The Evolution of Contracting: Evidence From the U.S. Freight Rail Industry*

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ABSTRACT

Although they lie at the very foundation of economic exchange, the primal questions of whether and when economic actors employ contracts and how the propensity to contract evolves over time have received relatively little empirical attention. We address these lacunas using an extensive database of spot-market and contract shipments in the U.S. freight rail industry. We find that the evolution of contracting is driven by many factors, including legislative changes, contracting experience, the extent and nature of prevailing competition, transaction complexity, asset specificity, and technological change.

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> "I have come to the conclusion that the main obstacle faced by researchers in industrial organization is the lack of available data on contracts and the activities of firms."
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> – Ronald Coase, Nobel Prize acceptance speech (Coase,1992).

1. Introduction

The economic literature on contracting is both old and venerable, with contracts often cast as one of several alternative means by which a transaction between two (or more) parties may be consummated. At one extreme, parties can complete a transaction in a spot market, whereby Party A provides a good or service to Party B, and B provides an agreed upon amount of funds (or equivalent nonpecuniary remuneration) to A. At the other extreme, as first noted by Coase (1937), the transaction can be completed entirely outside the scope of a market by bringing it inside the firm.[1] Intermediate between these two extremes are various alternative governance approaches that can effectively consummate exchange.

Seminal contributions by Williamson (1973, 1975) and Klein, Crawford and Alchian (1978) identify a variety of exchange characteristics that affect the relative merits of using alternative governance approaches. Williamson (1975) argues that a combination of small numbers bargaining, uncertainty, bounded rationality, and opportunism give rise to "exchange difficulties" which, in turn, shape governance decisions.[2] Klein, Crawford and Alchian (1978) emphasize the critical role that asset specificity and incomplete contracts play in creating appropriable quasi-rents that alter the propensity for *ex post* recontracting and opportunistic behavior, which also affect governance decisions. In this light, the relative merits of using spot markets, contracts, or vertical integration to govern a set of transactions depend on these various market and exchange features. A rich body of theoretical research has built upon these original insights.[3]

A correspondingly large body of empirical research – mainly set in transaction cost economics (TCE) – has subsequently developed that offers direct support to these seminal theoretical

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1 Coase (1937) associates a firm with the set of activities that are governed by fiat rather than by the market mechanism.

2 See Williamson (1975, p. 7)

3 See Hart (1995) in particular and most notably. See Carlton (1979) for specific discussion of the interrelationships between transaction costs and contracts, and Carlton (1991) for general discussion of the costs associated with reliance on spot market pricing relative to contracts in the presence of demand uncertainty. See Halonen-Akatwijuka and Hart (2020) for a recent examination of the use of continuing contracts.

contributions.[4] New research continues to emerge that provides important insights into when and how transaction costs affect the structure of exchange. For instance, while the implications of transaction costs have been studied intensively, direct quantitative estimates of the levels of transaction costs are more nascent. MacKay (2022) develops a model and corresponding empirical analysis that directly quantifies the magnitude of buyer transaction costs. Krasnokutskaya and Seim (2011) separately identify seller procurement auction participation (i.e., transaction) costs and seller project completion costs. Similarly, Atalay et al. (2019) draw upon the "revealed preference" structure of firms to examine intrafirm and interfirm transactions, conditional upon the distance of the transaction, to determine the value of internalizing transactions. These benefits may arise, *inter alia,* from lower intrafirm vis-à-vis interfirm transaction costs. Other scholars consider new and under-explored settings in which to examine transaction costs. For example, Soliño and De Santos (2010), De Schepper et al. (2015), and Petersen et al. (2019) identify important differences in transaction costs that emerge when governments employ public-private partnerships rather than undertake purely public provision of infrastructure projects. In sum, recent TCE research—with its inquiries of under-explored dimensions, its development of novel theory, and its implementation of sophisticated empirical methods—has generated a modern and updated set of insights.

Despite these notable advances, the extant literature remains ripe for additional exploration, in part because it has focused on identifying the determinants of cross-industry variations in observed contracting patterns.[5] That is, studies typically identify observable cross-sectional differences in the nature of the transaction (e.g., whether the exchange involves asset-specific investments) and then relate this variation to observed differences in the choice of governance mechanism (e.g., spot markets, short- or long-term contracts, or vertical integration).[6] These studies do not examine how the choice of governance structure changes over time. Yet these changes can be pronounced. To illustrate, consider Figure 1 which shows that the share of freight railroad shipments in the United

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[4] For comprehensive literature reviews, see Shelanski and Klein (1995), Crocker and Masten (1996), Masten and Saussier (2000), Macher and Richman (2008), Tadelis and Williamson (2013), Lafontaine and Slade (2013), and Cuypers et al. (2021).

[5] Notable exceptions include Pittman (1991), Pirrong (1993, 2017), and Mayer and Argyres (2004) who conduct detailed case studies that examine the evolution of contracting in railroad sidetrack agreements, ocean bulk shipping, liquefied natural gas, and personal computers, respectively.

[6] See Joskow (1985), for example.

States that occurs under contracts (rather than tariffs or price lists akin to spot markets) has increased dramatically over time. That is, the propensity to use one governance approach versus another evolves over time—even for similar transactions within the same industry. Explanations for this pattern might be found within the traditional TCE framework. However, explicit examination of such intertemporal variation can provide a fresh lens on and empirical test of extant theoretical research. Examinations of intertemporal variations in the use of alternative governance mechanisms may also reveal new theoretical drivers that do not arise in cross-sectional empirical settings.

--- Insert Figure 1 here ---

Additional insights may also arise when the temporal evolution of contracting is combined with industry-specific data. For example, Figure 2 disaggregates Figure 1 into fourteen broad commodity classifications.[7] Substantial differences in the use of contracts versus tariffs are clearly evident across these commodities. For instance, contracting in agriculture (viz., farm) is modest (around 25 percent). In contrast, contracting in coal, miscellaneous mixed, and containers is substantial (nearing 100 percent). While all commodities exhibit some tariff-to-contract transition over time, markedly different levels, rates, and patterns are observed.

--- Insert Figure 2 here ---

Most empirical TCE research to date focuses on the canonical make-versus-buy decision, where "make" is considered vertical integration or insourcing, and "buy" is considered some type of contractual relationship or outsourcing.[8] In contrast, Figures 1 and 2 provide insights into an element of research that is much discussed but rarely investigated: namely, whether market participants rely on spot markets or contracts to govern exchange. While the extant literature has focused on various contractual features, including design, duration and completeness, relatively

[7] The fourteen commodity classifications are at the two-digit Standard Transportation Commodity Code (STCC) level: (1) Farm, (2) Coal, (3) Nonmetallic Minerals, (4) Food, (5) Wood, (6) Paper, (7) Chemicals, (8) Stone, (9) Metal, (10) Transportation, (11) Waste, (12) Containers, (13) Miscellaneous Mixed, and (14) Hazardous. Commodities not classified above are aggregated into an "Other" category and used as the omitted category in empirical estimations.

[8] See, e.g., Klein (2005) and Bresnahan and Levin (2013) for extensive reviews.

little empirical work has considered the more primal questions of whether and when parties choose to use contracts at all.[9]

With these considerations in mind, this paper seeks to advance the existing literature in two ways. First, we compare the use of contracts with the use of what is effectively a spot-market option. Second, we identify and quantify several time-varying determinants of exchange governance— determinants that are usually beyond the reach of standard cross-sectional analyses—including legislative changes, transaction complexity and asset specificity, contracting experience, intra- and inter-industry competition, and technological change. We do so by drawing on a database of millions of individual market transactions in the U.S. freight rail industry that spans several decades.

Along with those factors identified in existing cross-sectional studies of exchange governance, our empirical results indicate that several time-varying factors shape firms' decisions to employ contracts versus spot-market-like tariffs in the freight rail industry. For instance, we find (as expected) legislation that explicitly permits contracting facilitates its use, but (perhaps more surprisingly) does so in heterogeneous fashion across commodities and over time. We also find that transaction complexity and asset specificity, as well as contracting experience, significantly affect the propensity for railroads and shippers to employ contracts rather than tariffs. We also find that the extent of competition affects freight rail contracting decisions in nuanced ways that depend upon origin (O) and destination (D) geographic area breadth, commodity and service characteristics, and potential transportation alternatives. The number of competitive alternatives available at a specific O or D or within an O–D pair jointly provided by multiple railroads (so-called interline service) increases the use of contracting—over aggregated commodities and only within narrowly-defined geographic areas. The number of competitors offering freight rail service within a particular commodity at a specific D also affects contracting propensities, while the extent of intra-industry competition at more broadly-defined geographic areas does not. Viable (commodity-specific) and proximate (distance-dependent) inter-industry competition via water barge also increases the propensity to contract. Finally, technological change, as effectuated in the freight rail industry through innovations in intermodal shipping, is found to increase contracting

[9] See, e.g., Lafontaine and Slade (2013) for an excellent taxonomy and review.

propensity. These findings are robust to empirical tests that consider alternative estimation approaches, different measurement methods, and alternative sets of explanatory variables.

The remainder of this paper is organized as follows. Section 2 reviews a set of important policy changes that motivated alterations in the choices of exchange governance made by freight rail carriers beginning in the late 1970s. Section 3 describes the data and provides the conceptual lens through which we explore the evolution of the choice of exchange governance mechanisms – contracts versus posted tariffs – in the freight rail industry. Section 4 provides descriptive and correlation statistics, specifies the empirical model, and presents baseline results and robustness tests. Section 5 concludes by providing a reflective discussion of the key findings, offering potential directions for future research, and identifying the limitations of our research.

2. Background: The Legal Evolution of Rail Contracting

In October 1980, President Carter signed the Staggers Rail Act into law. The Act provided a comprehensive recalibration of the policies that had governed the rail industry for decades. The Staggers Act is commonly viewed as one of the most successful deregulatory measures of the 20th century.[10] The Act contained several deregulatory features, including a shortened timeline for rail abandonment proceedings, an expedited merger review process, relaxed railroad entry conditions, expanded regulatory oversight exemptions of certain commodities or certain transport (via equipment type), and expanded pricing flexibility for rail carriers.

The Staggers Act also granted profound regulatory relief to rail carriers by legalizing contracting. To understand the gravitas of this change, consider that, beginning with the passage of the Interstate Commerce Act of 1887, the terms and conditions for freight rail shipments in the U.S. were heavily prescribed by the Interstate Commerce Commission (ICC). Customers who wished to have goods shipped by rail could do so only at terms that were established by the ICC under common carriage tariffs. These tariffs—often detailed by commodity type and distance—were publicly available to all shippers. For example, in 1960, the tariffed rate for an 800-mile shipment of rugs and carpeting in rail carloads was set by the ICC to be “185 cents per 100 pounds for a minimum of 24,000 pounds, and, in the case of the rail rates, 148 cents on weight in excess

[10] In the legislation authorizing the sunsetting of the Interstate Commerce Commission, the accompanying Senate Commerce Committee Report declared “[t]he Staggers Act is considered the most successful rail transportation legislation ever produced, resulting in the restoration of financial health to the rail industry.” S. Report No. 104-176, at 3, 1995.

thereof."[11] All rail traffic shipped in the U.S. was subject to these regulated tariffs with the terms overseen by the ICC; deviation from any tariff term was strictly prohibited (Palay, 1985).

In 1961, New York Central Railroad and a shipper entered into a contract at a different (viz., lower) rate than the established ICC tariff, conditional upon the shipper committing no less than 80 percent of its annual volume between the origin-destination (O-D) pair: Amsterdam, New York and Chicago, Illinois.[12] The ICC investigated this contract and found it to be illegal, providing two reasons why it would constitute a "destructive competitive practice" if allowed to stand. First, the contract would lead to "the destruction in large measure of what is in general a just, reasonable, and otherwise lawful rate structure necessary to maintain an adequate national transportation system."[13] Second, the contract would "destroy competition for the duration of the contract."[14]

The ICC ruling was not only a focused attack on the specific contract at issue, but also a more broadside attack on the general use of contracts. In concurring opinions, two ICC Commissioners went so far as to opine that "[c]ontract rates could well mean the end of a national transportation system, either as we have known it (highly workable despite its imperfections), or, as many hope to see it, a truly coordinated system featuring the use of each mode of carriage under single billing."[15] Although challenged in federal court, the ICC ruling was upheld: the use of individually negotiated rail contracts for rail shipments in the U.S. was and remained illegal.[16]

With the further deterioration of the rail industry, the ICC changed direction 17 years later by acknowledging that contracts may be beneficial in some circumstances because "a shipper is guaranteed a certain rate for the period of the contract while the carrier knows what service that shipper will receive."[17] This policy change transitioned the use of contracts from a *per se* illegal basis to one in which contracts were judged on a case-by-case basis.

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[11] See New York Central Railroad Company v. United States, 194 F. Supp. 947 (1961) available here.

[12] See Contract Rates on Rugs and Carpeting from Amsterdam, N.Y., to Chicago, 313 I.C.C. 247, 254 (1961); Guaranteed Rates from Sault Ste. Marie, Ontario, Canada, to Chicago, 315 I.C.C. 311, 323 (1961).

[13] Id.

[14] Id.

[15] Id.

[16] Given the illegality of formal contracting, it is not surprising that some amount of informal or oral contracting arose during the pre-Staggers era. See Palay (1985) for a discussion.

[17] Change of Policy Railroad Contract Rates, Ex Parte No. 358-F (ICC served Nov. 9, 1978).

When Congress initiated further reform of the rail industry, it determined that the Commission had not gone far enough in permitting expanded use of contracts.[18] In what eventually became the Staggers Rail Act of 1980, legislation specified that railroads "may enter into a contract with one or more purchasers of rail services to provide specified services under specified rates and conditions."[19] The legislative history of Staggers reveals that the contract provisions were intended "to encourage carriers and purchasers of rail service to make widespread use of such agreements."[20] Collectively, the contract rate provisions of the Staggers Act were considered to be "among the most important in the bill."[21]

Several key features of contracting that were enabled by the Staggers Act appear critical to its growth. First, contracting authority was substantially broader than the original ICC case-by-case approach.[22] Second, all rail contract disputes were removed from ICC jurisdiction,[23] and instead relegated to the appropriate state or federal court.[24] Third, anticompetitive allegations regarding contracts were to be dealt with by the antitrust laws and agencies rather than by railroad regulators.[25] Fourth, contracts between rail carriers and shippers were largely to be held confidential,[26] which subsequently permitted differential rail carrier pricing and facilitated the crafting of individual contracts. Finally, and perhaps most importantly, constraints around price-quality tradeoffs were eased. Pre-Staggers regulatory proscriptions on parties negotiating prices and quality levels created constraints that led to standard tariffs for all shipments. These tariffs were predicated on unilateral rail carrier "best-efforts" in quality, rather than negotiated and mutually-agreed upon levels of quality.[27] This restriction—more constraining for some than

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[18] See, e.g., H.R. Rep. No. 96-1035, 96th Cong., 2nd Sess. (May 16, 1980) at 57 (House Report).

[19] Former 49 U.S.C. 10713(a) (1995) (now codified at 49 U.S.C. 10709(a))

[20] See Staggers Rail Act of 1980, Report of the Committee on Conference on S.1946 to Reform the Economic Regulation of Railroads and for other Purposes, September 29, 1980, p. 98.

[21] See Railroad Transportation Policy Act of 1979, Report of the Committee on Commerce, Science, and Transportation on S.1946, Report No. 96-470, November 29, 1979, p. 9.

[22] The Staggers Act did not endow railroads with unfettered ability to undertake contracting. The Act states that "a rail carrier may not enter into a contract with purchasers of rail service except as provided in this section." Former 49 U.S.C. 10713(a) (1995). This limiting language was eliminated with the passage of the ICC Termination Act of 1995.

[23] See former 49 U.S.C. 10713(i) (1995) (now codified at 49 U.S.C. 10709(c)).

[24] See former 49 U.S.C. 10713(i)(2) (1995) (now codified at 49 U.S.C. 10709(c)(2)).

[25] House Report at 58.

[26] See Stone (1991).

[27] See Phillips (1991, p. 557) and Palay (1985, p. 162).

others—created governance disequilibria in the immediate wake of Staggers that would predictably be rectified once the constraint was lifted.

In summary, all freight rail traffic was subject to common carrier regulation prior to the Staggers Act. Under this regulatory regime, freight rail carriers posted a generally available price for shipments with particular characteristics. This price was subject to regulatory approval and, once published, was available to all customers (shippers) who wished to avail themselves of that price. With the passage of the Staggers Act, railroads were freed to establish prices that reflected prevailing market conditions,[28] and were granted the authority to negotiate and implement Pareto-improving contracts with shippers. These contracting changes permitted railroads and shippers to expand the dimensionality of the terms under which they could engage in business, including quality and other special service levels.[29]

The Staggers Act thus permitted a choice between two distinct exchange governance mechanisms: tariffs (akin to spot market prices) and contracts. Railroads continued to offer a menu of set prices that are still referred to as "tariffs" in the industry for shipments between specific origins and destinations. As with pre-Staggers Act tariffs, post-Staggers Act tariffs are not customer-specific, and service quality generally is determined by standard service provisions (so-called "best-efforts") of the rail carrier involved. Moreover, for certain commodities, regulations still require that railroads offer a tariffed rate of service: a common carrier obligation. In the wake of the Staggers Act, however, tariffs have evolved into a mechanism akin to a simple public pricing document that enunciates the terms under which service will be provided. Post-Staggers Act prices are, absent regulatory intervention, set by the rail carrier and can change as prevailing market conditions change. Price increases require twenty-day notice; price reductions occur at the discretion of the rail carrier. Prices do not adjust instantaneously to equilibrate the supply of and the demand for transportation services, as would be the case in a perfect spot market. However, the prices are influenced by the same forces that shape spot market prices.[30] Railroads and shippers

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[28] For discussions of the residual price regulation in the wake of Staggers, see Mayo and Sappington (2016), Burton and Hitchcock (2019), and Mayo and Willig (2019).

[29] Malone (1980) provides several examples.

[30] In his seminal work on vertical integration and contracts in the electric utility industry, Joskow (1985) similarly relies on imperfect approximations to a perfect spot market. He employs the Department of Energy's definition of "spot" market purchases of coal as purchase orders or contracts with a duration of less than one year.

can enter into contracts for shipments between particular origins and destinations. Unlike tariffs, contracts are customized for particular shippers, reflecting mutually agreed-upon prices and levels of service quality.[31] The terms of these contracts can be kept confidential and are legally enforceable.

3. Conceptual Framework

Masten and Saussier (2000) observe that the decision to contract is discrete, and is determined by whether the parties anticipate greater net benefit from contracting vis-à-vis an alternative exchange governance mechanism. In our industry setting, we observe two governance mechanisms under which exchange occurs: (1) shippers purchase "best-efforts" transportation services for specific commodities and origin-destination pairs under tariffs established by railroads; or (2) shippers and railroads negotiate contracts for transportation services for specific commodities and origin-destination pairs that represent mutually-agreeable prices and associated terms of carriage. Accordingly, our empirical analysis seeks to provide insights into the determinants of whether shipments occur under contracts or tariffs.[32]

Data Sources

The main data are drawn from annual versions of the Surface Transportation Board (STB) Carload Waybill Sample (CWS).[33] The CWS Program requires freight railroads that terminate 4,500 or more carloads annually to sample and report their waybills.[34] Freight waybills provide detailed railroad carrier- and shipment-specific information, including the commodities shipped, corresponding weights and revenues, and shipment origin(s) and destination(s).

Sampled waybills are submitted electronically to Railinc Corporation (a private contractor), which first processes and corrects any record errors and then provides this information to the STB

[31] Some contracts may be relatively straightforward, involving relatively simple movements of goods between two points. Other contracts may be quite complex, involving shipments from multiple origins to multiple destinations.

[32] The Appendix provides a simple theoretical framework that reflects several of the key elements that are likely at play in our empirical analysis.

[33] The Surface Transportation Board is the successor regulatory body to the ICC, which was terminated in 1995. Pub. L. No. 104–88, 109 Stat. 803, codified in relevant part at 49 U.S.C. §10706.

[34] Sampling rates vary depending upon the number of carloads per waybill shipped as follow: 2.5 percent for 1 to 2 carloads; 8.3 percent for 3 to 15 carloads; 25 percent for 16 to 60 carloads; 33.3 percent for 61 to 100 carloads; and 50 percent for 101 or more carloads.

and the Federal Railroad Administration (FRA). Processed carload waybill records provide information on railcars (e.g., number, type, and ownership), origin and destination locations, and freight (e.g., tons, miles, revenue, and commodity type). Origin and destination locations are available at different geographic units of observation, including Federal Information Process System (FIPS), Standard Point Location Code (SPLC), and Freight Station Accounting Codes (FSAC). FIPS is the broadest geographic unit of observation, defined at the state level and the county level. SPLC is a narrower geographic unit of observation, defined at the city or region level. FSAC is the narrowest geographic unit of observation, defined at the actual freight railroad station.[35] We use FSAC as our baseline, but consider SPLC and FIPS in empirical robustness tests. Commodities are categorized using the U.S. Department of Commerce Standard Transportation Commodity Code (STCC) system. STCCs are seven digits: the first two digits represent major commodity groups; each additional digit adds commodity classification refinement.

As mentioned, the Staggers Act maintains confidentiality in contract reporting. The STB restricts access to waybill data according to federal regulation 49 CFR 1244.9 via a system of included and deleted data fields. Shipment information sent to Railinc is encrypted and marked with a flag indicating whether it occurs under contract or tariff. Three distinct CWS versions exist: (1) a "public" version that removes all confidential data fields and replaces actual contract revenue with public tariff-based revenue; (2) a "masked" version that provides some confidential non-revenue data fields but replaces contract revenues with tariff-based revenues; and (3) an "unmasked" version that provides all confidential data fields and actual contract and tariff-based revenue. By application to and approval from the STB, we use the unmasked CWS data over 1984–2014, but we drop the first three years because reliable CWS data for estimation purposes only begin in 1987.[36] Each year includes roughly 500,000 records (waybills), with a total sample of just over 15 million observations. Each waybill is referred to as a "shipment," which can range from one carload to an entire trainload (e.g., more than 100 carloads).

[35] The FIPS codes have five digits: the first two digits correspond to the state; the remaining digits reflect the county. The SPLC codes have six digits: the first two digits identify the state, province or territory; the next two digits reflect the county; the last two digits pertain to the city or region. The Railinc-assigned FSAC codes are carrier-specific and unique for every station that originates billing.

[36] The application, reported in the Federal Registrar: Surface Transportation Board. "Release of Waybill Data." 81 Federal Register 79 (25 April 2016), pp. 24158. Our starting date, 1984, coincides with the first available unmasked waybill sample. Our ending year coincides with the last available yearly data at the time of our application.

We supplement the CWS data with information from four additional sources. The supplemental data provide additional controls and allow for robustness testing, but slightly reduce the number of observations in empirical estimations. First, we include a measure from the Federal Reserve Bank of St. Louis that reflects total U.S. industry capacity utilization.[37] This is a percentage-based measure that varies monthly. Second, we include waterway facility- and location-specific information from the U.S. Army Corp of Engineers (which is only available using FIPS codes). These data measure the distance (in miles) of each FIPS location to a navigable coal, dry bulk, general, or liquid-processing water barge facility. Third, we include water barge shipment information from annual versions of Informa Economics IEG "Barge Commodity Profile" (Informa Economics IEG, 2004-2014). These data indicate the annual amount (in ton-miles) that particular commodities are transported by water barge. Fourth, we adjust the CWS data for all mergers and exits over our sample to ensure that ownership is reflected accurately.[38] The freight railroad industry experienced substantial consolidation Post-Staggers Act: from 36 class I carriers in 1978 to seven in 2014.

Transaction Cost-Related Factors

Extant TCE theory posits that contracting decisions depend on the magnitude and type of associated transaction costs. In the freight rail industry, transaction costs vary over time and across contracting parties and are affected by factors that include the following.

Legislation – Given the pre-Staggers regulatory contracting restrictions, the transaction costs associated with railroad-shipper contracts were effectively infinite. As Section 2 notes, the binding nature of this constraint was especially salient as common carrier regulation first prohibited (until 1978) and then failed to fully embrace (over 1978-1980) contracting to implement shipper-specific service quality levels. To the extent that freight rail carriers and shippers valued quality heterogeneously, the inability to contract in this dimension created exchange governance disequilibria.[39] Counterfactually, had such contracting restrictions not existed, some pattern of

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[37] These data are available from the Federal Reserve Bank of St. Louis here.

[38] We employ several sources to do so, including the Association of American Railroads (AAR), Illinois Central, Laurent Aublette, and Wikipedia.

[39] The notion that demand-side market heterogeneity may underlie differences in optimal governance structures arises in other industries. To illustrate, Lyon and Hackett (1993) examine the exchange governance implications of quality demand differences (as manifested in reliability) in the natural gas supply industry. The authors note that residential retail customers have a high demand for reliability relative to industrial customers, which creates a natural co-existence of long-term contracts (for

exchange intermediate between "all contracts" and "all tariffs" would have been observed. However, with the existing legal hurdles in place, equilibrium levels of contracting could not be unattained.

Once the Staggers Act removed contracting restrictions, the transaction costs associated with writing and implementing contracts declined precipitously. However, a new, unconstrained equilibrium did not occur instantaneously because freight rail carriers and shippers had configured their capital to reflect prevailing pre-Staggers Act restrictions. Given the long-lived nature of this capital, any contracting transition was thus likely to arise only after the capital had depreciated sufficiently.[40] To account for contracting behavior after the passage of the Staggers Act, we employ time (viz., year) fixed effects in our regression equation.

Complexity – The use of contracts vis-à-vis tariffs in the post-Staggers Act freight rail industry likely varied with the associated transaction complexity. We proxy for transaction complexity primarily by using the commodity of the freight shipment. For some commodities (e.g., coal, paper, etc.), both origin (O) and destination (D) locations and the volume shipped can be reasonably anticipated and contracted for in advance. Such predictability suggests that post-Staggers contracting for these commodities is less complex and therefore more likely to have increased considerably soon after the passage of the Staggers Act. For other commodities (e.g., agriculture), greater O and/or D uncertainty or volume variability exists due to variation in geographic-related supply (e.g., crop yields) or demand (e.g., exports) conditions.[41] This commodity uncertainty raises the transaction costs for freight railroad carriers and shippers, which could slow the post-Staggers Act adoption of contracting. We use a series of two-digit STCC indicator variables (*STCCs*) to capture commodity heterogeneity.

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residential customers) and spot markets (for industrial customers). The authors find that the aggregate empirical data on the percent of natural gas sales conducted as spot markets transactions and under long-term contracts in the industry is consistent with quality demand heterogeneity, with long-term contracts employed to reduce the transaction cost of supplying natural gas to customers who value reliability particularly highly.

40 Meyer and Tye (1988) observe that "[a] clean slate for negotiating a market-driven contract between the various participants—a contract that provides incentives for all participants to commit the needed capital under market rather than regulatory circumstances—will emerge only as the previously committed capital (sunk cost) is amortized."

41 Interviews with multiple railroad executives revealed that shipment origins vary due to changes in growing conditions, whereas shipment destinations vary due to changes in export markets. This heterogeneity can complicate contracting for freight rail transportation services.

We also include a separate transaction complexity measure that captures persistence in shipment origins and destinations by commodity over time: $PERSISTENCE_{it}$ is an indicator variable equal to one if commodity *i* appears in the same O-D pair in a consecutive year *t*, and zero otherwise.[42] This variable is defined at the FSAC geographic level in baseline estimations and at the SPLC and FIPS geographic levels in empirical robustness tests. We expect persistence in commodity-specific shipments will reduce complexity and result in more contracting relative to spot market transactions.

Asset Specificity – Economic exchange is often affected by the presence of relationship-specific investments. Such asset specificity occurs when parties to the transaction make transaction-specific asset investments that have lower values in alternative uses. In the context of the governance decision between vertical integration and contractual alternatives, empirical analysis has shown that the presence of asset specificity increases incentives to vertically integrate. However, as noted by Joskow (1985, p. 38), to the extent that vertical integration is not economical, "contractual arrangements to govern exchange between independent agents will emerge to economize on these transactions costs."

One form of asset specificity in the freight rail industry relates to the use of specialized railcar types. For illustration, Figure 3 compares the two-digit STCCs to the Surface Transportation Board (STB) railcar types utilized. Several broad patterns are readily apparent: Containers and Miscellaneous Materials and Containers almost exclusively use Flat TOFC/COFC (intermodal) Cars; Hazardous Materials predominantly use Tank Cars; Paper uses Equipped Box Cars; Farm uses Covered Hopper Cars; Transportation uses Flat Other Cars; Chemicals and Stone use Covered Hopper Cars; Metals use Equipped Gondola Cars; and Nonmetallic Material and Coal use Open Top Hopper Cars.

Compared to "generic" railcars (e.g., Plain Box or Gondola Cars), more specialized railcars represent greater specificity in use within these commodities. For example, multi-level flatcars are designed nearly exclusively for transporting automobiles. Absent any contractual protections, one party making relationship-specific investments in multi-level flatcars might be subject to *ex post*

[42] This variable is set at one in the first year the two-digit STCC and O-D pair occur in the data. It remains equal to one or resets to zero, depending upon whether the two-digit STCC persists in that O-D pair the next year.

opportunism.[43] We create a set of indicator variables for several specialized railcar types that proxy for asset specificity. Such specificity is likely to increase contracting propensity, to mitigate such opportunism. Specialized Railcars (*SPEC RC*) indicate whether shipment *i* for railroad *j* at shipment date *t* utilizes equipped box cars (EQB_{jt}), equipped gondola cars (EQG_{ijt}), open-top special hopper cars (OTH_{ijt}), refrigeration cars (REF_{ijt}), or the aforementioned multi-level flat cars (MLF_{ijt}). General (i.e., industry-termed "plain") and non-specialized railcars serve as the baseline.

--- Insert Figure 3 here ---

A second form of asset specificity in the freight rail industry relates to car ownership. High-volume shippers (and third-party logistics firms) often utilize railcars that they own directly or lease from non-railroad entities.[44] Such private railcar ownership can create value for both freight rail carriers and shippers. For carriers, it frees capital that can be used for other purposes (e.g., track or yard maintenance). For shippers, it affords greater control, supply assurances, and economic efficiencies relative to those available with equipment owned by the rail carrier. To illustrate, shippers can store commodities in their own railcars and at locations of their choosing. Frequent shippers of the same commodity (e.g., chemicals) and O-D pair can utilize their own railcars without any post-shipment interior cleaning, whereas standard practice with railroad-owned equipment mandates costly interior cleanings. While creating potential benefits for both freight rail carriers and shippers, private railcar ownership can alter *ex ante* and *ex post* contracting incentives. Shipper railcar investment reduces freight railroad operating costs and can be employed to negotiate more favorable service terms. At the same time, shipper railcar ownership represents asset-specific investments that increase the potential for opportunism, which might be mitigated to some extent by contracting. The variable $PRIV\ RC_{ijt}$ is an indicator of whether shipment *i* by railroad *j* at shipment date *t* occurs in privately-owned railcars.

Experience – The contracting permitted by the Staggers Act enhanced the ability of freight rail carriers and shippers to implement arrangements that increased the joint value of their interaction.

[43] See Palay (1985) for a detailed case study of this asset specificity associated with rail transportation of automobiles using autoracks.

[44] As the industry press indicates, "[r]ailroad freight is a volume business. Shippers and receivers are unlikely to turn to the nation's railroad carriers for those freight cars if their volumes are light. That is simple economics. However, if a company is a high-volume shipper, then its management will consider owning or renting its own railcars." https://www.freightwaves.com/news/commentary-the-complexity-of-owning-or-leasing-freight-cars.

Nevertheless, virtually every aspect of the contracting process was new: from design, to negotiation, to administration. To realize the maximum potential joint value creation, railroads had to learn how to contract with shippers. Although the associated costs were relatively high initially, they likely fell with experience. Contract design and administration, in particular, became more routine over time and as the number of shipments increased. Prior contracting experience – via the consequent cost reductions realized – likely increased the propensity for shipments to move under contract rather than under tariff. We therefore include a measure of experience that represents the discounted, cumulative count of shipments made under contract (net of the focal O-D pair) by railroad *j* at time *t* defined as follows:

$$EXPERIENCE_{it} = \delta \cdot EXPERIENCE_{it-1} + \left(\sum ALL\ CONTRACT\ SHIPMENTS_{it} - \sum FOCAL\ O-D\ CONTRACT\ SHIPMENTS_{it}\right)$$

where δ represents the discount factor. Discounting allows for the possibility that current contracting propensity might be influenced particularly heavily by relatively recent contracting experience. A yearly discount factor of twenty percent is used as a baseline, but other discount factors and variable permutations are considered in empirical robustness tests.[45] EXPERIENCE is defined at the FSAC geographic level in baseline estimations, and at the SPLC and FIPS geographic level in empirical robustness tests.

Competition-Related Factors

The extent of competition in the provision of transportation services may also affect the propensity to employ contracts. To illustrate, when shippers enjoy the presence of multiple carriers capable of supplying their desired O-D shipments, the resulting competition may promote individualized shipper contract offerings. With the leverage afforded by the presence of competitive alternatives, shippers may be able to extract more favorable terms from rail carriers than their posted tariffs offer. Furthermore, shipper-specific contracts might permit rail carriers to secure the patronage of shippers with relatively attractive competitive options by offering favorable carriage terms and conditions.

Measuring the extent of prevailing competition is challenging in part because the geographic market within which competition prevails can vary across commodities.[46] Because the CWS

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[45] These variations do not materially affect the estimation results reported below.

[46] MacDonald (1987, 1989), Pittman (1990), and Kwoka and White (1999) suggest that source competition—at the origin and/or at the destination—may be as important as origin-destination

contains millions of heterogeneous shipments, our ability to capture precise variations in competitive alternatives for specific shipments is limited. However, we approximate these variations using the number and service-type combinations of railroads with presence at either the shipment origin (O) and destination (D) or the shipment origin-destination (O-D) pair and at varying commodity and geographic levels. We use two intra-industry competition measures in separate baseline estimations: (1) $O\ RR\ COMP_{ijt}$ and $D\ RR\ COMP_{ijt}$ measure the respective number of distinct freight rail competitors providing service at the shipment origin and destination; and (2) $OD\ SRR\ COMP_{ijt}$ and $OD\ IRR\ COMP_{ijt}$ measure the respective number of same railroad (single-line) and different railroad (inter-line) competitors providing service over the shipment origin-destination pair.[47] These variables are examined across all (i.e., aggregated) commodity levels and within specific (i.e., disaggregated) commodity levels. They are defined at the FSAC geographic level in baseline estimations, and at the SPLC and FIPS geographic level in empirical robustness tests.

To illustrate the O and D competition measures, suppose that railroads R_1, R_2, R_3 and R_4 operate at the O and railroads R_2, R_3 and R_4 operate at the D. For shipment i from O to D, $O\ RR\ COMP_{ijt}$ equals three and $D\ RR\ COMP_{ijt}$ equals two for all railroads. To illustrate the O-D competition measures, suppose further that R_1 relies upon R_2 for D shipments while R_2, R_3 and R_4 each complete their own D shipments. For shipment i from O to D, $OD\ SRR\ COMP_{ijt}$ equals three for R_1 and two for R_2, R_3 and R_4, while $OD\ IRR\ COMP_{ijt}$ equals zero for R_1 and one for R_2, R_3 and R_4. The alternative intra-industry measures capture the potentially distinct competitive pressures brought to bear by commodity, service type, and geographic differences.

We also consider inter-industry competition from water barge transportation. To capture barge competition, we employ a measure of the distance from shipment origin and destination to the nearest navigable waterway terminal. Following Burton (1993), we employ the variable $BARGE\ COMP_{it}$, which is defined as $1 - (M_{it}/G_t)$: M_{it} denotes the maximum distance (in miles) between the origin or the destination of shipment i and the closest water barge facility at time t; and G_t denotes the global maximum distance (in miles) of any origin or destination to its closest water

competition in providing shippers with competitive alternatives, particularly for bulk commodities such as grain.

[47] These proxies for competition abstract from the indirect competitive pressures for contracting that other carriers without an origin or destination presence might bring to bear.

barge facility at time t. This measure is adjusted to zero for commodities that never incur water barge transport in our sample. $BARGE\ COMP_{it}$ is thus distance-adjusted and commodity-specific: values close to zero reflect little or no viable barge competition, whereas values increasing toward one indicate more viable and more proximate barge competition.

Technological Change

In cross-sectional analyses of contracting, it is not possible to test or control for the possibility that technological change in an industry affects the propensity of parties to use contracts rather than spot markets. In contrast, our decades-long data permit us to examine this possibility directly by considering a major change in the means by which railroads transport goods during the sample window. Specifically, railroad shipments for many years were transported using "break bulk" processes that relied on small, heterogeneous containers.[48] Under break bulk shipping, freight transfer from one transportation mode to another (e.g., loadings and unloadings) was expensive and risky (due to accidents and thefts, for example). Consequently, intermodal competition was *de minimis*: truck freight generally remained on trucks; rail freight typically remained on rail; and barge freight usually remained on barges.

With the advent of intermodal shipping containers and double-stack rail transport, freight transfer costs between modes fell dramatically and thereby encouraged intermodal traffic expansion. Given multi-party coordination and logistics requirements associated with intermodal traffic, however, the associated transaction costs are significantly higher than when working with a single trucking company or a single freight rail carrier. Intermodal transportation complexity thus gave rise to a cottage (and now large-scale) industry of "intermodal marketing companies" that act as intermediaries between shippers and transportation companies (e.g., trucks, railroads, barges).[49] These third-party logistics providers purchase shipping capacity to reflect anticipated shipper needs, serve as a single point of contact, and significantly reduce freight transportation

[48] See, e.g., https://www.morethanshipping.com/history-shipping-containers/.

[49] This is a particular instance of the more general phenomenon identified by Joskow (1985): "[e]conomic institutions (or governance structures) emerge to minimize the costs of making transactions. These costs include both ordinary production costs (land, labor, capital, materials, and supplies) that make up the components of a neoclassical cost function and certain transaction costs associated with establishing and administering an ongoing business relationship. These transaction costs…are real economic costs that must be taken into account along with ordinary production costs in structuring cost-minimizing economic institutions." (p. 35)

transaction costs.[50] Because these companies conduct a relatively large volume of business, they often negotiate with railroads rather than simply accept posted tariffs. In combination, the containerization cost reductions and intermodal marketing companies' abilities to mitigate shipper transaction costs that would have otherwise arisen from intermodal service have led to substantial intermodal transportation growth in the freight rail industry.[51] To capture the potential impact of this technological change, we use $INTERMODAL_{ijt}$, an indicator variable of whether shipment i for railroad j during shipment year t moves via a trailer or container on a flat car (TOFC/COFC). These railcars are specifically designed to enable intermodal transportation by facilitating multiple transportation modes, thereby reducing transportation costs. This variable also indicates the increased likelihood that the transaction is administered by an intermodal marketing company under contract rather than tariff.

Controls

We include several additional control variables that might affect the propensity of rail carriers or shippers to employ contracts rather than tariffs. One such variable captures an element of prevailing macroeconomic activity. Contracts may be relatively beneficial during robust economic periods both to shippers (e.g., who can turn shipments into sales relatively rapidly) and to rail carriers (e.g., who particularly value expanded flexibility to manage constrained rolling rail stock). To account for this possibility, we employ the variable $CAP\ UTIL_t$, which is a continuous (i.e., 0-100) measure of aggregate US industry capacity utilization in month t.

The use of contracts might also depend upon particular freight shipment characteristics. We control for several shipment-level characteristics, including: (1) an indicator of whether the shipped commodity is exempt from STB regulation (*EXEMPT*);[52] (2) the logged distance (in miles) of the shipment (*SHIP DIST*); and (3) the logged weight (in tons) of the shipment (*SHIP WEIGHT*). Table 1 provides definitions for the variables described.

--- Insert Table 1 here ---

[50] See e.g., https://blog.intekfreight-logistics.com/what-is-intermodal-marketing-company-imc.

[51] With the proliferation of containers and trailers, intermodal traffic emerged as the most rapidly growing major rail segment. https://www.aar.org/issue/freight-rail-intermodal/

[52] The Surface Transportation Board (STB) has exempted certain commodities from regulation over time under Ex Parte 346. Commodity examples include primary metal products, waste and scrap materials, and lumber and wood products, among others.

4. Empirical Analysis

Descriptive and Correlation Statistics

Table 2 provides descriptive statistics of the dependent and independent variables using the full sample and sub-samples disaggregated by contract and tariff. Over our entire sample, roughly 60 percent of shipments occur under contract. The 14 two-digit STCC indicator variables identified in Table 2 represent roughly 93 percent of the estimated sample, with six categories—miscellaneous materials (30%), transportation (9%), food (7%), hazardous materials (7%), coal (7%) and containers (6%)—accounting for roughly two-thirds. Commodity shipment persistence within FSAC O-D pairs and across successive years is substantial. Contracting experience (logged, measured net of FSAC O-D contracting experience, and discounted over time) is large in magnitude, but exhibits substantial heterogeneity. Specialized railcar indicator variables are roughly twenty percent of the sample, while slightly more than half of the shipments utilize privately-owned railcars. The average number of FSAC O or D competitor railroads is under one-half, while the average number of single-line and inter-line service alternatives at an FSAC O-D pair is notably smaller. Finally, slightly less than half of the shipments are intermodal.

The contract and tariff sub-samples exhibit several notable differences. Contracts are more prevalent than tariffs in transportation, container, and miscellaneous material commodities. In contrast, tariffs are more prevalent than contracts in farm, food, and wood commodities. Contracts are more prevalent with greater complexity as reflected in the FSAC O-D commodity persistence measure. Contracts are employed more commonly as contracting experience increases. Contracts and tariffs are employed similarly for many specialized railcar types, but differently for equipped box cars (more tariff-based) and multi-level flat cars (more contract-based). The use of private railcars is much more prevalent under contracts than under tariffs. Nearly all of the intra-industry competition averages, as well as the inter-industry (barge) competition averages, are smaller for shipments under contract than under tariff. Intramodal transport is more prevalent under contracts than tariffs.

Table 3 provides pair-wise correlation statistics for the dependent and independent variables using the full sample. (STCCs are excluded due to space constraints.) Contracting is positively correlated with commodity shipment persistence, contract experience, specialized multi-level flat railcar use, private railcar use, and intermodal shipments. Contracting is negatively correlated with all other specialized railcar usage. Finally, contracting is negatively correlated with intra-industry and inter-industry competition.

--- Insert Tables 2 and 3 here ---

The descriptive statistics in Table 2 and correlation statistics in Table 3 are informative, but do not reveal the contracting heterogeneity that occurs over time and across commodities. Recall that Figure 1 shows considerable variation in the level of and change in contracting over time, and Figure 2 identifies stark differences in contracting propensity across commodities. These effects are largely driven by particular Class I freight rail carriers: (i) entering into contracting at different times; and (ii) varying their contracting usage across commodities and/or over time.[53] These freight rail carriers' use of contracting varies by intensity, by time interval, and by commodity. A few carriers began contracting relatively soon after the Staggers Act passage, and expanded contracting rapidly and across all commodities. Other carriers entered into contracting either later, more gradually, or only for particular commodities. Substantial heterogeneity in contracting thus prevails across and within freight rail carriers, over time, and by commodity.

The data reveal at least four general patterns. First, contracting increases across all Class I freight rail carriers over the sample period. Second, contracting accelerates in two "waves"— one beginning in 1995 and another beginning in 2000. Third, certain commodities (e.g., coal and miscellaneous materials) are almost exclusively transported via contract, while other commodities (e.g., food and farm) exhibit greater variation. Fourth, contracting heterogeneity prevails within and across carriers, within and across commodities, and over time.

We now turn to an empirical model to estimate how variations and shifts in legislative and regulatory factors, transaction cost factors, competition, and technological change in the industry affect the choice between contracts and tariffs and help explain these patterns.[54]

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[53] Freight railroads are classified by revenue: Class I (largest), Class II, and Class III (smallest). The Class I carriers represent the majority (i.e., approximately 80 percent) of observations and an even larger percentage of ton-miles.

[54] Our use of the Surface Transportation Board (STB) CWS entails a confidentiality agreement that precludes reporting on individual railroad's contracting approaches in general, by specific commodities, or over time.

Empirical Model

The primary objective of our empirical analysis is to identify the determinants of contracting that have evolved in the freight railroad industry after the passage of the Staggers Act. Our dependent variable ($CONTRACT_{ijt}$) is dichotomous—equal to one if shipment *i* occurs under contract for railroad *j* at shipment date *t* and zero otherwise. The combined CWS and supplemental data offer millions of observations that are available over 1984-2014. However, reliable CWS data for estimation purposes begins in 1987.

Given the binary nature of the dependent variable, we employ probit estimation:

$$PR\ (Y = 1 \mid X) \ = \ \Phi(X^T \beta)$$

where Y represents the dependent variable ($CONTRACT_{ijt}$) and X represents a matrix of independent and control variables.[55] $\Phi(\cdot)$ denotes the cumulative standard normal distribution function. The β parameters are determined by maximum likelihood estimation.

Empirical Results

Tables 4 and 5 present the baseline estimation results at the FSAC geographic level. Table 4 reports the year and commodity (STCC) fixed effect coefficients. Table 5 reports the independent variable coefficients and their corresponding marginal effects.[56] Standard errors are robust, clustered (by freight railroad carrier), and reported below the coefficients. The models in the tables capture intra-industry competition at different STCC levels: Models 1-2 aggregates over all two-digit STCCs; Models 3-4 disaggregates within two-digit STCCs. In each model pair, the first estimation considers O and D competition and the second estimation considers O-D (single-line and inter-line service) competition.

The Table 4 results suggest that time since the Staggers Act passage is an important determinant of contracting. Nearly all of the year fixed effect coefficients are positive in sign, and many are statistically significant, relative to the 1987 baseline. Year fixed effect coefficients are relatively large in magnitude during the 1994-1995, 1999, and 2004-2014 periods. These findings

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55 We adopt this single-equation specification in lieu of a more complex multi-equation specification capable of capturing the potential for variations in contracting to affect observed levels of our independent variables. Thus, our findings are necessarily caveated by the potential for endogeneity in our specification.

56 Due to space constraints, the coefficients on the control variables discussed at the end of Section 3 above are not reported in Table 5. None of these coefficients are statistically significant.

suggest that the legislative endorsement of the Staggers Act initially enabled, and subsequently facilitated, the use of contracting in the industry.

The findings in Table 4 also indicate that post-Staggers contracting propensities vary by commodity shipped, suggesting that transaction complexity can affect contracting decisions. For instance, *STCC-PAPER* ($p < .05$) and *STCC-MISCM* ($p < .05$) are positive and significant. Pulp and paper products typically are shipped from specific production locations to specific, unchanging consumption locations. By contrast, *STCC-FARM* is negative and significant ($p < .05$). Farm product origin and destination locations vary considerably over time as prevailing supply (e.g., crop yield, weather) and demand (e.g., export) conditions change. The identified findings thus suggest that origin or destination uncertainty can increase contracting transaction costs and thus reduce contracting propensities. This finding is consistent with extant cross-sectional empirical research that suggests "the costs and limitations of contracting grow with the complexity and uncertainty of the transaction" (Masten, 2000, p. 35).

--- Insert Table 4 here ---

Table 5 provides further evidence that transaction complexity affects contracting decisions. The variable *PERSISTENCE* is an indicator of whether a commodity persists in the same FSAC O-D pair over consecutive years. Its coefficient is positive and significant ($p < .05$) across all models, suggesting commodities that demonstrate persistence within an O-D pair over time are thus more likely to be shipped using contracts than tariffs.

The Table 5 results provide support for the well-known proposition that asset specificity is an important determinant of contracting propensity. First, the use of some specialized rail equipment has a positive and significant impact on the propensity to contract: equipped box cars (*SPEC RC EQB:* $p < .05$)—employed extensively for paper shipments—and multi-level flatcars (*SPEC RC ML FLAT:* $p < .05$)—employed predominantly for miscellaneous material and automobile shipments—are more likely to be conducted under contract than tariff. Second, the use of private railcars (*PRIV RC*: $p < .05$) significantly increases the observed contracting propensity.

The findings in Table 5 identify prior contracting experience as a driver of contracting. *EXPERIENCE* is positive and significant ($p < .001$), providing support for the general hypothesis that, as parties gain contracting experience, the incremental transaction costs associated with this governance mechanism fall, thereby increasing its use.

The Table 5 results provide insights into how intra-industry competition affects contracting decisions. The first two models examine freight rail competition at aggregated STCCs (i.e., the number of freight rail competitors providing service to the same O and D or the same O-D pair across all commodities): Model 1 indicates *O RR COMP* ($p < .05$) and *D RR COMP* ($p < .001$) are positive and significant; Model 2 indicates *OD SRR COMP* is negative but not significant, and *OD IRR COMP* is positive and significant ($p < .05$). The next two models examine freight rail competition at disaggregated STCCs (i.e., the number of freight rail competitors providing service to the same O and D or the same O-D pair and in the same commodity as the focal shipment): Model 3 indicates *O RR COMP* is positive but not significant, and *D RR COMP* is positive and significant ($p < .05$); Model 4 indicates *OD SRR COMP* and *OD IRR COMP* are positive but not significant. These findings suggest that the impact of intra-industry competition on freight-rail contracting varies not only with commodity characteristics, but also with available competitive service alternatives at the origin and destination and origin-destination pair. We explore other permutations of intra-industry competition in empirical robustness tests below.

The findings in Table 5 indicate that *BARGE COMP* is positive and significant ($p < .001$), indicating that the prospect of inter-industry competition increases the propensity for freight rail contracting. Recall that this variable is both distance-adjusted and commodity-specific, where a value close to zero indicates little, if any, viable water barge competition whereas values closer to one represent more viable and more proximate water barge competition. The baseline findings indicate that for commodities that can be shipped by water barge, proximity of the shipment's origin and destination to a water barge transport facility increases the likelihood that freight railroads and shippers employ contracts rather than tariffs.

Finally, the Table 5 results indicate that technological changes within the freight rail industry – captured here by intermodal shipments that utilize standardized containers – significantly altered the use of contracts relative to spot market tariffs. *INTERMODAL* is positive and significant ($p < .05$) in all model estimations. This significant increase in the use of contracts for intermodal shipping was, in turn, precipitated by the emergence of transaction-cost-reducing intermodal marketing companies that employ contracts to aggregate shipping across transportation modes.

--- Insert Table 5 here ---

Economic Impact

Table 5 also reports the economic impact of the main variables of interest on contracting propensities via average marginal effects: specifically, differences from the base category for discrete variables and rates of change ($\frac{\partial y}{\partial x}$) for continuous variables. Among the discrete variables, *PERSISTENCE* has a relatively large impact, increasing the probability that a shipment moves by contract by more than four percent. Some asset specificity measures also have relatively pronounced effects on contracting: Equipped Box Car (*SPEC RC EQB*) use increases the probability that the freight rail shipment is under contract nearly four percent; Multi-Level Flat Car (*SPEC RC MLF*) use increases the contracting probability by over thirteen percent; and Private Railcar (*PRIV RC*) use increases the contracting probability by more than five percent. Intermodal freight rail shipments increase the likelihood of contracting by nearly ten percent.

Among the continuous variables, *EXPERIENCE* has a relatively large impact on the probability of employing contracts rather than tariffs: a one unit increase in (logged) contracting experience increases the probability of contracting by more than five percent. The extent of intra-industry competition also has sizable effects on contracting propensities. A one unit increase in freight rail competitors operating at the O (D) increases the contracting probability by a 0.5 (2.3) percent, and a one unit increase in interline service competitors operating over an O-D pair increases the contracting probability by 6.7 percent. Finally, inter-industry competition from water barges increases the probability of contracting by roughly seven percent.

Robustness Results

We briefly review some of the empirical robustness tests undertaken to better establish the integrity of our findings. Our findings are robust to other estimation methodologies, including logit and linear probability model (LPM) estimation. The empirical findings are also robust to a "growth rate" formulation, whereby a duration measure (viz., the time since Staggers Act passage) is interacted with each commodity (viz., the two-digit STCCs), creating a series of time trend-by-commodity interaction terms. The findings derived from this estimation approach are very similar to the findings from the baseline estimation reported in Tables 4 and 5 in terms of signs, magnitudes, and significance of the independent variables of interest.

We also examine the robustness of our findings to different permutations of the independent variables. First, the baseline estimations use FSAC as the geographic unit of observation for commodity shipment persistence and contracting experience. Table 6 demonstrates that replacing FSAC with SPLC (Models 1-2) or FIPS (Models 3-4) as the geographic unit of observation little impact on the baseline findings—i.e., coefficients on these respective variables remain positive and significant. Second, one of our baseline findings is that experience with the contracting process is an important determinant of the subsequent use of contracts. Our baseline measure of contracting experience is a summation of the number of annual and discounted shipments (net of the O-D pair) that occur via contract, which allows the benefits of contracting experience to depreciate over time. We considered three permutations to examine the robustness of this finding: (1) varying discount factors (e.g., from ten to fifty percent); (2) employing a simple count of contract shipments made that precede shipment *i* by railroad carrier *j* over the one year prior to shipment date *t*; and (3) employing the percentage of contract shipments to total shipments that occur in a year. Contracting experience remained positive and significant in each permutation.

We also examine alternative measures of intra-industry competition. Our baseline estimations use two freight railroad competition measures at the FSAC geographic unit of observation: (1) the number of competitor railroads at the same origin (O) and same destination (D) as the focal shipment; and (2) the number of competitive alternatives providing single-line or inter-line service over the same O-D pair as the focal shipment. Table 6 considers these competition measures at more aggregated geographic units of observation: Models 1-2 at the SPLC (city-region) level; and Models 3-4 at the FIPS (state-county) level. The findings in Table 6 indicate that no competition measure achieves statistical significance, suggesting that intra-industry competition defined over broad geographic areas (e.g., SPLC, FIPS) is not a significant driver of contracting relative to such competition defined over narrow geographic areas (viz., FSAC).

Finally, we examine whether our results are confounded by omitted or included variable bias. As noted above, we supplement the CWS data with other data sources, including economy-, industry- and railroad carrier-specific information. To probe the sensitivity of the estimation to these data, we estimate the model without these control variables. We find that our principal findings remain unchanged.

--- Insert Table 6 here ---

5. DISCUSSION AND CONCLUSION

Despite the substantial body of research on contracts as an exchange governance mechanism, empirical studies to date have not focused on the primal issue of when transacting parties employ contracts rather than spot markets. Furthermore, most empirical contracting research is cross-sectional in nature, and so does not examine the evolution of contracting choices over time. The present study addresses both of these lacunas.

We believe that the industry setting we consider, the rich proprietary data we employ, and our focus on the evolution of the choice between contracts and spot markets allow us to make useful contributions to the empirical literature on contracts as an exchange governance mechanism. Our analysis of the freight rail industry allows us to examine several institutional, industry and firm transaction-level determinants of exchange governance in an inherently important industry. The granularity of the CWS data capture millions of transactions over an extensive time window, which provides a rare opportunity to examine in detail and with precision the choice between contracts and (spot market) tariffs over time. We find that several factors influence this choice, including legislative changes, transaction complexity and asset specificity, contracting experience, intra- and inter-industry competition, and technological change. We also find that both time-invariant and time-varying factors influence contracting decisions.

Some of our findings support conclusions in earlier, predominantly cross-sectional, analyses. For instance, transaction complexity increases the use of contracting. Our empirical findings document how contracting in freight rail varies with shipment complexity: certain commodities exhibit relatively stable origin (O) and destination (D) locations that facilitate the use of contracts, while other commodities exhibit relatively uncertain or variable O and D shipment locations that advantage the use of (spot-market) tariffs. Similarly, the presence of asset specificity drives the adoption of more contracting relative to spot markets. While these factors are certainly important for organizing economic exchange, these findings are not particularly surprising when considered within the broader empirical TCE literature. Nonetheless, our examination of these factors in the context of the freight rail industry provides a fresh validation of findings in the extant contracting research.

We also identify factors that influence how contracting evolves temporally and varies across products. For instance, the post-Staggers Act contracting evolution (from relatively modest beginnings to slow but punctuated increases in subsequent years and to a leveling-off in the latter years) appears to reflect a pre-Staggers Act disequilibrium in the use of contracts and spot markets. The post-Staggers growth of contracting is consistent with the removal of exogenous constraints on contracting, and the movement toward an equilibrium in the use of alternative exchange governance mechanisms. Our decades-long transaction-level data have also allowed us to examine the important role that parties' experience with particular exchange governance mechanisms can play in the use of contracting. We find a temporal growth in contracting that is consistent with experience-based reductions in the marginal transaction costs of employing contracts over time. Our rich data have also allowed us to consider the potential for technological change within an industry to alter the choice between contracts and spot markets. We find that the introduction of standardized intermodal shipping containers and double-stack rail transport—along with the corresponding growth of intermodal marketing companies—promoted increased contracting. The identification and validation of these time-varying drivers of contracting add to our understanding of the determinants of contracting.

Other factors indicate how contracting decisions are affected in ways that are less well-understood and relatively under-researched. In particular, we document how contracting decisions are affected by the extent of competition. Intra-industry competition affects contracting decisions in three dimensions: (1) service type; (2) geographic breadth; and (3) commodity breadth. We find that a larger number of competitors providing service at specific O and D locations or inter-line service across O and D locations, in narrowly-defined geographic areas, and in aggregated commodity classifications increases contracting. Inter-industry competition that is proximate (i.e., to the O and D location) and viable (i.e., able to be shipped by a transportation alternative) is also found to increase contracting propensities.

Our research suggests at least three potential directions for further study. First, the determinants of the choice between contract and spot market might be examined in other industries where these organizational arrangements both prevail, e.g., trucking, refining, and natural gas. Second, future research might investigate how competition affects not only the contracting decision, but also relevant contract features (e.g., clauses, terms, and duration). Third, future research might examine how variations in the observed exchange governance (i.e., contracts versus tariffs) affects the firms' economic activities: for instance, shipping volume and frequency and the level and composition of investment activity.

Our analysis is not without its limitations. Our examination of the use of contracts versus tariffs in a single industry potentially limits the generalizability of our findings. Our institutional setting also limits our ability to investigate other important considerations identified in the extant contracting literature. For instance, Lafontaine and Slade (2013) observe that empirical contracting studies consider settings where the alternative to contracting is vertical integration. Vertical integration is exceedingly rare in the U.S. freight railroad industry.

As with any empirical analysis, our insights are also constrained by the nature of the data employed. The CWS data impose three primary constraints. First, the contract indicator in the CWS data may reflect a single shipment, or it may cover many shipments that occur over time. Accordingly, the data do not allow for investigations of contract duration, such as those in the seminal studies by Joskow (1985, 1987). Second, the CWS data do not offer access to the underlying contracts themselves. We are thus unable to advance the extant literature that explores the determinants of contract features, such as the extent of contractual completeness (e.g., Crocker and Reynolds, 1993) or whether contracts include price adjustments or other flexibility clauses (e.g., Crocker and Masten, 1991; Murrell and Păun, 2017). Third, although data in the immediate wake of the Staggers Act would be ideal, reliable CWS data only begin in 1987.

Despite these limitations, we believe our analysis extends the empirical TCE literature by employing a rich data set to examine the evolution of the choice between contracts and spot market transactions in an important industry. We also hope that our work will encourage related investigations in other industries and other countries.

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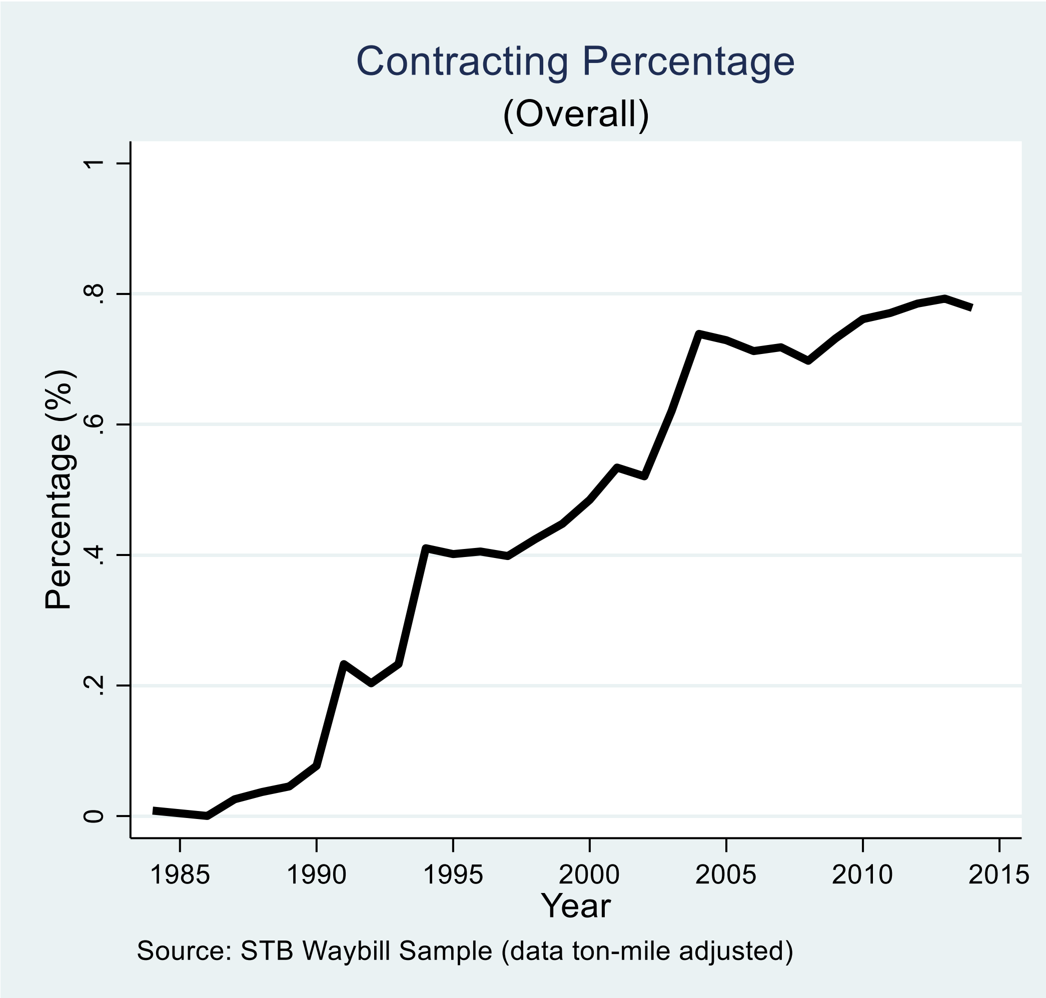
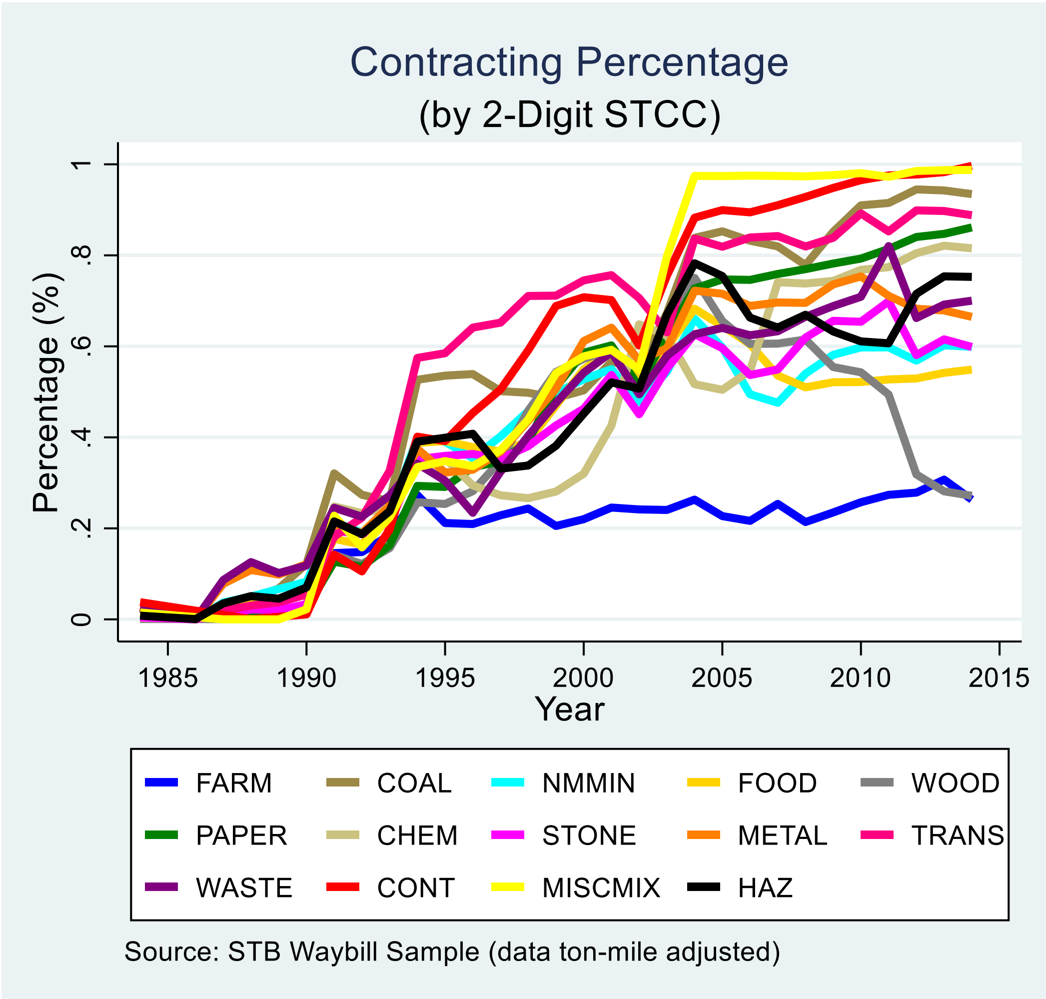
Figure 1: Contracting Percentage (Overall)



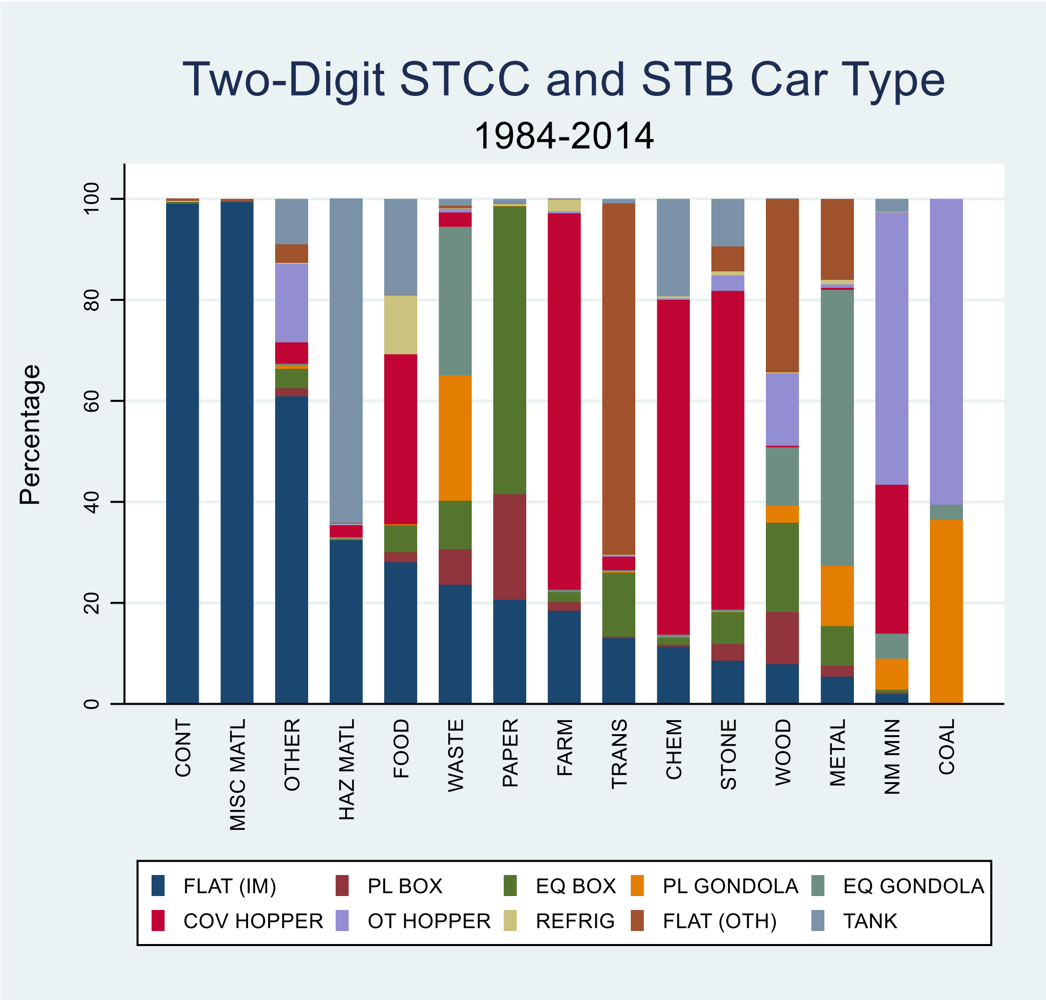
Notes: (1) Figure created using Carload Waybill Sample (CWS) data over 1984-2014. (2) Contracting percentage determined using ton-mile adjusted shipments.

Figure 2: Contracting Percentage (Two-Digit STCCs)



Notes: (1) Figure created using Carload Waybill Sample (CWS) data over 1984-2014. (2) Contracting percentage determined using ton-mile adjusted shipments. (3) Commodities are defined at the two-digit Standard Transportation Commodity Code (STCC) level and represent 93 (98) percent of all (ton-mile adjusted) shipments.

Figure 3: STB Railcars and Commodities



Notes: (1) Figure created using Carload Waybill Sample (CWS) data over 1984-2014. (2) The commodities are defined at the STCC two-digit level. (3) The car types are categorized using STB definitions (with minor refinements where sensible): Trailer or Container on Flat Cars (FLAT (IM)); Plain Box Cars of any length (PL BOX); Equipped Box Cars (EQ BOX); Plain Gondola Cars (PL GONDOLA); Covered Hopper Cars (COV HOPPER); Open Top Hopper Cars (OT HOPPER) of any service class; Refrigerator Cars (REFRIG) of any type; Other Flat Cars (FLAT (OTH)); and Tank Cars (TANK) of any capacity.

Table 1: Variable Descriptions

VARIABLE	DEFINITION
CONTRACT	Shipment-level indicator of under contract (1) or under tariff (0)
STCC	Shipment-level commodity indicators in following Department of Commerce two-digit Standard Transportation Commodity Code (STCC): farm (FARM), coal (COAL), non-metallic minerals (NMIN), food (FOOD), wood (WOOD), paper (PAPER), chemicals (CHEM), stone (STONE), metal (METAL), transport (TRANS), waste (WASTE), containers (CONT), miscellaneous materials (MISC) and hazardous materials (HAZ)
PERSISTENCE	Shipment-level indicator of commodity persistence between origin-destination (O-D) FSAC (baseline), SPLC and FIPS pairs in successive years
SPEC RC	Shipment-level indicators in following Specialized Rail Cars (SPEC RC): equipped box cars (EQB), equipped gondola cars (EQG), open-top special hopper cars (OTH), refrigeration cars (REF), and multi-level flat cars (MLF)
PRIV RC	Shipment-level indicator of private rail car use
EXPERIENCE	Discounted cumulative count of shipments under contract net of focal FSAC (baseline), SPLC and FIPS origin-destination (O-D) pair shipments under contract
O/D RR COMP	Count of unique railroads that serve same origin (O) or same destination (D) FSAC (baseline), SPLC and FIPS as the focal shipment
O-D RR COMP	Count of railroad combinations (single-line [SRR] or inter-line [IRR]) that serve same origin-destination (O-D) FSAC (baseline), SPLC and FIPS pair as the focal shipment
BARGE COMP	Distance-adjusted and commodity-specific measure of origin (O) or destination (D) location to navigable coal-, dry-bulk, general- or liquid-processing water barge facility for the focal shipment
INTERMODAL	Shipment-level indicator of standardized trailers or containers on flat car (COFC/TOFC)
CAP UTIL	Indexed-measure of monthly U.S. total capacity utilization
EXEMPT	Shipment-level indicator of whether commodity is exempt from STB regulation
SHIP DIST	Shipment-level measure of distance (in miles) [logged in estimation]
SHIP WEIGHT	Shipment-level measure of weight (in tons) [logged in estimation]

Table 2: Descriptive Statistics

	FULL SAMPLE				CONTRACT SAMPLE		TARIFF SAMPLE	
VARIABLE	**MEAN**	**SD**	**MIN**	**MAX**	**MEAN**	**SD**	**MEAN**	**SD**
CONTRACT	0.60	0.49	0.00	1.00	1.00	0.00	0.00	0.00
STCC FARM	0.04	0.19	0.00	1.00	0.02	0.13	0.06	0.24
STCC COAL	0.07	0.25	0.00	1.00	0.06	0.24	0.08	0.27
STCC NMIN	0.03	0.16	0.00	1.00	0.02	0.14	0.04	0.19
STCC FOOD	0.07	0.25	0.00	1.00	0.06	0.23	0.09	0.28
STCC WOOD	0.04	0.19	0.00	1.00	0.03	0.16	0.06	0.23
STCC PAPER	0.04	0.20	0.00	1.00	0.04	0.18	0.05	0.22
STCC CHEM	0.05	0.23	0.00	1.00	0.05	0.21	0.07	0.25
STCC STONE	0.02	0.16	0.00	1.00	0.02	0.14	0.03	0.18
STCC METAL	0.03	0.17	0.00	1.00	0.03	0.16	0.03	0.17
STCC TRANS	0.09	0.29	0.00	1.00	0.10	0.31	0.07	0.26
STCC WASTE	0.03	0.16	0.00	1.00	0.02	0.15	0.03	0.18
STCC CONT	0.06	0.23	0.00	1.00	0.07	0.26	0.04	0.18
STCC MISC	0.30	0.46	0.00	1.00	0.37	0.48	0.20	0.40
STCC HAZ	0.07	0.25	0.00	1.00	0.06	0.24	0.08	0.27
STCC OTHER	0.07	0.25	0.00	1.00	0.06	0.24	0.08	0.27
PERSISTENCE	0.83	0.37	0.00	1.00	0.88	0.32	0.76	0.42
SPEC RC EQB	0.06	0.23	0.00	1.00	0.05	0.21	0.07	0.25
SPEC RC EQG	0.03	0.18	0.00	1.00	0.03	0.17	0.04	0.19
SPEC RC OTH	0.03	0.17	0.00	1.00	0.03	0.17	0.03	0.18
SPEC RC REF	0.01	0.10	0.00	1.00	0.01	0.08	0.01	0.12
SPEC RC MLF	0.06	0.24	0.00	1.00	0.08	0.27	0.04	0.20
PRIV RC	0.52	0.50	0.00	1.00	0.63	0.48	0.36	0.48
EXPERIENCE	9.87	4.94	0.00	13.38	12.50	1.14	5.93	5.77
O RR COMP	0.47	1.77	0.00	27.00	0.33	1.28	0.68	2.30
D RR COMP	0.33	1.11	0.00	17.00	0.29	0.91	0.38	1.36
O-D SRR COMP	0.00	0.07	0.00	4.00	0.00	0.04	0.01	0.09
O-D IRR COMP	0.01	0.11	0.00	7.00	0.01	0.10	0.01	0.14
BARGE COMP	0.29	0.40	0.00	1.00	0.24	0.38	0.38	0.42
INTERMODAL	0.48	0.50	0.00	1.00	0.57	0.50	0.36	0.48
OBSERVATIONS	15,085,231				9,056,278		6,028,953	

Notes: (1) Descriptive statistics determined using number of observations in the Table 4 and 5 estimations. (2) PERSISTENCE is defined at the FSAC geographic level. (3) EXPERIENCE is reported log-transformed and defined at the FSAC geographic level. (4) The intra-industry competition variables are defined at the FSAC geographic level and aggregated over all STCCs.

Table 3: Correlation Statistics (Full Sample)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) CONTRACT	1.00														
(2) PERSISTENCE	0.16	1.00													
(3) SPEC RC EQB	-0.05	-0.08	1.00												
(4) SPEC RC EQG	-0.02	-0.04	-0.04	1.00											
(5) SPEC RC OTH	-0.01	0.03	-0.04	-0.03	1.00										
(6) SPEC RC REF	-0.04	-0.04	-0.02	-0.02	-0.02	1.00									
(7) SPEC RC MLF	0.07	0.05	-0.06	-0.05	-0.05	-0.03	1.00								
(8) PRIV RC	0.26	0.07	-0.23	-0.15	-0.02	-0.08	-0.17	1.00							
(9) EXPERIENCE	0.65	0.10	-0.02	0.00	-0.02	-0.03	0.04	0.29	1.00						
(10) O RR COMP	-0.10	0.00	0.04	0.00	-0.01	0.01	0.00	-0.09	-0.16	1.00					
(11) D RR COMP	-0.04	0.01	-0.01	0.00	0.02	0.00	-0.03	-0.05	-0.13	0.07	1.00				
(12) O-D SRR COMP	-0.05	0.01	0.00	0.00	0.00	0.00	-0.01	0.00	-0.05	0.11	0.10	1.00			
(13) O-D IRR COMP	-0.03	0.02	0.01	0.00	-0.01	0.00	0.00	-0.03	-0.06	0.31	0.13	0.08	1.00		
(14) BARGE COMP	-0.17	-0.17	-0.05	0.23	0.23	0.04	-0.19	-0.11	-0.10	-0.02	0.01	-0.01	-0.02	1.00	
(15) INTERMODAL	0.21	0.24	-0.23	-0.18	-0.17	-0.10	-0.25	0.21	0.12	-0.01	0.03	0.01	0.02	-0.58	1.00

Notes: (1) Correlation statistics determined using number of observations in the Table 4 and 5 estimations. (2) STCC indicator variables dropped due to space constraints. (3) PERSISTENCE is defined at the FSAC geographic level. (4) EXPERIENCE is reported log-transformed and defined at the FSAC geographic level and aggregated over all STCCs. (5) The intra-industry competition variables are defined at the FSAC geographic level.

Table 4: Baseline Results (Fixed Effects)

	MOD 1	MOD 2	MOD 3	MOD 4
VARIABLE	β (SE)	β (SE)	β (SE)	β (SE)
YR 1988	0.117***	0.116***	0.117***	0.117***
	(0.032)	(0.031)	(0.031)	(0.031)
YR 1989	0.046	0.052	0.050	0.053
	(0.037)	(0.033)	(0.035)	(0.033)
YR 1990	-0.032	-0.050	-0.051	-0.049
	(0.070)	(0.080)	(0.080)	(0.080)
YR 1991	0.788**	0.771**	0.778**	0.773**
	(0.298)	(0.295)	(0.294)	(0.296)
YR 1992	0.599+	0.594+	0.600+	0.597+
	(0.325)	(0.326)	(0.326)	(0.327)
YR 1993	0.528+	0.527+	0.529+	0.530+
	(0.279)	(0.278)	(0.277)	(0.278)
YR 1994	0.982***	0.982***	0.985***	0.985***
	(0.274)	(0.271)	(0.267)	(0.271)
YR 1995	0.997***	0.993***	0.996***	0.997***
	(0.290)	(0.285)	(0.282)	(0.285)
YR 1996	0.683**	0.721**	0.675**	0.750**
	(0.262)	(0.268)	(0.257)	(0.277)
YR 1997	0.563*	0.557*	0.558*	0.561*
	(0.252)	(0.250)	(0.247)	(0.251)
YR 1998	0.692*	0.684*	0.688**	0.689**
	(0.269)	(0.266)	(0.262)	(0.267)
YR 1999	0.875***	0.859***	0.864***	0.863***
	(0.194)	(0.196)	(0.191)	(0.196)
YR 2000	0.588+	0.570+	0.573+	0.573+
	(0.326)	(0.341)	(0.336)	(0.341)
YR 2001	0.544	0.546	0.528	0.558
	(0.332)	(0.354)	(0.342)	(0.357)
YR 2002	0.312	0.300	0.301	0.305
	(0.270)	(0.281)	(0.279)	(0.282)
YR 2003	0.617+	0.612+	0.611+	0.618+
	(0.363)	(0.357)	(0.362)	(0.361)
YR 2004	1.017***	1.012***	1.010***	1.020***
	(0.145)	(0.145)	(0.147)	(0.147)
YR 2005	0.989***	0.987***	0.984***	0.992***
	(0.165)	(0.167)	(0.168)	(0.169)
YR 2006	0.959***	0.955***	0.952***	0.960***
	(0.168)	(0.171)	(0.172)	(0.173)
YR 2007	0.962***	0.966***	0.962***	0.970***
	(0.155)	(0.159)	(0.160)	(0.161)
YR 2008	0.943***	0.943***	0.939***	0.949***
	(0.164)	(0.169)	(0.169)	(0.172)
YR 2009	0.883***	0.887***	0.883***	0.893***
	(0.190)	(0.194)	(0.195)	(0.197)
YR 2010	0.985***	0.986***	0.983***	0.992***
	(0.180)	(0.184)	(0.185)	(0.187)
YR 2011	0.989***	0.991***	0.986***	0.994***
	(0.176)	(0.177)	(0.180)	(0.179)
YR 2012	1.087***	1.088***	1.084***	1.092***
	(0.196)	(0.197)	(0.200)	(0.200)
YR 2013	1.103***	1.103***	1.100***	1.107***
	(0.198)	(0.200)	(0.203)	(0.202)
YR 2014	1.088***	1.088***	1.086***	1.092***
	(0.193)	(0.195)	(0.197)	(0.197)
STCC FARM	-0.479*	-0.477*	-0.488*	-0.478*
	(0.201)	(0.202)	(0.204)	(0.202)

STCC COAL	0.424	0.422	0.419	0.418
	(0.278)	(0.276)	(0.279)	(0.276)
STCC MIN	-0.054	-0.056	-0.058	-0.056
	(0.155)	(0.157)	(0.159)	(0.157)
STCC FOOD	-0.229	-0.214	-0.231	-0.212
	(0.218)	(0.215)	(0.218)	(0.215)
STCC WOOD	0.029	0.040	0.018	0.041
	(0.118)	(0.117)	(0.120)	(0.117)
STCC PAPER	0.345*	0.355*	0.332*	0.357*
	(0.160)	(0.156)	(0.163)	(0.156)
STCC CHEM	-0.157	-0.151	-0.166	-0.150
	(0.270)	(0.271)	(0.271)	(0.271)
STCC STONE	-0.075	-0.074	-0.082	-0.073
	(0.145)	(0.145)	(0.148)	(0.145)
STCC METAL	0.258	0.254	0.249	0.255
	(0.168)	(0.169)	(0.170)	(0.169)
STCC TRANS	0.184	0.177	0.171	0.179
	(0.158)	(0.159)	(0.160)	(0.158)
STCC WASTE	-0.028	-0.030	-0.040	-0.029
	(0.188)	(0.189)	(0.189)	(0.188)
STCC CONT	0.383	0.394	0.391	0.395
	(0.270)	(0.268)	(0.270)	(0.268)
STCC MISCM	0.422*	0.424*	0.419*	0.425*
	(0.193)	(0.191)	(0.193)	(0.192)
STCC HAZ	0.134	0.128	0.115	0.127
	(0.151)	(0.149)	(0.155)	(0.149)
Controls	Y	Y	Y	Y
Independent Vars	Y	Y	Y	Y
Observations	15,085,231	15,085,231	15,085,231	15,085,231
Adj. R-Squared	0.452	0.450	0.450	0.450

Notes: (1) + p < 0.10; * p < 0.05; ** p < 0.01; *** p < 0.001. (2) The dependent variable is an indicator that the shipment occurred under contract (rather than tariff). (3) Standard errors (in parentheses) are robust, clustered by railroad carrier, and presented below the coefficients. (4) Additional unreported controls include a macroeconomic condition measure (US industry capacity utilization) and shipment-specific measures (commodity STB exempt, logged weight, and logged distance), as indicated in Table 1.

Table 5: Baseline Results (Independent Variables)

	MOD 1		MOD 2		MOD 3		MOD 4	
	β (SE)	MARG EFF	β (SE)	MARG EFF	β (SE)	MARG EFF	β (SE)	MARG EFF
PERSISTENCE	0.207***	0.042***	0.207***	0.043***	0.207***	0.043***	0.209***	0.043***
	(0.038)	(0.008)	(0.037)	(0.008)	(0.037)	(0.008)	(0.037)	(0.008)
SPEC RC EQB	0.190*	0.037*	0.184*	0.036*	0.188*	0.036*	0.184*	0.036*
	(0.084)	(0.016)	(0.084)	(0.016)	(0.084)	(0.016)	(0.084)	(0.016)
SPEC RC EQG	0.071	0.014	0.073	0.015	0.076	0.015	0.072	0.014
	(0.067)	(0.013)	(0.066)	(0.013)	(0.066)	(0.013)	(0.067)	(0.013)
SPEC RC OTH	0.161+	0.031+	0.161+	0.032+	0.158+	0.032+	0.161+	0.032+
	(0.095)	(0.017)	(0.095)	(0.017)	(0.094)	(0.017)	(0.095)	(0.017)
SPEC RC REF	0.321+	0.060+	0.313	0.059+	0.313	0.059+	0.314	0.059+
	(0.195)	(0.032)	(0.196)	(0.033)	(0.195)	(0.033)	(0.197)	(0.033)
SPEC RC MLF	0.780*	0.132**	0.777*	0.132**	0.781*	0.132**	0.778*	0.132**
	(0.322)	(0.046)	(0.321)	(0.046)	(0.323)	(0.046)	(0.322)	(0.046)
PRIV RC	0.254*	0.053+	0.248*	0.052+	0.249*	0.052+	0.248*	0.052+
	(0.122)	(0.027)	(0.122)	(0.028)	(0.122)	(0.028)	(0.123)	(0.028)
EXPERIENCE	0.264***	0.054***	0.253***	0.052***	0.257***	0.052***	0.252***	0.052***
	(0.032)	(0.006)	(0.032)	(0.006)	(0.032)	(0.006)	(0.032)	(0.006)
O RR COMP	0.024*	0.005*			0.048	-0.107		
	(0.010)	(0.002)			(0.045)	(0.113)		
D RR COMP	0.114***	0.023***			0.179*	0.067*		
	(0.026)	(0.005)			(0.083)	(0.033)		
O-D SRR COMP			-0.524	-0.107			-0.913	-0.187
			(0.560)	(0.113)			(0.712)	(0.143)
O-D IRR COMP			0.325*	0.067*			0.129	0.027
			(0.156)	(0.033)			(0.261)	(0.054)
BARGE COMP	0.341***	0.070***	0.328***	0.067***	0.330***	0.067***	0.327***	0.067***
	(0.073)	(0.017)	(0.074)	(0.017)	(0.072)	(0.017)	(0.073)	(0.017)
INTERMODAL	0.463*	0.097*	0.474*	0.099*	0.472*	0.099*	0.478*	0.100*
	(0.228)	(0.047)	(0.229)	(0.047)	(0.227)	(0.047)	(0.230)	(0.047)
CONSTANT	-3.017***		-2.827***		-2.901***		-2.834***	
	(0.576)		(0.558)		(0.575)		(0.536)	
Controls	Y		Y		Y		Y	
Year FE	Y		Y		Y		Y	
STCC FE	Y		Y		Y		Y	
Observations	15,085,231		15,085,231		15,085,231		15,085,231	
Adj. R-Squared	0.452		0.450		0.450		0.450	

Notes: (1) + $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. (2) The dependent variable is an indicator that the shipment occurred under contract (rather than tariff). (3) Standard errors (in parentheses) are robust, clustered by railroad carrier, and presented below the coefficients. (4) Average marginal effects (e.g., $\delta y/\delta x$ for continuous variables and discrete difference from the base category for factor variables) are reported next to each covariate. (5) Shipment persistence (PERSISTENCE) is defined at the FSAC geographic level. (6) Contracting experience (EXPERIENCE) is defined at the FSAC geographic level and logged. (7) Competition variables are defined at the FSAC geographic level and aggregated over two-digit STCCs (Models 1-2) and disaggregated at two-digit STCCs (Models 3-4). (8) Additional unreported controls include a macroeconomic condition measure (US industry capacity utilization) and shipment-specific measures (commodity STB exempt, logged weight, and logged distance) as indicated in Table 1.

Table 6: Robustness Results

VARIABLE	MOD 1	MOD 2	MOD 3	MOD 4
PERSISTENCE	0.241***	0.255***	0.286***	0.274***
	(0.038)	(0.034)	(0.049)	(0.039)
SPEC RC EQB	0.189*	0.181*	0.182*	0.174*
	(0.077)	(0.082)	(0.085)	(0.087)
SPEC RC EQG	0.079	0.070	0.074	0.077
	(0.062)	(0.067)	(0.072)	(0.068)
SPEC RC OTH	0.181+	0.161+	0.167+	0.172+
	(0.093)	(0.093)	(0.101)	(0.094)
SPEC RC REF	0.350*	0.314	0.319	0.311
	(0.172)	(0.192)	(0.199)	(0.195)
SPEC RC MLF	0.751*	0.770*	0.774*	0.764*
	(0.324)	(0.318)	(0.326)	(0.322)
PRIV RC	0.245*	0.246*	0.244*	0.237*
	(0.118)	(0.122)	(0.121)	(0.117)
EXPERIENCE	0.257***	0.254***	0.254***	0.257***
	(0.032)	(0.031)	(0.033)	(0.032)
O RR COMP	0.017		-0.001	
	(0.024)		(0.010)	
D RR COMP	0.032		0.012	
	(0.020)		(0.010)	
O-D SRR COMP		0.053		0.052
		(0.113)		(0.052)
O-D IRR COMP		0.060		0.010
		(0.044)		(0.015)
BARGE COMP	0.296***	0.322***	0.315***	0.303***
	(0.062)	(0.070)	(0.094)	(0.064)
INTERMODAL	0.434+	0.455+	0.459*	0.445+
	(0.255)	(0.242)	(0.223)	(0.239)
CONSTANT	-2.957***	-2.880***	-2.944***	-2.899***
	(0.543)	(0.542)	(0.557)	(0.553)
Controls	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
STCC FE	Y	Y	Y	Y
Observations	15,085,231	15,085,231	15,085,231	15,085,231
Adj. R-Squared	0.452	0.450	0.450	0.450

Notes: (1) + $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. (2) The dependent variable is an indicator that the shipment occurred under contract (rather than tariff). (3) Standard errors (in parentheses) are robust, clustered by railroad carrier, and presented below the coefficients. (4) Shipment persistence (PERSISTENCE) is defined at the SPLC geographic level (Models 1-2) and FIPS geographic level (Models 3-4). (5) Contracting experience (EXPERIENCE) is defined at the SPLC geographic level (Models 1-2) and FIPS geographic level (Models 3-4) and logged. (6) Competition variables are defined at the SPLC geographic level (Models 1-2) and FIPS geographic level (Models 3-4) and aggregated over two-digit STCCs (Models 1-4). (7) Additional unreported controls include a macroeconomic condition measure (US industry capacity utilization) and shipment-specific measures (commodity STB exempt, logged weight, and logged distance), as indicated in Table 1.

Appendix. A Simple Conceptual Framework

The following streamlined model is designed to provide a simple framework that reflects some of the key elements that are likely at play in the empirical analysis. Consider a setting where a single railroad (R) interacts with two potential shippers (S1 and S2). Let q_i denote the volume of Si's shipments and let $\underline{v}_i$ denote the maximum amount Si is willing to pay for each unit (i.e., one shipment) of the tariffed rail transport service ($i \in \{1,2\}$). We assume $\underline{v}_2 \geq \underline{v}_1$, so the tariffed service is at least as valuable to S2 as it is to S1.

In addition to supplying the tariffed rail service to S1 and/or S2, R can offer a contracted rail service to S2. v_2 is the maximum amount S2 is willing to pay for each unit of the contracted rail service. This service can entail features that differ from those of the tariffed service (e.g., special handling or expedited transport). For simplicity, we assume it is prohibitively costly for R to supply a contracted rail service to S1.

For expositional ease, we normalize R's cost of providing the tariffed rail service to 0. c_2 is R's unit cost of supplying the contracted rail service to S2. The transaction costs of providing the tariffed service are normalized to 0 for all parties. We further abstract from any shipper transaction costs associated with contracted rail transport. K_2 is R's transaction cost of contracting with S2.

R knows the values of $\underline{v}_1$, $\underline{v}_2$, and v_2. Furthermore, R can make take-it-or-leave-it offers to S1 and S2. We assume it is more profitable for R to supply the tariffed service to both shippers at unit price $\underline{v}_1$ than to supply the service only to S2 at unit price $\underline{v}_2$, so $\underline{v}_1\,[q_1 + q_2] > \underline{v}_2\, q_2$[57]

Our main finding in this simple setting where R acts to maximize its profit is the following.

Conclusion. R will serve S2 under contract rather than via tariff if and only if

$$v_2 - c_2 - \underline{v}_2 > \frac{K_2}{q_2}. \quad \text{(A1)}$$

Proof. The maintained assumption that $\underline{v}_1\,[q_1 + q_2] > \underline{v}_2\, q_2$ ensures that if R only offers the tariffed service, it will set unit price $p_T = \underline{v}_1$. R's corresponding profit is:

$$\pi_T = \underline{v}_1\,[q_1 + q_2]. \quad \text{(A2)}$$

To induce S2 to choose the contracted service at unit price p_2 rather than the tariffed service at unit price $p_T = \underline{v}_1$, R must set p_2 to ensure:

$$v_2 - p_2 \geq \underline{v}_2 - p_T \quad \Leftrightarrow \quad p_2 \leq v_2 - \underline{v}_2 + \underline{v}_1. \quad \text{(A3)}$$

(A3) implies that if R serves S2 under contract and S1 via tariff, the maximum profit that R can secure is:

[57] This inequality will hold if, for example, $\underline{v}_2 - \underline{v}_1$ and $|q_2 - q_1|$ are sufficiently small.

$$\pi_C \; = \; \underline{v}_1 \, q_1 + \left[\, v_2 - \underline{v}_2 + \underline{v}_1 - c_2 \, \right] q_2 - \; K_2 \; . \tag{A4}$$

(A2) and (A4) imply that R will serve S2 under contract rather than via tariff if:

$$\pi_C \; > \; \pi_T \quad \Leftrightarrow \quad \underline{v}_1 \, q_1 + \left[\, v_2 - \underline{v}_2 + \underline{v}_1 - c_2 \, \right] q_2 - \; K_2 \; > \; \underline{v}_1 \left[q_1 + q_2 \right]$$

$$\Leftrightarrow \quad \left[v_2 - c_2 - \underline{v}_2 \right] q_2 \; > \; K_2 \quad \Leftrightarrow \quad v_2 - c_2 - \underline{v}_2 \; > \; \frac{K_2}{q_2} . \; \blacksquare$$

The Conclusion identifies three factors that render R more likely to provide the contracted service to S2 rather than the tariffed service (in the sense that inequality (A1) is more likely to hold). The first factor is a relatively small transaction cost, K_2. K_2 can be small when, for example, R has relatively extensive experience in contracting with S2, or the complexity and the uncertainty regarding the transaction between S2 and R are relatively limited.

The second factor is a relatively large q_2, reflecting a relatively high volume of shipments by S2. When q_2 is large, R can spread the transaction cost associated with the contracted service over many units, thereby reducing the effective per-unit transaction cost.

The third factor is a relatively large value of $v_2 - c_2 - \underline{v}_2$, which represents the incremental joint surplus that the customization associated with contract transport can generate for S2 and R (relative to the joint surplus they secure under the tariffed service). In practice, this incremental surplus might be relatively large when, for example, contracting helps to protect non-fungible investment in (specialized) rail transport.