------|----------|---------|---------|---------|----------|---------|---------|---------|---------|
| 1   | 1990 | CA    | Los Angeles | Southern California Regional Rail Authority | Southern California Regional Rail Authority | 82.3 | 82.3 | 100.0 | 100.0 | 0.0 | 1.0 | 0.0 | 100.0 | 0.0 | 0 | 0 | 8.23 | 0.12 | 100.00 |
| 2   | 1990 | CA    | Sacramento | Sacramento Regional Transit District | Sacramento Regional Transit District | 81.9 | 81.9 | 100.0 | 100.0 | 0.0 | 1.0 | 0.0 | 100.0 | 0.0 | 0 | 0 | 8.23 | 0.12 | 100.00 |
| 3   | 1990 | CA    | Sacramento | Sacramento Regional Transit District | Sacramento Regional Transit District | 81.9 | 81.9 | 100.0 | 100.0 | 0.0 | 1.0 | 0.0 | 100.0 | 0.0 | 0 | 0 | 8.23 | 0.12 | 100.00 |
| 4   | 1990 | CA    | Sacramento | Sacramento Regional Transit District | Sacramento Regional Transit District | 81.9 | 81.9 | 100.0 | 100.0 | 0.0 | 1.0 | 0.0 | 100.0 | 0.0 | 0 | 0 | 8.23 | 0.12 | 100.00 |

### Table 3: Summary of Historical Rail Corridor Transactions and Attributes

| obs | year | state | region | buyer | seller | price | length | width | p. corr. acres | p. out. acres | p. mem. tracks | t. mem. tracks | p. route | t. route | rights | density | p. signal | p. gauge | p. home | t. route |
|-----|------|-------|--------|-------|--------|-------|--------|-------|---------------|---------------|---------------|---------------|----------|---------|---------|---------|----------|---------|---------|---------|---------|
| 1   | 1990 | CA    | San Rafael | Southern Pacific | Southern Pacific | 82.3 | 82.3 | 100.0 | 100.0 | 0.0 | 1.0 | 0.0 | 100.0 | 0.0 | 0 | 0 | 8.23 | 0.12 | 100.00 |

*Value in millions (1984 dollars)*
Econometric Railroad Corridor Valuation Model

**Approach**

In the last twenty-five years, Class I line sales to short line railroads, and to a much smaller extent public agencies, have been so prolific that the Class I companies have created whole departments dedicated to the sale of branch lines. As a result, certain sellers, and in many cases specific buyers, have been involved in a repeated number of transactions such that they have developed “rules of thumb” or informal estimates of what they believe a particular property’s value to be. For example, a railroad branch line is often valued initially at one to three times the revenue attributable to the line.47

In cases where a branch line supports little or no traffic, the Class I seeks to get at least the net liquidation value (NLV) of the property and assets. In a simple view, the Class I is selling a parcel of real estate upon which a rather used bit of railroad infrastructure and perhaps some old buildings may exist. The NLV of the property and assets is simply the going price for real estate in that region and the net scrap value of the ties and rail.48 In fact, railroad companies often scrap old tracks, selling the used crossties to landscaping contractors and the used rail to metal scrappers to be cut and re-smelted. For this and other reasons, some of the corridor transactions we examine in this paper have no tracks associated with them.

Our approach first tests the simple representation of transaction value as a function of the quantities of land and track being purchased. Building on our hypothesis that transaction value is also influenced by a variety of other factors, we design a fully specified model to include a set of the potential explanatory variables discussed above, recognizing that some of the variables may provide duplicate perspectives of the same underlying phenomenon. Given the limitations of applying the fully specified model to a relatively small data set, we seek to identify a smaller group of explanatory variables that logically and statistically account for transaction value.

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48 Interview with Jim Derwin, former CSXT Assistant Vice President Plant Rationalization (retired), July 13, 2004.

While the functional form and the component equations of our fully specified model present price as a function of asset characteristics, the ensuing analysis omits any further discussion or application of a hedonics approach. Unlike an automobile, a home, or a computer, a freight railroad right-of-way is not a regularly sold product in a clearly defined market with substitutable versions or brands. In other words, a public agency interested in purchasing a product to meet a specific mode-of-transportation objective likely does not have the option to purchase an alternative product with a different and more desirable set of attributes. Rather, purchasing agencies are, by default, attribute-takers instead of attribute-choosers. Thus, considerations for the consumer behavior represented in hedonic price equations are not relevant to our approach, despite the similarities in form between our fully specified model and a typical hedonic price equation.
In the following sections, we describe the identification of our models, summarize the results of our estimations, and discuss the possible implications of our findings.

**Simple First-Order Test**

Our approach first tests a simple representation of transaction value as a function of the quantity of purchased land, both corridor and out-parcel acres, and the quantity of purchased track miles. In this model, we apply the preliminary assumption that any trackage rights gained by the buyer are paid for in the future through user fees. An ordinary least-squares regression takes the form of

\[
(1) \quad \text{price} = \beta_1 \cdot p_{\text{tot acres}} + \beta_2 \cdot p_{\text{track}},
\]

and yields results of \( \beta_1 = 0.28 \) (t = 4.18) and \( \beta_2 = -2.03 \) (t = −2.17), which are significant at the five-percent level.

One of the transactions in our dataset does not fit this simple model in that it includes only trackage rights and no purchased land or track. Removing this observation and regressing the model on the subset yield similar results also at a significance level of five percent:

\( \beta_1 = 0.28 \) (t = 4.07) and \( \beta_2 = -2.03 \) (t = −2.11).

While we would expect the parameter on purchased corridor acres (\( \beta_1 \)) to be positive, the negative parameter on purchased track miles (\( \beta_2 \)) merits further inspection. In examining the correlation between the two variables, we find that they are highly correlated at a value of −0.92 and conclude that this characteristic is likely the driving force behind the unexpected regression results. Thus, to move forward in developing an appropriate model, we must “separate” the influences of land area and purchased track length and evaluate transactions along different dimensions.

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51 We do not include an intercept in this simple regression because of the “price times quantity” characteristic of the expressed function. Similarly, we do not include intercepts in the other “price times quantity” models listed in this paper: equations (2), (3), (4), (4.1), and (5).
**Fully Specified Model**

A right-of-way transaction can be viewed alternatively as a package of overall corridor length and the number of purchased out-parcel acres. The influence of corridor length will likely vary depending upon the type of corridor mileage. In our dataset, we present three types: purchased route miles, miles of purchased open land, and route miles of purchased trackage rights. We can identify these types more robustly by considering other contextual influences as described earlier: corridor width, freight rights, traffic density, signal condition, etc. In doing so, we expect to define a more realistic and “truer” view of factors in transaction price.

Building on our hypothesis, we design a more fully specified model to include the set of the potential explanatory variables that we expect will have a more significant cumulative influence on transaction price. The functional form of the fully specified model is represented by

$$
\text{price} = [\beta_1 \cdot p_{\text{route}} + \beta_2 \cdot p_{\text{corr}} + \beta_3 \cdot t_{\text{route}} + \beta_4 \cdot p_{\text{out acres}}] \times \\
[\beta_5 \cdot (\text{gdp}_r_5 - \text{gdp}_r_5\text{mean}) + \beta_6 \cdot (\text{op}_\text{ratio} - \text{op}_\text{ratio}\text{mean})],
$$

where $\beta_1$ through $\beta_4$ represent the price per unit of each of the corresponding purchased assets; $\beta_5$ and $\beta_6$ represent the effects of quarterly GDP growth and operating ratio of the selling railroad, respectively; and $\text{gdp}_r_5\text{mean}$ and $\text{op}_\text{ratio}\text{mean}$ are equal to the means of the respective variables for the dataset.

This functional form of the model comprises multiple equations, each of which isolates a particular component of the transaction price by asset type. These equations include

$$
\beta_1 = \alpha_0 + \alpha_1 \cdot \text{width} + \alpha_2 \cdot p_{\text{num tracks}} + \alpha_3 \cdot \text{rights} + \alpha_4 \cdot \text{density} + \alpha_5 \cdot p_{\text{signal}} + \\
+ \alpha_6 \cdot \text{pop} + \alpha_7 \cdot \text{home},
$$

$$
\beta_2 = \gamma_0 + \gamma_1 \cdot \text{width} + \gamma_2 \cdot \text{pop} + \gamma_3 \cdot \text{home},
$$

$$
\beta_3 = \eta_0 + \eta_1 \cdot t_{\text{num tracks}} + \eta_2 \cdot \text{density},
$$

$$
\beta_4 = \theta_0 + \theta_1 \cdot \text{pop} + \theta_2 \cdot \text{home}.
$$
Equation (2.1) expresses the overall price per mile of purchased track as a function of some standard cost per route mile, the width of the right-of-way, the number of tracks along the route, trackage rights on the purchased track granted to the selling railroad, traffic density on the purchased track, the signal condition of the track miles, and population density and median home value of the surrounding area.

Equation (2.2) expresses the overall price per mile of right-of-way without track as a function of some standard cost per mile, width, population density, and median home value.

Equation (2.3) expresses the overall price per mile of trackage rights as a function of some standard cost per mile, the number of tracks along the route, and traffic density on the existing track.

Equation (2.4) represents the price per acre of out-parcel land, accounting for some standard cost per acre, population density, and the median value of homes.

This partitioning of transaction price into components allows us to identify which of the variables included in our dataset affect the “input” prices of specific assets and which variables apply to the overall transaction price. Inserting equations (2.1) through (2.4) into the functional form of the fully specified model produces the equation

\[
\text{price} = \left[ \alpha_0 \ast p_{\text{route}} + \alpha_1 \ast p_{\text{route} \_\text{area}} + \alpha_2 \ast p_{\text{track}} + \alpha_3 \ast p_{\text{route} \_\text{rights}} \\
+ \alpha_4 \ast p_{\text{route} \_\text{density}} + \alpha_5 \ast p_{\text{route} \_\text{sig}} + \alpha_6 \ast p_{\text{route} \_\text{pop}} \\
+ \alpha_7 \ast p_{\text{route} \_\text{home}} + \gamma_0 \ast p_{\text{corr}} + \gamma_1 \ast p_{\text{corr} \_\text{area}} + \gamma_2 \ast p_{\text{corr} \_\text{pop}} \\
+ \gamma_3 \ast p_{\text{corr} \_\text{home}} + \eta_0 \ast t_{\text{route}} + \eta_1 \ast t_{\text{track}} + \eta_1 \ast t_{\text{route} \_\text{density}} \\
+ \theta_0 \ast p_{\text{out} \_\text{acres}} + \theta_1 \ast p_{\text{out} \_\text{acres} \_\text{pop}} + \theta_2 \ast p_{\text{out} \_\text{acres} \_\text{home}} \right] \\
\times \left[ \beta_5 \ast (\text{gdp}_r \_5 - \text{gdp}_r \_5\text{mean}) + \beta_6 \ast (\text{op\_ratio} - \text{op\_ratio}\text{mean}) \right]. \tag{3}^{52}
\]

\(^{52}\) Please refer to Exhibit 2 for variable definitions and formulas.
This equation represents the set of influences we believe would significantly affect transaction prices, yet with a dataset of 21 observations and effectively 20 variables in equation (3), we are limited in our ability to estimate the associated parameters meaningfully. We must instead examine related and more narrowly defined models consisting of various combinations of the assets and contextual variables in equation (3) to find a smaller group of explanatory variables that may logically and statistically represent transaction value factors. Through this process, we expect to discover trends across our tested models for the signs and relative magnitudes of significant variable coefficients.

**Best Overall Models**

We first define a model incorporating as explanatory variables only the basic assets purchased: purchased route miles, purchased open corridor miles, trackage rights route miles, and acres of out-parcel land. The model takes the form of

\[
\text{price} = \beta_1 \cdot \text{p\_route} + \beta_2 \cdot \text{p\_corr} + \beta_3 \cdot \text{t\_route} + \beta_4 \cdot \text{p\_out\_acres}.
\]

Running a least-squares regression, we find that the parameters for purchased route miles, purchased open corridor miles, and trackage rights route miles are significant at the one-percent level while the parameter for purchased out-parcel acres is not significant:

\[
\begin{align*}
\beta_1 &= 1.38 \ (t = 3.71) \\
\beta_2 &= 1.10 \ (t = 3.06) \\
\beta_3 &= 2.63 \ (t = 4.43) \\
\beta_4 &= -0.33 \ (t = -0.80).
\end{align*}
\]

53 Summaries of estimated coefficients and significance statistics from these models are included in the Appendix.
Re-estimating without the variable for out-parcels produces similar coefficients and significance statistics for the remaining three variables from the model

(4.1) \[ \text{price} = \beta_1 \cdot p\_route + \beta_2 \cdot p\_corr + \beta_3 \cdot t\_route, \] which yields

\[
\beta_1 = 1.21 \ (t = 3.98) \\
\beta_2 = 1.06 \ (t = 3.00) \\
\beta_3 = 2.47 \ (t = 4.46).
\]

We proceed using the three variables in equation (4.1) as the foundation for developing our model and evaluating the significance and appropriateness of the other variables included in the fully specified model.

We test a number of models specifying the variables included in the fully specified model (equation (3)) in different combinations in addition to the three core variables mentioned above. In doing so, we recognize the limitations in statistically explaining the price with a full range of variables, given the very limited number of observations in our dataset. From our endeavors and based upon our small sample size, we find that the added variables and their combinations are statistically insignificant, with one exception, and hence, do not make any additional contribution to our core model as specified in equation (4.1). The exception is the variable representing signalized purchased route miles. This variable, when included with general purchased route miles, is significant without changing the relative significance of the three core variables.

In considering each of the potential factors in the overall price per mile of purchased route, we discover that most of the combined variables, such as freight rights miles, are too highly correlated with purchased route miles as represented singly to offer any meaningful addition to equation (4.1). Similarly, since the number of tracks equals one in all of the observations where route miles are purchased, the variable for purchased track miles drops out of the model.
We find that the problem of correlated variables also affects our ability to include combined variables, such as purchased open corridor land area, in estimating the overall prices for open corridor land and trackage rights.

The socioeconomic factors of population density and median home value potentially associated with the value of corridors and out-parcels do not contribute significantly to our model. In various regression iterations, we include these variables as indirect influences (on asset prices, particularly for out-parcels) and direct influences (on overall transaction price), and find that in both cases they do not account to a significant degree for the variation in transaction price. Likewise, we are unable to significantly model transaction price as function of either GDP growth or operating ratio.

Based on our analysis, we conclude that equations (4.1) and (5), listed below, best account for the variation in the prices of transactions in our dataset.

\[
(5) \quad \text{price} = \beta_1 \cdot p\_route + \beta_2 \cdot p\_route\_sig + \beta_3 \cdot p\_corr + \beta_4 \cdot t\_route. 
\]

In our efforts to improve the application of these models, we consider a number of general econometric measures. We test for heteroscedasticity and determine that the models are homoscedastic. We also examine the Cook’s D influence statistic for each observation in our dataset and test the model with potentially “troublesome” observations removed from the dataset. We find that the exercise reduces the root mean square error of both models while maintaining the magnitude and significance of each of the variables. The root mean square error for equation (4.1) improves from 68.576 to 61.276, and from 61.621 to 55.083 for equation (5). Thus, we present the results of equations (4.1) and (5) as applied to the adjusted dataset:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Equation (4.1) Coefficients</th>
<th>Equation (5) Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchased route miles</td>
<td>$\beta_1 = 1.30$ (t = 4.76)</td>
<td>$\beta_1 = 0.82$ (t = 2.50)</td>
</tr>
<tr>
<td>Purchased signaled route miles</td>
<td>$\beta_2 = 1.12$ (t = 2.24)</td>
<td></td>
</tr>
<tr>
<td>Purchased open corridor miles</td>
<td>$\beta_2 = 0.86$ (t = 2.65)</td>
<td>$\beta_3 = 0.87$ (t = 2.96)</td>
</tr>
<tr>
<td>Purchased trackage rights miles</td>
<td>$\beta_3 = 1.40$ (t = 2.07)</td>
<td>$\beta_4 = 1.73$ (t = 2.77)</td>
</tr>
</tbody>
</table>
Each of the estimated coefficients is significant at the five-percent level or higher. Equation (5) exhibits a lower root mean square error than equation (4.1) as shown above, indicating an improvement in goodness of fit over the latter equation.

These results indicate that the cost of purchasing one route mile of corridor, not considering other characteristics, is approximately $1.30 million. When we consider the signal condition of the route as well, the basic price per route mile is $0.82 million, with an additional $1.12 million per mile if the purchased route is signaled.

According to the results for both equations, the price per mile of open corridor ranges between $0.86 million and $0.87 million. As with the value of purchased track miles, this value is independent of corridor width and other contextual influences.

The price of trackage rights is appreciably higher than the base price for either purchased track or open corridor at over $1.40 million and $1.73 million per mile, as estimated by both equations, respectively. This value is independent of traffic density as considered in our presentation of a fully specified model.

We conduct an analysis similar to the one described in this section with transaction price per total corridor mile as the endogenous variable. However, none of the tested models produce significantly estimated parameters on the explanatory variables.\textsuperscript{54}

**Conclusions and Next Steps**

As outlined above, we believe that there are a number of factors influencing the price of railroad right-of-way transactions. In compiling a set of sample transactions, we attempt to quantify various attributes of the transactions and the rights-of-ways. This exercise proves to be rather difficult at the desired level of detail, thus limiting the overall number of transactions in our dataset to twenty-one. While we are able to define a number of potential explanatory variables, the set of values for these variables is not as diverse as we might find in a larger dataset. For

\textsuperscript{54} Upon request, the authors can provide results of models that are not explicitly described in this paper.
example, in most transactions where a route and track are purchased, continued freight rights are granted to the selling railroad. This lack of diversity in the data prevents us from estimating many of the terms in the fully specified model.

Given these limitations, we are able to estimate the general price effects of certain transaction components. First, as one might expect, purchased route miles and trackage rights are more expensive per mile than corridor land without any infrastructure, although it is unclear between the former two assets which is more costly. Second, in reviewing the results for purchased route miles, we find that as we add related, additional explanatory variables such as signal condition, we introduce a range of price per mile with a ceiling higher than the price when only route mileage is considered. This result is to be expected because considering only the length of a purchased route neglects other influences that could drastically increase or decrease the route’s value as perceived by a public agency. Although signals present an array of required future maintenance costs and upgrade investments, we might explain the increase in price attributable to the signaled route by the fact that having a working signal system in place decreases the up-front costs a public agency faces in implementing rail transportation services on the route. Finally, the higher costs associated with purchasing trackage rights reflect a premium paid to avoid risks and financial obligations inherent in owning track.

In our introduction, we briefly touch on the low and high of prices paid for a corridor: $0.3 million per mile for the cheapest transaction and approximately $6.3 million per mile for the most expensive. Our model produces a predicted value for the “low” transaction of $1.0 million per mile and a predicted value for the “high” transaction of $1.1 million per mile. These rather large discrepancies between actual and predicted values may be explained in part by examining some of the unique, qualitative characteristics of these two transactions. For example, the cheaper transaction involved a long stretch of unused track in Marin County, north of San Francisco. Unlike many of the other rights-of-way discussed in this paper, this corridor did not have a planned transportation use specifically attached to it at the time of the transaction. Rather, the transaction simply preserved “the option … for voters to approve a commuter rail line …

55 Values are expressed in 2004 dollars.
sometime in the future.”\textsuperscript{56} Furthermore, had the public authority not purchased the route, the selling railroad would likely have abandoned the track all together.

On the other hand, the most expensive transaction in our dataset consisted of a three-mile segment of open right-of-way and an almost-two-acre parcel of adjacent land in San Diego. Given the relative price, it is surprising that no track infrastructure was included. However, the short coastal corridor resides in a historic section of the city, and shortly after its purchase it was converted into a vital light rail and commuter rail link connecting areas south to areas east and north. This conversion required that the purchasing agency fund the shifting and extension of existing freight rail tracks, adding what might be viewed as a price premium representative of the operational and logistical setbacks faced by the selling railroad. These types of considerations would naturally increase the value of the transaction.

Throughout the course of our analysis, we find that the width of a purchased corridor, and thus purchased acreage, does not appear to play a significant role in influencing transaction prices.\textsuperscript{57} Indeed, the hypothesis of width insignificance drives both our full specification of an explanatory model as well as our evaluation of that model, and offers the perspective that, in contrast to our original expectation and the appraisal valuation method, the real and overarching value of a right-of-way is directly and uniquely related to its length.

Enhancements to this study will be based primarily upon the expansion of the dataset, in terms of the number of observations, the level of quantified detail about each transaction, and the diversity of the set of transactions. This expansion will enable us to not only adjust and improve the results of this study, but also evaluate transaction prices within specific categories. For example, transactions executed at prices in a particular tier, take place in the eastern/western United States, occur before/after a particular year, involve a purchasing agency at the state level, or involve repeat buyers/sellers, may constitute unique markets and thus exhibit differing behaviors.


\textsuperscript{57} While this finding could represent a true lack of influence, it may also be derived from the default width assumptions we used in our dataset for transactions where these data were not available.
Further econometric inquiries into the subject of right-of-way transactions will build upon the work presented in this study to help answer the questions of whether there is an actual phenomenon underlying sales in the right-of-way market, whether public agencies behave in a rational and consistent way when purchasing rights-of-way, and whether there is an extant and distinct market for private-to-public freight corridors in the real world that has revealed a specific price function.

**About the Authors**

*Larry Shughart*, a Principal at Charles River Associates, specializes in performance management, financial management, and network operations engineering, and consults mainly to the railroad and trucking industries. During his tenure at CRA, Mr. Shughart has coauthored expert testimony in support of a national railroad labor arbitration hearing and an expert report to the U.S. Surface Transportation Board regarding regulatory oversight and reauthorization of TTX’s antitrust immunity. Mr. Shughart has served as strategic advisor to a number of clients including the Province of British Columbia, on matters relating to the restructuring and privatization of BC Rail; the Union Pacific Railroad, on analyses of various regulatory matters; the U.S. Department of Transportation Office of Inspector General, on recommendations related to Amtrak passenger train scheduling and operations; and the Florida Department of Transportation, in preparing the bi-annual rail plan.

Prior to joining CRA, Mr. Shughart spent 14 years at CSX Corporation, in Jacksonville, Florida, where he worked in a variety of areas, including intermodal, performance improvement, locomotive operations, strategic planning, service design, finance, operations research, and engineering. Prior to CSX, Mr. Shughart worked in the short line industry.

His academic experience includes membership on the engineering department advisory board at the University of Florida and research support for the Massachusetts Institute of Technology (MIT) Center for Transportation Studies. Mr. Shughart also served as a professor of economics at the University of North Florida. (M.S. Transportation, MIT; B.S. Chemistry/B.S. Business, University of Pittsburgh)
Ammon Matsuda, an Associate at Charles River Associates, has experience in performing market research and quantitative analyses for various transportation modal industries, specifically freight and passenger rail. His work at CRA has involved building valuation and forecasting models for discounted cash flow and sensitivity analysis, conducting econometric analysis, and performing in-depth evaluation and auditing of models and expert reports. Currently, he is part of the CRA team conducting an annual review of Amtrak’s ridership and revenue forecasts for the Northeast Corridor. This work includes analyzing the trends and characteristics of various modal travel volumes and calibrating sophisticated forecasting models using relevant input data. In a recent project, he developed a detailed pro forma financial outlook for alternative strategies for revitalizing the Jordanian railroad, including traffic forecasts; capital costs for track, locomotives, and rail cars; and operating costs that reflect a number of different operating and investment scenarios. Other projects at CRA have required him to study the competitive environments, market concentrations, and transaction histories of products in engineering construction, industrial manufacturing, steel production, and pharmaceuticals. His additional responsibilities include providing litigation support through document analysis, quality assurance of data, and the submittal of supporting text for expert testimony reports, proposals, and CRA publications. (B.S. Economics, Brigham Young University)

Masroor Hasan, a Senior Associate at Charles River Associates, specializes in travel demand forecasting, transportation systems planning and evaluation, and transportation engineering. His experience also encompasses microscopic traffic simulation and traffic data collection. For the Office of the Inspector General, U.S. Department of Transportation, Mr. Hasan is currently managing a project that deals with critically reviewing the existing data and models utilized for estimating potential revenues, ridership and operating expenses in the eleven designated potential high-speed rail corridors in the United States. He also managed CRA’s assessment of Amtrak’s ridership and revenue forecasts in their 2003 Business Plan for the Northeast Corridor. Mr. Hasan was actively involved in the project ‘Travel Demand Modeling for the Northwest Connectivity Study,’ for the Georgia Regional Transportation Authority as well. He also conducted a revenue maximizing analysis of Amtrak’s proposed Acela service while reviewing Amtrak’s 2000 Strategic Business Plan. In addition, Mr. Hasan performed an extensive analysis of the Baseline National Motor Carrier Survey data as part of the Commercial Vehicle
Information Systems and Networks Model Deployment Initiative. He has assisted in analyzing the impacts of delay-reducing strategies as part of a large project for San Francisco International Airport. Prior to joining CRA, Mr. Hasan was a Research Assistant at Massachusetts Institute of Technology’s Intelligent Transportation Systems Laboratory. (M.S. Transportation, MIT; M.S./B.S. Civil Engineering, Bangladesh University of Engineering and Technology)
Appendix

Equation: \( (1) \)
Model: \( \text{price} = \beta_1 \cdot \text{p\_tot\_acres} + \beta_2 \cdot \text{p\_track} \)
Dataset: Full

<table>
<thead>
<tr>
<th>Root MSE</th>
<th>84.6667</th>
<th>Chi-square</th>
<th>5.63</th>
</tr>
</thead>
<tbody>
<tr>
<td>( R^2 )</td>
<td>0.6560</td>
<td>DF</td>
<td>3</td>
</tr>
<tr>
<td>Adjusted ( R^2 )</td>
<td>0.6198</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Variable     | Parameter Estimate | Standard Error | t-value | Pr > |t| |
|--------------|--------------------|----------------|---------|------|
| p\_tot\_acres | 0.27677            | 0.06619        | 4.18    | 0.0005 |
| p\_track     | -2.02755           | 0.93533        | -2.17   | 0.0431 |

Equation: \( (1) \)
Model: \( \text{price} = \beta_1 \cdot \text{p\_tot\_acres} + \beta_2 \cdot \text{p\_track} \)
Dataset: Full, excluding obs 6

<table>
<thead>
<tr>
<th>Root MSE</th>
<th>86.9697</th>
<th>Chi-square</th>
<th>5.48</th>
</tr>
</thead>
<tbody>
<tr>
<td>( R^2 )</td>
<td>0.6561</td>
<td>DF</td>
<td>3</td>
</tr>
<tr>
<td>Adjusted ( R^2 )</td>
<td>0.6179</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Variable     | Parameter Estimate | Standard Error | t-value | Pr > |t| |
|--------------|--------------------|----------------|---------|------|
| p\_tot\_acres | 0.27677            | 0.06799        | 4.07    | 0.0007 |
| p\_track     | -2.02755           | 0.96077        | -2.11   | 0.0491 |

Correlation of Estimates

\[
\begin{array}{cc}
\text{p\_tot\_acres} & \text{p\_track} \\
\text{p\_tot\_acres} & 1.0000 & -0.9212 \\
\text{p\_track} & -0.9212 & 1.0000 \\
\end{array}
\]
Equation: \( (4) \)
Model: \[
\text{price} = \beta_1 \cdot \text{p\_route} + \beta_2 \cdot \text{p\_corr} + \beta_3 \cdot \text{t\_route} + \beta_4 \cdot \text{p\_out\_acres}
\]
Dataset: Full

Root MSE \hspace{1cm} 69.2777 \hspace{1cm} Chi-square \hspace{1cm} 11.29
R\(^2\) \hspace{1cm} 0.7939 \hspace{1cm} DF \hspace{1cm} 10
Adjusted R\(^2\) \hspace{1cm} 0.7455

| Variable      | Parameter Estimate | Standard Error | t-value | Pr > |t| |
|---------------|--------------------|----------------|---------|------|---|
| \text{p\_route} | 1.37638            | 0.37112        | 3.71    | 0.0017 | |
| \text{p\_corr} | 1.10183            | 0.36034        | 3.06    | 0.0071 | |
| \text{t\_route} | 2.62664            | 0.59329        | 4.43    | 0.0004 | |
| \text{p\_out\_acres} | -0.33229        | 0.41632        | -0.80   | 0.4358 | |


Equation: (4.1)
Model: \[ \text{price} = \beta_1 \cdot \text{p\_route} + \beta_2 \cdot \text{p\_corr} + \beta_3 \cdot \text{t\_route} \]
Dataset: Full

Root MSE 68.5757  
Chi-square 4.77  
R\(^2\) 0.7862  
DF 6  
Adjusted R\(^2\) 0.7506

| Variable | Parameter Estimate | Standard Error | t-value | Pr > |t| |
|----------|--------------------|----------------|---------|------|---|
| p\_route | 1.21033            | 0.30421        | 3.98    | 0.0009 |
| p\_corr  | 1.05934            | 0.35277        | 3.00    | 0.0076 |
| t\_route | 2.46725            | 0.55300        | 4.46    | 0.0003 |

Cook's D Statistic
1 0.000
2 0.469
3 1.647
4 0.000
5 0.070
6 0.010
7 0.168
8 0.001
9 0.004
10 0.008
11 0.000
12 1.431
13 0.000
14 0.000
15 0.094
16 0.002
17 0.003
18 0.293
19 0.000
20 0.001
21 0.000
Equation: (5)
Model: \[ \text{price} = \beta_1 \cdot \text{p\_route} + \beta_2 \cdot \text{p\_route\_sig} + \beta_3 \cdot \text{p\_corr} + \beta_4 \cdot \text{t\_route} \]

Dataset: Full

Root MSE 61.6206
R^2 0.8370
Adjusted R^2 0.7986

| Variable     | Parameter Estimate | Standard Error | t-value | Pr > |t| |
|--------------|--------------------|----------------|---------|------|---|
| p\_route     | 0.67063            | 0.36022        | 1.86    | 0.0800 |
| p\_route\_sig| 1.27249            | 0.55312        | 2.30    | 0.0343 |
| p\_corr      | 1.03629            | 0.31715        | 3.27    | 0.0045 |
| t\_route     | 2.70935            | 0.50794        | 5.33    | <.0001 |

Cook's D Statistic

1 0.000
2 0.298
3 1.216
4 0.000
5 0.091
6 0.012
7 0.081
8 0.351
9 0.257
10 0.222
11 0.000
12 1.005
13 0.000
14 0.002
15 0.078
16 0.005
17 0.003
18 0.385
19 0.000
20 0.001
21 0.000
Equation: (4.1)
Model: \( \text{price} = \beta_1 \cdot \text{p\_route} + \beta_2 \cdot \text{p\_corr} + \beta_3 \cdot \text{t\_route} \)
Dataset: Full, excluding obs 3

Root MSE \(61.2755\)  Chi-square \(3.18\)
\(R^2\) \(0.7142\)  DF \(5\)
Adjusted \(R^2\) \(0.6637\)

| Variable | Parameter Estimate | Standard Error | t-value | Pr > |t| |
|----------|-------------------|----------------|---------|------|-----|
| p\_route | 1.30978           | 0.27509        | 4.76    | 0.0002 |
| p\_corr  | 0.86378           | 0.32597        | 2.65    | 0.0168 |
| t\_route | 1.39092           | 0.67313        | 2.07    | 0.0544 |

Cook's D Statistic

1  0.000
2  0.739
3  0.000
4  0.084
5  0.006
6  1.558
7  0.001
8  0.010
9  0.017
10  0.000
11  0.080
12  0.000
13  0.000
14  0.090
15  0.002
16  0.001
17  0.340
18  0.000
19  0.000
20  0.000
Equation: (5)  
Model: \[ \text{price} = \beta_1 \cdot p_{\text{route}} + \beta_2 \cdot p_{\text{route\_sig}} + \beta_3 \cdot p_{\text{corr}} + \beta_4 \cdot t_{\text{route}} \]  
Dataset: Full, excluding obs 3  

\begin{array}{l}
\text{Root MSE} & 55.0829 \\
\text{Chi-square} & 9.63 \\
R^2 & 0.7826 \\
\text{DF} & 6 \\
\text{Adjusted R}^2 & 0.7282 \\
\end{array}

\begin{array}{l}
\text{Variable} & \text{Parameter Estimate} & \text{Standard Error} & \text{t-value} & \text{Pr > |t|} \\
p_{\text{route}} & 0.82342 & 0.32880 & 2.50 & 0.0235 \\
p_{\text{route\_sig}} & 1.11970 & 0.49889 & 2.24 & 0.0393 \\
p_{\text{corr}} & 0.86605 & 0.29303 & 2.96 & 0.0093 \\
t_{\text{route}} & 1.72804 & 0.62347 & 2.77 & 0.0136 \\
\end{array}

\begin{array}{l}
\text{Cook's D Statistic} \\
1 & 0.000 \\
2 & 0.741 \\
3 & 0.000 \\
4 & 0.114 \\
5 & 0.011 \\
6 & 1.588 \\
7 & 0.270 \\
8 & 0.321 \\
9 & 0.278 \\
10 & 0.000 \\
11 & 0.061 \\
12 & 0.000 \\
13 & 0.002 \\
14 & 0.079 \\
15 & 0.006 \\
16 & 0.001 \\
17 & 0.482 \\
18 & 0.000 \\
19 & 0.000 \\
20 & 0.000 \\
\end{array}