

**BEFORE THE
SURFACE TRANSPORTATION BOARD**

STB Docket No. FD 36873

**UNION PACIFIC CORPORATION, ET AL. – CONTROL – NORFOLK SOUTHERN
CORPORATION, ET AL.**

VERIFIED STATEMENT OF MARK A. ISRAEL

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I. INTRODUCTION

A. QUALIFICATIONS

1. My name is Mark Israel. I am a Founding Partner at Econic Partners, an economic consulting firm I joined in April 2025. Prior to joining Econic Partners, I was the President of Compass Lexecon, also an economic consulting firm, where I had worked since 2006. From 2000 to 2008, I served on the faculty at the Kellogg School of Management, Northwestern University. I received my Ph.D. in economics from Stanford University in 2001.
2. I specialize in the economics of industrial organization—the study of competition in imperfectly competitive markets, including the study of antitrust and regulatory issues—and applied econometrics. At Kellogg and Stanford, I taught graduate-level courses covering topics including business strategy, industrial organization/competition economics, and econometrics. My research on these topics has been published in leading peer-reviewed economics journals including the American Economic Review, the Rand Journal of Economics, the Journal of Industrial Economics, the Journal of Law and Economics, and the Journal of Competition Law and Economics, among others.
3. My work focuses on the application of economic theory and econometric methods to competitive analysis of the impact of mergers, antitrust issues including a wide variety of single-firm and multi-firm conduct, class certification, and damages estimation. I have analyzed these competition issues on behalf of a wide range of clients, including private companies and government entities. I have specific expertise in the analysis of vertical mergers and vertical foreclosures cases but have also done extensive work analyzing horizontal mergers. I have submitted expert reports, declarations, and affidavits to government agencies and federal and state courts. I have testified in federal court, multiple state courts, and in many regulatory and arbitration proceedings in the U.S. and other countries. I have presented competitive analyses to the U.S. Department of Justice and the Federal Trade Commission on dozens of occasions. My work has included analysis of competition in many transportation-related cases, including previous submissions to the

Surface Transportation Board (“STB” or “the Board”), as well as cases involving airlines, barges, food distribution, and many others. My complete CV is attached to this statement as Attachment 1.

B. ASSIGNMENT

4. I have been asked to provide an economic analysis of the proposed merger of the Union Pacific Railroad (“UP”) and Norfolk Southern Railway Company (“NS”).¹ Specifically, I have been asked to:
- Analyze the vertical effects of the proposed merger in order to determine whether the combined vertical effects enhance competition and serve the public interest.
 - Assess the additional effects of the Committed Gateway Pricing proposal, including whether it further enhances competition and serves the public interest.
 - Analyze the potential competitive effects of the proposed merger caused by a reduction of the number the loss of “independent routes” in corridors where UP and NS serve different legs of the movement but do not overlap at either endpoint of the corridor.

C. BACKGROUND

1. Union Pacific

5. The Union Pacific Railroad is a Class I freight railroad operating in 23 states in the western two-thirds of the United States, meaning it has very little overlap with Norfolk Southern, which operates primarily in the eastern United States.² The UP network includes 32,880 route miles, (26,291 miles owned by UP, the rest accessed by UP via trackage rights or

¹ I submitted a verified statement in this proceeding in December 2025. Since that time, additional waybill data have become available, and I have updated my previous analyses where applicable. My opinions are unchanged from those expressed in my prior statement.

² Union Pacific Corporation, Form 10-K for Fiscal Year Ended December 31, 2024, filed February 7, 2025, p. 5 (hereinafter “UP 2024 10-K”) available at <https://investor.unionpacific.com/static-files/8cb99809-9965-4d4d-bd6e-612f0d6149f8>.

other agreements).³ UP provides service to Pacific and Gulf Coast ports, major US gateways along the Mississippi River, and gateways on the Mexican and Canadian borders.⁴ UP also maintains coordinated schedules with other carriers in order to move shipments to and from the eastern U.S.⁵

6. UP categorizes its traffic into three large commodity groups: bulk, industrial, and premium.⁶ In 2024, shipments of bulk commodities (grain, fertilizer, food, refrigerated products, and coal and renewables) comprised 32% of UP’s freight revenue.⁷ Industrial shipments (construction, industrial chemicals, plastics, etc.) accounted for 37% of freight revenues, and premium shipments (intermodal and automobiles) accounted for the remaining 31% of freight revenues.⁸

2. Norfolk Southern

7. The Norfolk Southern Railway Corporation is a Class I freight railroad operating primarily in the eastern United States, meaning that it has very little overlap with UP, which operates primarily in the western United States. NS operates on 35,000 miles of rail track⁹ (28,300 miles operated or maintained by NS¹⁰, the rest accessed via trackage rights or other agreements) in 22 states and the District of Columbia.¹¹ The corridors on the NS network with the heaviest freight volume in 2024 include: New York City to Chicago, Chicago to

³ UP 2024 10-K, p. 18.

⁴ UP 2024 10-K, p. 6.

⁵ UP 2024 10-K, p. 6.

⁶ UP 2024 10-K, p. 6.

⁷ UP 2024 10-K, p. 6.

⁸ UP 2024 10-K, p. 6.

⁹ Norfolk Southern Corporation, Form 10-K for Fiscal Year ended December 31, 2024, filed February 10, 2025, p. K8 (hereinafter “NS 2024 10-K”) available at <https://app.quotemedia.com/data/downloadFiling?webmasterId=101533&ref=318901838&type=PDF&symbol=NSC&cdn=bacf9f720528f8a750cab76320e29c2d&companyName=Norfolk+Sout+herm+Corporation&formType=10-K&dateFiled=2025-02-10>.

¹⁰ NS 2024 10-K, pp. K4, K8.

¹¹ NS 2024 10-K, p. K4.

Macon, Central Ohio to Norfolk, Cleveland to Kansas City, Birmingham to Meridian, and Memphis to Chattanooga.¹² NS also serves 43 ports, including all major container ports between New York and Florida; nine lake ports on the eastern Great Lakes including Detroit and Chicago; and ten river ports connecting the eastern and western US.¹³

8. NS categorizes their freight shipments into three categories: merchandise, intermodal, and coal.¹⁴ In 2024, merchandise traffic accounted for 62% of NS’s railway operating revenues¹⁵ and intermodal and coal shipments accounted for 25% and 13% of railway operating revenue, respectively¹⁶

3. The Proposed Transaction

9. UP seeks to acquire NS, creating a transcontinental railroad operating over 50,000 route-miles in 43 states, serving nearly 100 ports. The proposed merger is an end-to-end, vertical combination of rail networks, which have little overlap today, but rather which meet at the major gateways along the Mississippi River—Chicago, St. Louis, Memphis, and New Orleans—each of which is served by multiple railroads. Today the separate networks of UP and NS can be used to move traffic across the United States, but only with an interchange in the middle. Post-merger, a single rail network will be able to move that same traffic with no interchange required, an inherently cost-reducing, quality-enhancing change.
10. In economic terms, this would be a merger of complementary products that will generate significant efficiencies. The transaction would introduce single-line rail service between points in the eastern and western US that can be served only by interline rail service today. It would enable shippers to ship goods across the country without the need to stop and

¹² NS 2024 10-K, p. K4.

¹³ “Ports and International” available at: <https://www.norfolksouthern.com/en/ship-by-rail/our-rail-network/ports-international>.

¹⁴ NS 2024 10-K, pp. K5-6.

¹⁵ NS 2024 10-K, pp. K5-6.

¹⁶ NS 2024 10-K, p. K6.

make an interchange in the middle with all the associated complications, delays, and costs that such interline service entails.¹⁷ Put simply, it would create a more efficient rail system.

11. Nobel Prize-winning economics developed by Bengt Holmström and others explains why vertical integration is the only way to achieve the “faster, more efficient, more reliable and more accessible way[s] to ship goods” that the merged UP and NS have committed to and will have the incentive to provide.¹⁸ As I discuss in detail below, it would be impossible for other alternatives short of a full merger between the parties (e.g., contracts or trackage agreements) to come close to addressing every possible situation that arises in the daily operations of two independent railroads, and thus, those alternatives could not deliver the benefits that this merger will create. These benefits include: more effective competition and service from increased single-line options—an improvement that will allow rail to compete more effectively with trucks and to serve historically underserved areas; improved quality, faster transit times and increased reliability; and increased investment in the rail network, including planned investment of a billion dollars to accommodate merger-related growth on main lines and in yards and terminals.¹⁹ All of these benefits—the inherent quality improvements from single-line service, the cost reductions from eliminating interchanges, and the incentives to invest more because the combined railroad internalizes the combined benefits on the full network—are inherent to the transaction and cannot be obtained without it. Blocking the transaction would deny shippers and downstream consumers these benefits and thus be anti-competitive and welfare destroying, particularly

¹⁷ Union Pacific, “Union Pacific and Norfolk Southern to Create America’s First Transcontinental Railroad,” July 29, 2025, available at <https://www.up.com/press-releases/growth/norfolk-southern-transcontinental-nr-250729>.

¹⁸ Union Pacific and Norfolk Southern, “Facts About the Union Pacific and Norfolk Southern Combination,” available at <https://assets.up-nstranscontinental.com/One%20Pagers/20251107-up-ns-myths-facts-onepager.pdf>, accessed November 24, 2025.

¹⁹ Union Pacific and Norfolk Southern, “America’s First Transcontinental Railroad,” July 29, 2025, pp. 5, 7, available at <https://assets.up-nstranscontinental.com/One%20Pagers/Investor%20Presentation%20-%20America%27s%20First%20Transcontinental%20Railroad.pdf>. See also, Joint Verified Statement of Eric Gehringer and John F. Orr (hereinafter “Gehringer-Orr V.S.”), ¶ 223.

since any potential vertical competitive concerns—to the extent any are valid—can be dealt with via conditions, as discussed below.

12. To ensure further that the proposed merger enhances competition—including on routes that are not directly affected by the merger in the sense that they do not combine UP service on one end and NS service on the other—UP and NS have offered an additional commitment—their Committed Gateway Pricing (“CGP”) proposal. CGP would allow BNSF and CSX to quote through rates to customers on routes that are sole served on each end based on CGP and without any concurrence process. Thus, the CGP proposal extends the merger’s benefits to certain routes and shippers that would otherwise not benefit as directly from the transaction.

II. SUMMARY OF CONCLUSIONS

13. My primary opinion is that the combined vertical effects of the proposed merger of UP and NS are procompetitive, meaning that they will enhance competition in the rail industry, create downward pressure on price relative to the state of the world that would exist absent the merger, and benefit shippers in the form of greater investment, higher quality service, and a more efficient rail network.
14. More specifically, I find:
 - The proposed UP/NS merger is an overwhelmingly complementary “end-to-end” merger. As such, fundamental economics teaches that it will generate significant merger-related benefits. Put simply, whereas mergers of substitute products may, in some cases, create competitive concerns including upward price pressure (among others), mergers of complementary products have the *exact opposite effect* (as a matter of the same profit maximization math). Indeed, for reasons developed throughout this report, a merger is *required* to unlock these benefits.
 - The main theories of vertical foreclosure that have been developed in the economic literature are ill-matched to this transaction and the railroad industry. This follows for several reasons.

- First, as is well recognized, a very large percentage of rail rates are set pursuant to negotiations between shippers and railroads, which generally result in contractual terms that are more complex than simply a price per ton or carload at which shippers can ship as much as they want (a so-called “linear price”). Rather, they generally result in “non-linear” contracts that specify an amount that will be charged for a given amount shipped. In such situations, the usual theories of foreclosure simply do not apply, and instead, fundamental economics teaches that the merger will benefit shippers (or cause them no harm).
- Second, even in those situations where there is not such negotiation between shippers and railroads—i.e., where shippers use other pricing mechanisms—the usual theories of foreclosure remain ill-suited to this industry. In particular, if those shipments are made via Rule 11 pricing—so that separate prices are obtained from each railroad involved in carrying the shipment from its origin to its ultimate destination—standard vertical foreclosure theories do not apply, but rather the transaction gives rise to inherent benefits (“Cournot Complement effects”). And the sparse economic literature on cases where there may nevertheless be harm in such circumstances does not fit the facts of to this case. And for those shipments made via through rates, I explain below how straightforward empirical tests reject the applicability of standard theories of vertical foreclosure.
- Recent foreclosure theories that have been developed based on the highly counterintuitive claim that a merger that provides the merged railroad more information about its combined costs will generate harms to shippers are based on unreasonably restrictive assumptions and is the reversed once those restrictions are relaxed.
- This is not to say that no economist opposing this transaction will be able to come up with a theory under which foreclosure is possible. The nature of the economic literature on vertical contracting and mergers is that nearly anything is at least theoretically possible. But basing policy and enforcement decisions on what might be possible *in theory* is a recipe for welfare-harming decisions. It is enough to observe

that any such foreclosure theory would at most apply to transactions in which shippers do not negotiate non-linear contracts. And even then, for shipments made under Rule 11, I know of no paper in the current economic literature that would support a theory of vertical harm applicable to such activity. And for through rates, any such theory would be an “edge case,” which rests on restrictions on firms’ behavior that are unlikely (or rare, at best), as well as other tenuous assumptions. Such a theory should not serve as the basis to block such a beneficial transaction. Rather, the remote possibility of such cases is what the Applicants’ Open Gateway Commitments are designed to address.

- There is no valid competitive concern associated with the loss of so-called “independent routes” on corridors where UP and NS serve different legs of the movement (and do not overlap at either endpoint of the corridor). Applying an algorithm based on one previously used in the Canadian Pacific (“CP”) and Kansas City Southern (“KCS”) proceedings—and then further analyzing the routes flagged by that algorithm—I find that, once shippers’ options are properly assessed, none of the corridors I study loses an independent route as a result of the proposed merger.
- With no realistic prospect for material harm to competition from vertical foreclosure and significant demonstrable benefits, the proposed merger unambiguously raises consumer and shipper welfare and enhances competition.
- For multiple reasons, a vertical merger of the Applicants’ complementary rail networks is the only means of achieving the significant benefits that this merger will unlock. First, the efficient management of complementary rail networks requires coordinated actions by the railroads that own the networks. Such coordination—such as the ability to eliminate interchanges and provide single-line, cross-country service—requires a single railroad. Second, independent railroads make suboptimal decisions because each railroad considers only its own profit when making decisions and does not appropriately consider the effect of its decisions on the complementary network. So, for example, Union Pacific ignores the benefits that an improved rail network in the West will have on Norfolk Southern in the East. Thus, each separate

railroad finds too few such investments profitable from the point of view of the combined railroad or society as a whole. As demonstrated by Nobel Prize-winning economics, in industries with characteristics like those of the railroad industry, there is no way to solve this problem other than a merger; separate railroads will always make suboptimal investment decisions. This follows because:

- Contracts cannot address the coordination problems created by poor incentives because many of one railroad's actions and activities are unobservable and/or not verifiable by the other railroad. Unobservable actions imply that contracts cannot prescribe all the actions required for optimal coordination of complementary networks. A contract would have to specify all actions to take in any possible future state of the world, an obviously impossible task.
- In contrast, the merger of the two complementary networks integrates the complementary networks into a single railroad, creating optimal incentives, eliminating the need to coordinate via contracts, and unleashing significant benefits.
- The Committed Gateway Pricing proposal further enhances competition by providing improved pricing options for certain routes that would not directly participate in the vertical benefits of the merger. And while there is no evidence the proposed merger will lessen competition from other sources or regions, the Committed Gateway Pricing will also expand existing product and geographic competitive options to new routes. I demonstrate via economic modeling that the Committed Gateway Pricing proposal should be expected to generate additional substantial benefits.

III. ECONOMIC THEORIES OF FORECLOSURE PROVIDE NO VALID BASIS TO OPPOSE THE TRANSACTION

15. The proposed UP/NS merger is a merger of complementary rail networks that primarily serve different regions of the United States.²⁰ Combining UP's and NS's networks into a single coast-to-coast rail network will allow the merged railroad to maximize profits across the integrated network, thus creating downward pressure on prices relative to the situation without the merger. Merging the parties' networks will also enable the combined carrier effectively to coordinate operations, thus lowering costs and improving quality through single-line service and enhancing the incentive to invest in the consolidated network. As one particularly tangible example (but just one of many benefits), integration would allow the merged carrier to bypass congested gateways and thus offer faster, more reliable, lower-cost, single-line service to shippers.
16. In some prior vertical mergers, the STB has indicated a concern that the conditions for vertical foreclosure may be present and questioned whether the merging railroad could foreclose competition post-merger.²¹ In particular, the STB has expressed concern regarding foreclosure on routes with one sole-served segment and one competitive segment served by two or more carriers.
17. In this section, I perform a detailed economic analysis of the characteristics of the railroad industry to assess whether any such foreclosure concerns are valid. As outlined in the summary of conclusions above, I find that the economic theories of foreclosure that have been developed in the literature are ill-matched for the railroad industry. In particular
 - In a large percentage of cases, shippers are not “price takers,” but rather negotiate contracts. These generally feature non-linear pricing rather than a constant “linear”

²⁰ See Verified Statement of Dr. Elizabeth Bailey.

²¹ See, for example, *Canadian Pacific Railway Limited et al., - Control – Kansas City Southern, et al.*, Surface Transportation Board Docket No. FD 36500, Decision No. 35, March 14, 2023 (hereinafter “CPKCS Decision”) p. 4 (“Even end-to-end mergers, however, can pose competitive risks, and indeed this decision overturns prior agency precedent that did not sufficiently recognize such concerns.”).

price at which shippers move each ton or carload of traffic. Standard economic theories of foreclosure do not apply to such cases; rather in these situations the merger will either benefit shippers or leave them unharmed. In particular, economics teaches that shippers and railroads will negotiate efficient contracts pre- and post-merger in such cases, and that those contracts will be as good or better for the shipper post-merger. As I show in Figure 1 below, this scenario likely covers the clear majority of rail shipments.

- Where there is not negotiation over non-linear contracts, but rather shippers buy according to pricing terms set under Rule 11, the merger generates benefits by combining complementary products (“Cournot complement effects”), and the theories of countervailing harm from the economic literature do not apply.
- Where there is not negotiation over non-linear contracts, but rather shippers buy according to pricing terms set via through rates, one cannot rule out some of the standard theories of foreclosure based on theory alone (as one can do in the above cases). However, in this case, empirical tests reject the standard theories of foreclosure described in the economics literature. In particular, standard theories of foreclosure—at least those that do not depend on unreasonable restrictions on railroad behavior and other assumptions at odds with the reality of the industry—rely on pre-merger rates being below the level that the vertically merged carrier would charge. Said differently, such theories rely on there being something preventing the vertically dis-integrated railroad from raising prices pre-merger, even though it provides sole-service on one end. In such cases, the merger could create an incentive to foreclose to eliminate that barrier—whatever it may be—to raising prices. In the economic theories where this below-integrated-level pricing occurs, it occurs when shippers receive their through rate from a railroad that faces competition for its part of the service, rather than receiving their through rate from the sole-serving participating railroad. Hence, if those theories hold, two conditions must be satisfied. First, one should see shippers strongly preferring to get through rate pricing from railroads on the competitive end, rather than from the sole-served end. Second, in those cases

where they get pricing from the competitive end, prices should be lower than those obtained from the sole-served end. Using data on actual pricing and shipments in the railroad industry, I show that *neither of those conditions holds*, and thus show that the empirical evidence rejects these theories.

18. Some recent theories of foreclosure have taken a different tack, arguing that the harm from vertical mergers can arise because the merging firm obtains better information about the combined firm's costs—specifically, better information about the costs of the railroad that competed along its part of the route prior to the merger—than it had pre-merger. This result is counterintuitive however, given that better information about costs would generally be expected to increase efficiency of operations. Indeed, even the paper finding harm to *consumer welfare* from increased information finds that *total welfare and output* go up with the merger, meaning the industry is operating more efficiently. And I show below that, not surprisingly, the negative result on consumer welfare rests on highly restrictive assumptions, and that once those restrictions are relaxed to more closely reflect actual market conditions, consumer welfare also goes up with improved information.
19. As noted above, an economist opposing this transaction may nevertheless be able to come up with a theory under which foreclosure is possible. In the economic literature on vertical contracting, nearly anything is theoretically possible given enough restrictions on the form of contracting and firm behavior. However, any such theory of foreclosure would at most apply to a very limited set of cases: those where shippers do not negotiate non-linear pricing terms with railroads, where they do not obtain pricing directly from the sole-served railroad in the pre-merger case, and—at least according to any economic papers I am aware of—where they do not use Rule 11 pricing. They would also depend on restrictions on firm behavior and other assumptions that do not fit the facts of the railroad industry. I deal with many such “edge cases” in Appendix A, explaining why they are ill-suited for the railroad industry and should not raise concerns. More generally, such edge cases based on economic models that do not fit the railroad industry certainly should not serve as the basis to block such a beneficial transaction. Rather, the remote possibility of such cases is what the Applicants' Open Gateway Commitments are designed to prevent.

A. SHIPPERS WHO NEGOTIATE NON-LINEAR TERMS WITH RAILROADS ARE NOT HARMED BY THE MERGER

20. A large fraction of interline rail shipments are governed by sophisticated contracts, which shippers have *negotiated* with the railroads, and which often include terms conditioned on price, volume, and perhaps other factors. Such negotiations can occur in cases where interline prices are obtained via Rule 11 or where prices are obtained via through rates. I will use the term “negotiated non-linear contracts” with shippers to refer to such situations.^{22,23} As I show below, *the merger raises no competitive risks for such shipments*, but instead, if anything it creates benefits—in the form of downward pricing pressure relative to the situation with no merger—for such shipments.

1. Negotiated Non-linear Contracts make up a large percentage of interline rail shipments.

21. A significant fraction of rail shipments moves pursuant to negotiated non-linear contracts. Figure 1 summarizes the various pricing arrangements used by UP, NS and their customers for their interline traffic. The vast majority of the parties’ interline traffic in 2024, approximately {{ }} percent for UP and {{ }} percent for NS, involves either long-term contracts, private quotes, or other non-tariff arrangements. Under these pricing mechanisms, railroads and shippers engage in negotiations, and all three pricing arrangements are likely to reflect at least some form of non-linear terms. The only set of traffic that is unlikely to entail any private negotiations or non-linear terms consists of

²² Pricing is non-linear when the price terms are conditioned on volume in some way, e.g., when price reflects an understanding about expected volumes, or when there are volume discounts (i.e., when prices decline with volume), or in cases where there are volume commitments (i.e., price is available for achieving a specific volume). As one specific example, a contract that specifies both a price and a quantity (p, q)—carrying q amount of traffic for p dollars—is a non-linear contract since it specifies both p and q, rather than setting a linear price at which the shipper can ship as much or as little as it wants.

²³ I focus here on environments where railroads have good information about their interline partners’ costs and discuss cases where that is not true in a later section.

shipments moving under tariff rates—which accounts for {{ }} percent or less of interline traffic for UP and NS combined.²⁴

Figure 1
UP and NS Interline Traffic by Pricing Document Type {{

}}

Source: UP and NS Waybill Data 2019-2024

Notes:

- 1) “All UP/NS Interline” does not equal the sum of UP and NS panels due to the avoidance of double counting UP and NS interline movements.
- 2) The document type for 1 percent of NS interline traffic could not be identified.

22. To be clear, I am not claiming that every contract, private quote, or other non-tariff arrangement reflects negotiation between shippers and railroads over non-linear pricing terms. In some of these cases, contractual terms may be quite simple—approximating

²⁴ “Tariff” traffic consists of movements identified by UP and NS as moving under tariff price authorities and is inclusive of public quotes. While “tariff” traffic as defined here could potentially involve non-linear terms such as rebates, it is the subset of traffic that is least likely to reflect negotiations with non-linear terms.

linear pricing—and in other cases, railroads may largely establish contract terms with limited negotiation. That said, my experience in the industry, the complexity of the contracts, and the fact that even private quotes often take the form of a given quantity at a given price—which is a form of non-linear pricing since it specifies both price and quantity, rather than a per-unit price at which any amount can be shipped—all indicate that a very large percentage of these cases reflect negotiated non-linear contracts.²⁵ And in all such cases, economics teaches that there are not foreclosure concerns, but rather the merger will either benefit shippers or leave them unharmed, as I explain next.

2. Where shippers negotiate non-linear contracts, they will not be harmed—but rather are likely to benefit—from the merger

23. It is well established in economics that non-linear contracts between a seller and a buyer—meaning cases in which the price in the contract is conditioned on volume in some way—increase output and enhance efficiency. And, as a matter of economics, when the seller and the buyer negotiate, much of what they do is to divide these efficiency gains between them, meaning each party benefits from setting these efficient pricing terms.
24. In settings where a shipper bargains over non-linear contracts with two complementary rail networks, the same benefits arise. And a merger between the firms selling the complements does not interfere with the generation of these benefits—meaning it does not give rise to foreclosure harms. Rather, a merger often increases benefits. *Put simply, a merger between complementary railroads in settings where individual shippers negotiate sophisticated (non-linear) contracts is either benign or efficiency-enhancing and shipper-welfare enhancing.*

²⁵ See, for example, United States Government Accountability Office, “Freight Rail Pricing: Contracts Provide Shippers and Railroads Flexibility, but High Rates Concern Some Shippers,” Report to Congress, December 2016, available at <https://www.gao.gov/assets/gao-17-166.pdf>, site accessed November 24, 2025, p. 9 (“Contracts may include additional negotiable terms to the railroad’s standard terms such as volume commitments and service standards.”), p. 14 (“In 2014 about 76 percent of regulated freight was shipped by contract.”).

25. The economics behind this conclusion are straightforward. Consider a situation in which a transcontinental route is served by one railroad in the West (UP) and two railroads in the East (NS and CSX). Prior to the merger, the shipper will play the Eastern railroads against each other to get the best rate. The railroads will compete until price falls to the cost of the higher-cost railroad, and then the lower cost railroad will price just under that cost and win the business because the higher cost railroad cannot profitably match that price. The winning lower-cost railroad will earn a margin roughly equal to the difference between the two railroad's costs. That margin is known in economics as a "Ricardian rent." It is the profit that a firm earns because it has a cost advantage, and it is equal to the size of that cost advantage. Critically, the presence of that Ricardian rent creates a wedge between what is paid to the railroads and what it actually costs to move the goods, and this creates an inefficiency and takes value away from shippers.
26. Prior to the merger, the shipper will also negotiate with Union Pacific in the West. And they will strike the best deal they can given the presence of Ricardian rents in the East. But the inefficiency created by those Ricardian rents reduces the "pie" to be negotiated over and leaves the shipper (and Union Pacific) worse off.
27. Now consider the post-merger situation. Suppose first that CSX is the lower cost Eastern railroad. It still makes sense for the shipper to work with CSX and pay it a price just below NS's cost—that option is cheaper than the merged carrier shipping the goods itself and bearing NS's cost, which is higher than a price just below NS's cost. Therefore, the merger does not alter the factors that determine price; there are still Ricardian rents equal to the difference between the Eastern railroads' costs paid to CSX, and the shipper still negotiates (now with the merged UP) in the presence of those Ricardian rents. The merger has no harm (or benefit) in that case.
28. Suppose instead that NS is the lower cost carrier in the East. Now NS will carry the freight in the East, and the cost is NS's actual lower cost rather than NS's premerger price, which embeds a markup. Hence, the Ricardian rents are eliminated; the merged carrier correctly internalizes the actual cost of carrying the goods in the East. And the merged railroad and the shipper strike a deal in the absence of those Ricardian rents, leaving more value to go

around, and thus leaving the parties to the transaction (the shipper and the railroads) better off.

29. Finally, suppose that CSX is the lower cost Eastern railroad pre-merger but due to the efficiencies unlocked by the merger—in particular, the lower cost of interchange when crossing the Mississippi—UP/NS becomes the lower cost option for the Eastern leg post-merger. The merged railroad can win the business with a transfer price for the Eastern segment that is lower than CSX’s price, which once more eliminates a Ricardian rent and internalizes the cost in the East. As a result, there is again a welfare-enhancing outcome where both shippers and railroads are better off.
30. The details showing that the above intuition holds in a formal model are in Appendix A. But the basic point is simple: Either the merger changes nothing or, in the situation where the merged RR has the cheaper competitive leg, the merger creates a better deal for everyone, because it gets rid of the inefficiencies created by Ricardian rents.

B. SHIPPERS THAT ACCEPT RATES UNDER RULE 11 ARE NOT HARMED BY THE MERGER

31. Not all rail contracts involve highly negotiated, sophisticated contracts. Some shippers may accept offers from railroads with little negotiation. In what follows, I consider the two possibilities for such cases: Rule 11 pricing and through rate pricing. Together with the discussion above, this fully covers all situations—those that are negotiated non-linear contracts, and those that are not negotiated non-linear contracts, with the latter divided into Rule 11 and through rates. And below I will further divide through rates into those that are obtained from the sole-served railroad or those that are obtained from one of the railroads on the competitive leg (explaining why only the latter—a small subset of a small subset of traffic—even possibly gives rise to foreclosure concerns, and why even that possibility is rejected empirically in this case).

1. Rule 11 pricing is common and growing

32. Among these other (non-negotiated) cases, Rule 11 is likely to be the most common. As shown in Figure 2, Rule 11 rates are the most common interline arrangement and their use

has increased. In 2024, Rule 11 accounted for approximately {{ }} percent of the interline traffic for UP and NS.

33. Given the popularity of Rule 11 rates, it is especially telling that: (i) shipments using Rule 11 (without negotiated non-linear pricing) benefit from the merger (due to the “Cournot Complements effect, which generates downward pricing pressure when complementary railroads merge, as explained below) and (ii) the only theories of harm in the economic literature for such cases (in which buyers receive prices separately from each provider of a complementary product) do not apply here. I explain these points in more detail next.

Figure 2
UP and NS Interline Traffic by Pricing Arrangement {{

}}

Source: UP and NS Waybill Data 2019-2024

Notes:

1) “All UP/NS Interline” does not equal the sum of UP and NS panels due to the avoidance of double counting UP and NS interline movements.

2. The merger will generate benefits, not harms, for shippers using Rule 11 pricing

34. Under Rule 11, the competitive setting is a variant of what economists refer to as “Cournot Complements” pricing, named for the economist who first analyzed the situation nearly

200 years ago.²⁶ In this situation there are one or more sellers of each of two or more products that are perfect complements, meaning each component is a necessary component that together constitute a single product. Here the components are the eastern and western legs of transcontinental rail shipments. Pricing incentives and the effects of mergers in Cournot Complements settings—which is what the Rule 11 institution creates—have been widely studied in the economic literature. A general conclusion is that mergers in this setting either reduce prices or leave them unchanged, except in certain edge cases that do not apply to the merger at hand.

35. When shippers receive price quotes under Rule 11 but treat the offers as take-it-or-leave-it and do not negotiate with the railroads—the situation at issue in this section, since I dealt with the negotiated case above—they face what are known as Cournot Complements externalities. These externalities typically cause independent railroads to price higher than they would as a merged firm. The logic is as follows. When two complementary producers A and B set prices independently (pre-merger), an increase in the price by one of them raises the “combined price” paid by the customer (the sum of the two prices), which typically reduces the quantity demanded and leads to lower sales of *both* complements. The issue is that neither railroad considers the effect of its price on the profits of the *other* railroad, and thus they each set prices higher than would be optimal to maximize joint profits. This is essentially another version of the reason that separate firms selling complements have lower investment incentives than the combined firm: In both cases, each firm can take a costly action (cut price, invest more) to increase profits, but because they do not consider the profits of the *combined* firm, but rather consider only their own profits, they do not take as much of the costly action as would be jointly optimal. A merger solves both problems, leading to downward pricing pressure (relative to the situation with

²⁶ See Cournot, A. (1838), *Researches into the Mathematical Principles of the Theory of Wealth*, New York: Macmillan; Economides, N. and S. C. Salop (1992), “Competition and Integration Among Complements, and Network Market Structure,” *The Journal of Industrial Economics*, 40(1), 105–123; Vives, X. (1999), *Oligopoly Pricing: Old Ideas and New Tools*, MIT Press, pp. 176–177.

no merger) and increased investment. Indeed, this is the reason vertical/complementary mergers are rarely found to be anticompetitive.

36. A recent article in the economics literature (“Kadner-Graziano”) identifies two edge cases where a complements merger can theoretically harm consumers, but neither edge case applies to this merger.²⁷ Both edge cases assume that the merged firm engages in “pure bundling” of the merged complements, which in the context of this case would mean the merged firm would refuse to provide a Rule 11 rate to a competing railroad. However, that assumption does not fit the economics of the railroad industry, as shippers have the ability to break the pure bundling strategy. In particular, by rule, the merged carrier must provide a Rule 11 rate if the shipper requesting the rate has arranged service from the competing railroad for the other leg.²⁸ And critically, an unintegrated railroad has an incentive to provide a Rule 11 rate for a leg that it has a chance of winning—meaning it has an incentive to provide a Rule 11 rate for any leg where it is competitively relevant. This means that in cases where pure bundling could matter, the shipper can prevent it by first getting a Rule 11 rate from an unintegrated railroad and then requesting one from the merged firm. Thus, the pure bundling edge cases do not apply.
37. Even if one were to assume (counterfactually) that pure bundling were feasible, the theories of harm developed in Kadner-Graziano are ill-suited to the railroad industry. The first of them involves using pure bundling to deter entry. For such a theory to be relevant, one would have to believe that entry by railroads onto routes they do not otherwise serve is an important competitive consideration in the railroad industry, and thus build that reality into

²⁷ See Kadner-Graziano, A. S. (2023), “Mergers of Complements: On the Absence of Consumer Benefits,” *International Journal of Industrial Organization*, 89, Article 102935.

²⁸ Surface Transportation Board, Docket No. EP 705, “Competition in the Railroad Industry,” January 11, 2011, p. 4 (“Finally, for either type of movement—same-source movements for which a shipper has successfully obtained an alternative routing, or different-source movements that the bottleneck carrier cannot handle in single-line service—the Board held that it could not force the bottleneck carrier to quote a separately challengeable rate for the bottleneck segment unless the requesting shipper had already entered into a rail contract for the non-bottleneck segment at the time that the bottleneck rate was requested.”).

competitive analysis of railroad transactions, railroad rates, etc. That is not a commonly held view in this industry, as entry is not generally viewed as an important competitive consideration, and thus entry deterrence is an unlikely theory of harm. Further, even if it were relevant, whether pure bundling could even be used in this way is speculative and the welfare effects are ambiguous.²⁹ The other theory of harm requires that the BNSF and CSX (the non-merging railroads) legs are systematically less compatible with one another (in providing interline service) than are other combinations. I know of no evidence that this is true, and, given that eastern and western railroads all interchange at common gateways, it is unlikely to hold, meaning this theory is also ill-suited to the railroad industry.

38. In sum then, for shippers who do not negotiate non-linear contracts, but rather receive prices via Rule 11, the merger will generate Cournot Complement benefits, with no offsetting harms, and thus will not lead to foreclosure harms, but rather will benefit shippers.

C. SHIPPERS WHO ACCEPT THROUGH RATES ARE NOT HARMED BY THE MERGER

39. Finally, for completeness, I turn to the smallest case: shippers who do not negotiate non-linear contracts and do not get prices via Rule 11, but rather who receive (non-negotiated) through rates. As seen above, given the prevalence of negotiated contracts and Rule 11 pricing—neither of which gives rise to foreclosure concerns—this is a small category. It is also one in which foreclosure concerns cannot be ruled out as a matter of theory (at least when the shipper receives the through rate from a railroad that faces competition), but where I show that empirical tests reject standard foreclosure theories. This leaves only edge cases, which depend on restrictions on firm behavior and other assumptions that do not apply to the railroad industry, and which are addressed not by blocking the merger but

²⁹ Whinston (1990) makes the following observation about the use of pure bundling as an entry deterrence strategy: “Even in the simple models considered here [which are like the model in Kadner-Graziano], which ignore a number of other possible motivations for the practice [pure bundling], the impact of this exclusion on welfare is uncertain.” See Whinston, M. D. (1990), “Tying, Foreclosure, and Exclusion,” *The American Economic Review*, 80(4), 837–859.

rather via Open Gateway Conditions that can “clean up” any edge cases that may slip through.

1. Theoretical possibility of foreclosure for non-negotiated through rates where price is received from a railroad on the competitive end

40. As discussed above, some shippers accept through rates offered by railroads without negotiating. This occurs when rates are quoted to a shipper by a railroad on one leg of an interline route, where the contracting railroad arranges and pays for service by a complementary railroad on another leg. Under this pricing mechanism, the adjoining railroads are in a vertical arrangement where the customer-facing railroad sells the entire route to the shipper.
41. As a pure matter of economic theory, shippers who accept offers of through rates from railroads—without negotiating non-linear contractual terms—*could* face traditional foreclosure concerns following a merger. For these theories to hold, it would have to be the case that the carrier that solely serves one segment of the route can earn greater profits by merging with a carrier on the competitive segment of the route and foreclosing the remaining unintegrated carrier(s). A long-standing response to these concerns has been that the sole-serving carrier can charge the monopoly rate for the movement and earn the monopoly profit *prior to a merger*. If so, then the sole-serving carrier is already earning all the profits possible and cannot increase them by foreclosing an unintegrated carrier, meaning there should be no concern about foreclosure due to the merger. *Hence, any economic theory of foreclosure has to explain why the sole-serving carrier was not earning monopoly profits pre-merger, how the merger will alter that situation, and thus why it would have an incentive to foreclose the independent railroad post-merger.*
42. In general, theories of foreclosure—that is, explanations for why the sole-serving carrier was not earning the monopoly profit pre-merger—do not apply to situations where the shipper gets a price directly from the sole-served carrier. In those cases, the sole-serving carrier gets an input price from the “upstream” railroads (those not facing the shipper directly) and, in turn, sets the final price to the shipper. In that situation, nothing stops the sole-serving carrier from setting the monopoly price (conditional on that input price).

Notably it might set a higher than monopoly price if the input price is above the marginal cost of providing that service, but it should not provide a lower than monopoly price (again, absent shipper negotiation over non-linear pricing terms, which are covered elsewhere in this statement).

43. Thus, potential theories of foreclosure come down to a single, narrow case—prices that are not part of negotiated non-linear contracts, are not Rule 11, and are not through rates set by the sole-served carrier but rather are through rates received from one of the railroads on the competitive end. On its own this says that the scope for potential foreclosure is quite narrow, as this describes a narrow sliver of all shipments. And critically, the possibility of foreclosure in this narrow case is just that, a possibility, and one with specific empirical predictions that can be tested. I do so, below, and show that they do not hold.

2. Empirical tests reject the standard models of foreclosure in this case

44. Building on the logic discussed above, the case for foreclosure on non-negotiated through rates received by a shipper from a railroad on the competitive end (outside of edge cases, relying on unreasonable restrictions on firm behavior, discussed in Appendix A) would be as follows, in simple terms. Something about having to work through two downstream railroads (meaning two competing railroads who compete to win the shipper's business with a through rate) prevents the upstream, sole-served railroad from being able to charge the full monopoly price. Note that this is just a theoretical possibility that does not have to be true: It may be the case that the sole-serving railroad is able to charge the full monopoly price even in this setting. And whether it can or not depends on highly detailed assumptions about things like whether pricing offers are publicly observable or not and what form they take. But if it is true that the sole-serving railroad cannot charge the monopoly price in this case, two things should be observed:

- Shippers should strongly prefer to get through rates from railroads on the competitive end, rather than railroads on the sole-served end, because if they get through rates from the sole-served end they will pay at least the monopoly price, while—if the

foreclosure theory holds—if they get through rates from the competitive end, they will pay less; and

- Observed prices when through rates come from the competitive end should be lower than when the rates come from railroads on the sole-served end.

Hence, testing whether those two conditions hold—do shippers flock to getting through rates from the competitive end and are through rates lower when they come from the competitive end—provides a test of whether these theories of foreclosure effects resulting from a vertical railroad merger hold.

45. In the next section (Section III.D), I show that neither condition holds and thus the theory of foreclosure is rejected, even in the one narrow case where it was possible.
46. This analysis shows that the economic theories of anti-competitive foreclosure that make up the bulk of the economic literature do not apply to the railroad industry. Some parties may suggest alternative theories that predict foreclosure. However, these theories will fail due to some combination of the following: (i) they are inconsistent with generally accepted economic results; (ii) they are inconsistent with the clear empirical evidence in Section III.D; or (iii) they are based on assumed restrictions on railroad behavior that are inconsistent with the facts of the industry and other unsupportable assumptions. I discuss some of these theories in greater detail in Appendix A. I will respond to specific theories if they are raised by other economists, but even now I can say that they will not provide a basis to block such a beneficial transaction, and, to the extent they raise any concern at all, that is what the Open Gateway Conditions exist to address.

D. EMPIRICAL TESTS DEMONSTRATE THAT FORECLOSURE THEORIES DO NOT APPLY EVEN IN THE NARROW CASES WHERE THEY ARE THEORETICALLY POSSIBLE

47. In this section, I implement the empirical tests described above to test whether standard (non-edge) foreclosure theories hold even in the one narrow case where they might: non-negotiated through rates received from railroads on the competitive end. I show that they do not.
48. In particular, I implement the following tests:

- Where shippers obtain through rates, do they primarily obtain them from a railroad on the competitive end? **Answer: No.**
- Are through rates obtained from the competitive end lower than other rates?
Answer: No.

1. Shippers do not favor obtaining through rates from downstream competitive carriers

49. To implement the first test—assessing whether, when shippers obtain through rates, they primarily obtain them from the competitive end—I rely on data on through rates observed in the UP and NS 2019-2024 Waybill data limited to routes with a sole-serving carrier on one end and competition on the other end. I have to make two key implementation decisions: how to define competition (discussed below) and which through rates to study. For the latter, the issue is that this theory of foreclosure only applies to through rates that are not set pursuant to negotiation over non-linear contractual terms. But there is no perfect way to define such through rates in the data, so I consider three approaches:

- Look at all through rates;
- Look at through rates other than contracts (meaning private quotes, other non-tariff rates, and tariffs), in this way eliminating the through rates most likely to reflect negotiations over non-linear price terms (contracts);
- Look only at tariff rates (thus eliminating price quotes and other non-tariff rates, which may also reflect negotiation over non-linear price terms)

I show that all three approaches yield the same conclusion.

50. My analysis considers two alternative definitions of competition: “Competition Version 1,” which uses industry location data³⁰ and observed traffic,³¹ and “Competition Version 2,” which uses only industry location data. Of the two, Competition Version 2 is more likely to label a route-segment as sole served. I show that both approaches yield the same conclusion.
51. In Figure 3, I show the breakdown of UP and NS through rate traffic with a sole-served segment and a competitive segment. Using “Competition Version 1” I find that roughly {{ }} percent of the through rate traffic under consideration is contracted with a carrier on the sole-served segment. Similar findings emerge under my alternative competition definition (see lower panel). *Hence, shippers do not flock to getting through rates from a railroad on the competitive end; rather, it is right around {{ }}.* This is not consistent with a theory of foreclosure, as that would involve lower rates when they are received from the competitive end, meaning shippers should strongly prefer that setup.

³⁰ Access for a given Class I railroad at a particular station is determined using the centralized station master (“CSM”) and Serving Carrier/Reciprocal Switch (“SCRS”) files such that a particular railroad station, defined as the combination of: SPLC-SCAC-FSAC, is considered to be open to competition from another Class I carrier if the other Class I carrier has open access to one or more customers in common with the railroad/station in question.

³¹ In particular, if a Class I railroad is observed originating, terminating, or interchanging more than 1% of carloads for a given group of commodities at a particular station (SPLC-6) in the STB confidential Carload Waybill Sample from 2019-2023, that railroad is determined to be competitive at that origin or destination for shipments of that commodity group.

Figure 3
Pricing Arrangements on Routes with a Sole-Served and a Competitive Segment
2019 – 2024 {{

}}

Source: UP and NS Waybill Data 2019-2024, AAR Centralized Station Master (CSM), Serving Carrier Reciprocal Switching Data (SCRS).

Notes:

- 1) “UP/NS Total” does not equal the sum of UP and NS panels due to the avoidance of double counting UP and NS interline movements.
- 2) I determine who the shipper deals with based on the issuer of the shipment’s Price Authority.

52. In Figure 4, I examine this split over time. Again, the chart demonstrates that shippers do not favor dealing with the carriers on the competitive end when obtaining through rates. Instead, the percentage bounces around {{ }}, exactly as one would expect if there was no preference between the two, and the opposite of what one would expect if the theory of foreclosure held.

Figure 4
Through Rates By Who Shipper Deals With
UP/NS, All Traffic, By Year {{

}}

Source: UP and NS Waybill Data 2019-2024, AAR Centralized Station Master (CSM), Serving Carrier Reciprocal Switching Data (SCRS).

Notes:

1) I determine who the shipper deals with based on the issuer of the shipment's Price Authority.

53. As noted above, I conduct a similar analysis using the subset of through rate traffic moving under: (1) everything other than contracts (i.e., private quotes, other non-tariff rates, and tariffs) and (2) tariffs only. Each of these represents a way to zoom in on traffic less likely to reflect negotiations over non-linear pricing terms.
54. As shown in Figure 5, when looking at everything other than contracts, the economic evidence does not show that shippers prefer to obtain rates from a railroad on the competitive end. In fact, in the majority of years, more of the non-contract prices are obtained from the *sole-served* end, exactly the opposite of what the foreclosure theory would predict. The fact that shippers using non-contract rates do not seek out rates from the competitive end—as they would under the standard theory of foreclosure where those rates should be lower than rates obtained from the sole-served end—is strong evidence against a theory of foreclosure. Said differently, the standard theory of foreclosure requires that something is holding rates down when they are obtained from the competitive end, meaning shippers should strongly prefer that setup, but that pattern does not hold.

Figure 5
Through Rates By Who Shipper Deals With
Non-Contracted Traffic, By Year {{

}}

Source: UP and NS Waybill Data 2019-2024, AAR Centralized Station Master (CSM), Serving Carrier Reciprocal Switching Data (SCRS).

Notes:

1) I determine who the shipper deals with based on the issuer of the shipment's Price Authority.

55. Finally, Figure 6 looks at tariffs only. This is the most restricted set of traffic, but also the one least likely to be subject to negotiations over non-linear pricing terms. Again, I find that obtaining through rates from the competitive end is actually less common than obtaining them from the sole-served railroad, occurring less than {{ }} percent of the time. Once again, this refutes the standard theory of foreclosure in which the pattern should go the other way.

Figure 6
Through Rates By Who Shipper Deals With
Tariff Traffic, By Year {{

}}

Source: UP and NS Waybill Data 2019-2024, AAR Centralized Station Master (CSM), Serving Carrier Reciprocal Switching Data (SCRS).

Notes:

1) I determine who the shipper deals with based on the issuer of the shipment's Price Authority.

2. Rates are not lower when dealing with the competitive carriers relative to dealing with the sole-serving carrier

56. Next, I turn to the second part of the test: Are through rates lower when they are negotiated on the competitive end? Again, I consider my two definitions for the presence of competition, as well as alternative sets of through rates in an attempt to focus on rates that are not set by negotiation over non-linear contractual terms. As in the prior section these alternative sets are: (1) all traffic; (2) non-contract traffic; (3) tariff traffic only.
57. To implement this test, I run a multivariate regression analysis, comparing through rates obtained from the competitive end with through rates obtained from the sole-served end, after controlling for many other factors that affect rates.³² Regression analysis is a standard tool used by economists to measure economic relationships between a response variable (also known as a “dependent variable”) and a variable of interest, while holding constant

³² Data are aggregated to the following unit of observation: railroad, route, commodity, shipper, year-month, car type, car owner, pricing document type, and unit train flag.

key confounders (also known as “control variables”). I rely on aggregated UP/NS Waybill data from 2019-2024.

58. The measure of price in the regression is the natural logarithm of the rail rate, defined as the revenue per carload. In addition to the variables of interest (which indicates whether the rate comes from the competitive or sole-served side), I include control variables to account for various factors that may also impact pricing on a particular rail shipment, including controls for commodity, car owner, car type, whether it is a unit train, type of pricing arrangement (contract, private quote, etc.), average net weight per car, and the year/month of the observation. I also include what are known as “fixed effects” for each route—a set of control variables that fully account for all differences *across routes*. In this way, the test is implemented by comparing rates obtained from the competitive end and rates obtained from the sole-served end, holding constant the origin and destination—meaning only within-route variation is used to measure the effect, not across-route variation.
59. Figure 7 shows results based on the two methodologies used to define competitive and sole-served segments in prior figures (“Competition Version 1” using industry location data *and* observed traffic and “Competition Version 2” using only industry location data).

Figure 7
Test for Presence of Foreclosure Incentives in Through Rates

Independent Variable	Dependent Variable: Ln(Rate per carload)	
	Combined UP/NS Data	
	Competition Version 1	Competition Version 2
Through Rate: Shipper Deals with Competitive End [Base]	-	-
Through Rate: Shipper Deals with Sole-Serving Carrier	0.0164	0.0056
Std. Err.	[0.0279]	[0.0286]
P-value	0.557	0.846
Observations	391,594	367,917

Source: UP and NS Waybills 2019-2024, STB Confidential Carload Waybill Sample 2019-2023 (CCWS), AAR Centralized Station Master (CSM), Serving Carrier Reciprocal Switching Data (SCRS).

Notes:

- 1) Explanatory variables include fixed effects for: route, STCC3, car owner, AAR car initial, unit train dummy, type of pricing arrangement (contract, private quote, etc.), year-month, reporting railroad dummies; weight and weight².
- 2) ** P-value<0.05; * p-value<.1. Clustered standard errors in brackets (clustering at the route level).
- 3) “Competition Version 1” uses industry location data and observed traffic. “Competition Version 2” uses only industry location data.

60. The second row measures the difference between through rates when the shipper obtains through rates from the sole-serving carrier vs. through rates when the shipper obtains rates from the competitive end. If shippers receive lower rates when dealing with the competitive carriers this estimate would be positive and statistically significant. However, as shown in the second row of Figure 7, the estimate is a small, positive number, and statistically indistinguishable from zero.
61. The second column displays the results from the same test applied using the alternative competition definition (“Competition Version 2”). This estimate is also a small positive number and not statistically different than zero. If the foreclosure hypothesis were operative, the coefficient would be expected to be positive and economically and statistically significant.
62. As a further test, I conduct the same regression analysis applied to non-contract traffic, meaning private quotes, other non-tariff rates, and tariffs. By eliminating contract traffic, the analysis eliminates the subset of traffic, which is most likely to reflect negotiations with

non-linear terms. These analyses, presented in Figure 8, also find that through rates obtained from the competitive end are not lower by a statistically significant amount. Under both “Competition Version 1” and “Competition Version 2” the estimates are negative and statistically insignificant. Again, if the foreclosure hypothesis were operative, the coefficients would be expected to be positive and economically and statistically different than zero.

Figure 8
Test for Presence of Foreclosure Incentives in Through Rates
Non-Contract Traffic

Independent Variable	<u>Dependent Variable: Ln(Rate per carload)</u> Combined UP/NS Data	
	Competition Version 1	Competition Version 2
Through Rate: Shipper Deals with Competitive End [Base]	-	-
Through Rate: Shipper Deals with Sole-Serving Carrier	-0.0606	-0.0668
Std. Err.	[0.0422]	[0.0419]
P-value	0.151	0.111
Observations	182,503	169,247

Source: UP and NS Waybills 2019-2024, STB Confidential Carload Waybill Sample 2019-2023 (CCWS), AAR Centralized Station Master (CSM), Serving Carrier Reciprocal Switching Data (SCRS).

Notes:

- 1) Explanatory variables include fixed effects for: route, STCC3, car owner, AAR car initial, unit train dummy, type of pricing arrangement, year-month, reporting railroad dummies; weight and weight².
- 2) ** P-value<0.05; * p-value<.1. Clustered standard errors in brackets (clustering at the route level).
- 3) “Competition Version 1” uses industry location data and observed traffic. “Competition Version 2” uses only industry location data.

63. Finally, I conduct the same regression analysis applied to tariff traffic. This is a small subset of the overall interline traffic, but I study it despite the data limitations because it is least likely to be subject to negotiations over non-linear pricing terms. This analysis, presented in Figure 9, again finds negative estimates. Again, if the foreclosure hypothesis were operative, the coefficients would be expected to be positive and economically and statistically different than zero.

Figure 9
Test for Presence of Foreclosure Incentives in Through Rates
Tariff Traffic

Independent Variable	Dependent Variable: Ln(Rate per carload)	
	Combined UP/NS Data	
	Competition Version 1	Competition Version 2
Through Rate: Shipper Deals with Competitive End [Base]	-	-
Through Rate: Shipper Deals with Sole-Serving Carrier	-0.0058	-0.0069
Std. Err.	[0.0108]	[0.0117]
P-value	0.593	0.556
Observations	27,617	22,226

Source: UP and NS Waybills 2019-2024, STB Confidential Carload Waybill Sample 2019-2023 (CCWS), AAR Centralized Station Master (CSM), Serving Carrier Reciprocal Switching Data (SCRS).

Notes:

- 1) Explanatory variables include fixed effects for: route, STCC3, car owner, AAR car initial, unit train dummy, year-month, reporting railroad dummies; weight and weight².
- 2) ** P-value<0.05; * p-value<.1. Clustered standard errors in brackets (clustering at the route level).
- 3) “Competition Version 1” uses industry location data and observed traffic. “Competition Version 2” uses only industry location data.

64. To sum up the evidence presented in this section, my analyses demonstrate that there is no statistical evidence that shippers negotiate lower rates when they get through rates from the competitive end of a movement. If anything, most estimates show that rates are a bit lower when shippers get them from the sole-served end, although the difference tends to not be statistically significant. Once again, then, the empirical evidence does not support the theory of foreclosure, even in the narrow cases where it might apply.

E. ASYMMETRIC INFORMATION ON COSTS AND OTHER EDGE CASES DO NOT CREATE INCENTIVES FOR ANTICOMPETITIVE FORECLOSURE

65. The analysis above rules out the most prominent theories of foreclosure. In this section, I turn to some other theories of foreclosure that could potentially be raised. First, recent economic literature has raised the counterintuitive possibility that the improved information resulting from a merger could enable a form of foreclosure, through which railroads harm shippers by extracting more value from them. However, even the published literature on

this topic finds that more information is efficient, meaning that it increases total output and total welfare. In the case of the railroad industry, this would mean the industry was more effectively doing its job of moving traffic and that the ultimate consumers of the railroad industry—the downstream buyers who consume the products that are shipped—are better off. And I show that the counterintuitive finding in the literature that railroads having more information can harm shippers depends on the unreasonably restrictive assumption that shipper demand does not decline at all in response to higher prices, and that once this assumption is relaxed, the result is reversed, with more information increasing consumer welfare.

66. I then turn briefly to some other “edge cases”—economic theories where foreclosure may be possible, but which depend on unreasonable restrictions on firm behavior or other assumptions not well suited to the railroad industry. I explain why these theories provide no basis to oppose the merger, but at most point to the value of Open Gateway Commitments to resolve any stray cases. I provide more detail on edge cases in Appendix A.

1. Concerns regarding mergers when the sole-serving railroad has incomplete information

67. A recent model developed by Moresi *et al.* (“Moresi”) raises the possibility that foreclosure harms from vertical mergers may occur in settings where downstream competitors have private information.³³ For example, an upstream (non-customer-facing) railroad may have incomplete information about a downstream railroad’s costs or the shipper’s demand. The downstream, customer-facing railroad, of course, knows its costs and is likely to have better information about the shipper’s demand than the upstream firm because it interacts directly with the shipper. A vertical merger of such a downstream railroad with such an upstream monopolist would transfer the downstream railroad’s information upstream. The

³³ Moresi, S., D. Reitman, S. C. Salop, and Y. Sarafidis (2021), “Vertical Mergers in a Model of Upstream Monopoly and Incomplete Information,” *Review of Industrial Organization*, 59(2), 297–336.

concern raised in the Moresi model is that transferring information to the monopoly railroad through merger would allow the merged railroad to price more aggressively and thus more effectively extract shipper surplus.

68. This concern is misplaced. First, even in the Moresi model, both output and total welfare rise. Notably, in the context of the railroad industry, the fact that output increases means that the railroad industry is more effectively doing its job of moving goods, and that downstream consumers (those who buy from shippers) are better off, as more goods are bought and sold. Second, the finding in the Moresi model that the merger lowers consumer surplus is driven by an assumption that, certainly in the context of the railroad industry, is unrealistic and overly restrictive: that consumers (here, shippers) have perfectly inelastic demand, meaning that changes in price, in either direction, have no effect on demand. When this assumption is replaced by the more realistic assumption that shippers have downward sloping demand, the merger increases shipper welfare and continues to raise output and total welfare. I develop each these points in more detail in the following paragraphs.
69. The Moresi model has two elements: a vertical merger between an upstream monopolist and one of two downstream oligopolists, and the information transfer that the merger brings about. Given the inherent benefits of vertical mergers, described above, and the fact that information transfer frequently enhances efficiency, it would be surprising if adding an element of information transfer to a vertical merger resulted in a transaction that was harmful to consumer welfare. However, under the highly restrictive and stylized assumption that consumers (shippers) have perfectly inelastic demand with a known reservation price, the Moresi model finds that the merger harms consumer welfare because the improved information enables the merged firm to extract more value from consumers (shippers).
70. In fact, this prediction of the Moresi model is an artifact of the inelastic demand assumption. This assumption is unreasonable in the railroad industry for one or both of the following reasons: (i) shippers are likely to want to ship more in response to a lower price (standard downward sloping demand); and (ii) shippers likely have private information

about their valuations for any given shipment, which means that a shipper's expected purchases likely increase as price falls (downward sloping expected demand). The first of these likely holds because shippers sell their goods in downstream markets, and if shipping costs go up, they are likely to have to pass some of these variable costs on to their consumers, reducing demand for their products, and thus reducing the amount shipped. The second of these holds because even if shippers *do* in fact have a fixed reservation price (or willingness to pay), railroads surely do not know it, and so as railroads raise prices, the probability of going over that reservation price rises, reducing the expected amount sold.

71. Hence, the Moresi model only works in the context of a railroad merger under the truly extreme assumption that shippers have a fixed willingness to pay *and* railroads know what it is with certainty. Note how strong the second part of this assumption is in the context of the Moresi model: the sole-serving railroad is assumed to lack information about the other railroad's costs, yet to have perfect information about shippers' willingness to pay. In practice, the sole-serving carrier's uncertainty about shippers' willingness to pay is likely to be *greater than* its uncertainty about the downstream railroad's costs. Railroads are likely to have a reasonable understanding of the cost of rail service between two points. However, there is no reason to assume that a railroad that does not interact directly with a shipper has particularly good information about that shipper's willingness to pay for transportation or the shipper's customers' sensitivity to higher delivered prices. Strikingly, however, to generate its results, the Moresi paper assumes *perfect* information about shippers' willingness to pay, while information about other firms' cost to ship is limited. Such an assumption is not reasonable, yet it is required to generate the result that greater information harms shipper welfare.
72. In the Moresi model, under these extreme assumptions, the merger reduces shipper surplus (in fact, it leads to complete extraction of shipper surplus). However, this finding is an artifact of Moresi's assumptions that: (i) shippers have perfectly inelastic demand and (ii) the sole-serving carrier knows the shipper's reservation price (i.e., the highest price the shipper is willing to pay). In Appendix B, I show that a straightforward extension of the model to allow downward sloping demand for shippers leaves the output and welfare

results unchanged—the merger increases output and total welfare—but reverses the shipper welfare result. More specifically, I find that for the case of linear demand and uniformly distributed costs, a merger increases shipper surplus in addition to increasing output and total welfare. The increase in shipper welfare is the result of the railroad making more sales at lower prices and the fact that it cannot fully extract the shipper’s surplus as it can in Moresi. In addition, both the shipper and the railroad benefit from the increase in output that results from the elimination of inefficiently high prices resulting from poor information. These results mirror the standard efficiency effects of vertical mergers in the case of complete information, described above.

73. Put simply, as long as railroads face lower demand as they raise prices—the standard economic assumption—the Moresi result is reversed and greater information increases consumer surplus. For this reason, the information transfer (between UP and NS) engendered by the merger is not a source of competitive concern, but rather a benefit.

2. Edge Cases

74. This section has presented strong, general results rejecting foreclosure as a significant concern in the railroad industry. Those results consider carefully the modern literature on cases where foreclosure may occur, but reject those cases as inapplicable—as a matter of theory, marketplace realities, and empirical evidence—to the railroad industry. As I have explained, that is not to say that other economists could not present alternative theories of foreclosure and claim they apply to this industry and this transaction. Here, I can confidently say any such theories would describe, at best, “edge cases,” based on unreasonably restrictive assumptions about firm behavior or other assumptions ill-suited to the railroad industry. I briefly discuss these edge cases here and explain why they do not apply to this merger. See Appendix A for more detail.
75. As one example, in complete information settings with an upstream monopolist selling to downstream *differentiated* oligopolists using linear contracts (per-unit “wholesale” prices), a vertical merger can raise prices if downstream firms are highly asymmetric, specifically, if consumer substitution from competitor A to B in response to a reduction in B’s price is sufficiently different from the consumer’s substitution from B to A in response to a

reduction in A's price. However, such theories are ill-suited to the present case for multiple reasons. First, the restriction to linear pricing does not describe the vast majority of railroad transactions, in which terms are more complicated than that. Rather than involving a single price at which any amount of traffic can be shipped, they include volume commitments, different prices for different volumes, specific agreements on how much to ship, and so on. And second, the specific type of asymmetry such theories require in order to work does not arise when contracts are customer-specific and customers themselves sell products to final consumers, which is the case with shippers in the railroad industry (see Appendix A).³⁴

76. As an example that moves beyond linear pricing, in complete information settings with an upstream sole sourcing supplier selling through observable non-linear contracts, and with differentiated downstream oligopolists, the pre-merger price equals the price set by a fully integrated railroad.³⁵ If a merger occurred in this setting and there was no Rule 11 option, there would be a theoretical possibility that prices to shippers could rise if (i) downstream firms were sufficiently asymmetric, and (ii) the merging firm could not adjust its contract to ensure the fully integrated outcome continues to arise post-merger. However, given that this model assumes that railroads are already engaged in sophisticated non-linear contracting to ensure the fully integrated outcome pre-merger, there is no reason to believe they could not write a contract replicating that outcome post-merger, and in that case, the merger would not change anything. Hence, this is another case where claims of merger harm would be based on unreasonable restrictions on firm behavior in the post-merger case, with those restrictions, not the merger itself, generating the harms.

³⁴ The customers in rail freight markets are firms that sell the products they ship to customers, and rail services from different carriers are inputs into their production and sales process. Under the typical assumption that a shipper's profits from manufacturing and selling its product is a continuous function of the prices of different rail inputs, the cross derivatives of the demand for two rail inputs are equal. See Varian, H. R. (1992), *Microeconomic Analysis*, 3rd Edition, W.W. Norton & Company, p. 60.

³⁵ Mathewson, G. F. and R. A. Winter (1984), "An Economic Theory of Vertical Restraints," *The RAND Journal of Economics*, 15(1), 27–38, p. 34.

77. I discuss such edge cases further in Appendix A.

F. THERE IS NO VALID COMPETITIVE CONCERN ASSOCIATED WITH THE LOSS OF INDEPENDENT ROUTES IN CORRIDORS WHERE UP AND NS SERVE DIFFERENT LEGS OF THE MOVEMENT AND DO NOT OVERLAP AT EITHER END OF THE CORRIDOR

78. In response to UP/NS’s prior application, CPKC noted that the application did not provide an analysis of the effect of Applicants’ proposed merger on “the number of independent routes in corridors where UP and NS may serve different legs of the movement.”³⁶ I take this statement to express a concern that access to multiple “independent routes”—i.e., routes with no carriers in common—in a corridor creates competition on the corridor that could be diminished as the result of a vertical merger. I further understand that CPKC’s concern focuses on those corridors in which UP and NS serve different legs of the movement, so I limit my analysis to corridors in which UP and NS do not overlap at either end.³⁷
79. Given CPKC’s comments on UP/NS’s initial application, I have applied an algorithm for counting independent routes (the “algorithm”) based on and consistent with the method used in CPKC’s merger proceeding.³⁸ For purposes of this analysis, I define a “corridor” as all routes with origins or destinations in a BEA pair connected by single or interline rail service, and I define a “route” as a sequence of rail segments in a corridor. Independent routes are defined as routes within a corridor that share no Class I carriers with each other.
80. I perform an initial count of independent routes using the following method:

³⁶ Union Pacific Corporation and Union Pacific Railroad Company—Control—Norfolk Southern Corporation and Norfolk Southern Railway Company, Docket No. FD 36873, Decision No. 9, January 16, 2026, p. 5.

³⁷ *Id.* I understand that Dr. Bailey’s Verified Statement covers routes where UP and NS overlap at one or both ends of a corridor, I exclude these from my analysis.

³⁸ This is consistent with the approach taken in the CP-KCS proceeding. I utilize the CPKC method of counting the number of independent routes. However, I use six years of waybill data, rather than a single test year for identifying relevant routes; I consider routes with traffic of ten cars per year or more in at least one year and corridors with traffic of at least one car per day on average; I determine independent routes based on Class I railroads only, rather than considering all carriers.

- Using Waybill data from the six Class I railroads, identify all corridors (i.e., BEA pairs) with rail traffic at any point between 2019 and 2024 in which UP and NS serve different legs of the movement and do not overlap at either end of the corridor.
- For each corridor that averages at least one car per day, list each of the unique combinations of Class I railroads (i.e., ‘routes’) observed moving traffic in the corridor.
- The algorithm identifies the observed route that has the fewest overlaps with other routes in the corridor and treats this as the initial independent route in the corridor.
- The algorithm adds additional routes (with successively more overlaps) to the set of independent routes if they are independent of previously selected routes.

81. I follow this method to count independent routes in the pre-merger state of the world where UP and NS are independent and in the post-merger world where UP and NS are treated as a single carrier. The algorithm flags a corridor as losing an independent route when the number of independent routes is lower after the merger than before. I flag corridors where the algorithm identifies a reduction in the number of independent routes from three to two (“3-2”) or from two to one (“2-1”) for further analysis. I do not flag corridors that retain at least three independent routes following the UP/NS merger because they continue to receive service from a relatively large number of railroads after the merger.

1. Economic Analysis Shows that None of the Corridors Flagged by the Algorithm Would Suffer From Reduced Competition After the UP/NS Merger

82. When the independent route algorithm is run on the waybill data using the method described above, the algorithm identifies 74 corridors as losing an independent route due to the UP/NS merger. In fact, however, there should be no concern about loss of competition in any of these corridors. While identifying corridors with a reduction in independent routes is *intended* to capture corridors in which shippers lose competitive options, the above method cannot do so without modification. That is because the algorithm, as described above, considers only routes observed in the railroads’ waybill data. However,

there are often alternative independent routes that a more accurate algorithm would consider.³⁹

83. Specifically, as I describe below, the method needs to be modified so that the counting algorithm more accurately accounts for shippers' actual viable options, such as routes created by connecting established rail segments at common gateways, because those are competitive options, even if they are not observed in the railroads' movement data. Because carriers serving different segments of a corridor at a common gateway can connect (even if such a connection is not observed in the Waybill data) to create a route in the corridor, I treat those connections as alternative viable routes in my analysis. When I augment the set of routes considered by the counting algorithm in this way, I find that there are no longer any corridors losing an independent route as a result of the merger.
84. For example, there are frequently corridors observed in the waybill data with traffic moving from a western BEA to an eastern BEA, interchanging in Chicago, where waybill data shows the following combinations of carriers: (1) UP-to-CSX, (2) UP -to-NS, and (3) BNSF-to-NS. Looking only at the waybill data, the post-merger routes are: (1) UPNS-to-CSX; (2) UPNS; and (3) BNSF-to-UPNS. In this case, the algorithm treats this as a 2-to-1 corridor because when the BNSF-to-CSXT option is not observed in the data, every post-merger option that the algorithm "sees" includes the merged UPNS. This does not, however, accurately reflect all the economically viable alternatives. The example shows that BNSF and CSXT each serve the segment from their respective ends of the corridor to Chicago where they interchange traffic with other railroads in the corridor. If shippers want an independent route that is unaffected by the UP/NS merger, there is no reason why BNSF and CSXT could not interchange traffic with each other to serve this corridor. When the BNSF-to-CSXT route is considered, there are two independent routes before and after the UP/NS merger. Hence, it would be inaccurate to say that shippers will suffer from a

³⁹ The issue that all viable routes are not observed in the waybill data is particularly acute in corridors with small volumes of traffic.

loss of independent routes in the corridor as a result of the merger. The algorithm should consider an augmented set of routes to capture this accurately.

85. After examining each of the corridors flagged by the algorithm, I find that all of them have viable alternative routes, which, once incorporated by the algorithm, leads to the proper conclusion of no reduction in independent routes. More specifically, 63 corridors involving BEAs in the United States have viable alternative routes that depend on currently used rail segments that meet at established gateways. These viable alternative routes ensure that the UP/NS merger does not lead to a reduction in independent routes in these corridors. Another nine corridors involve routes that originate in Mexico, and the US-Mexico international gateways have sufficient independent carriers and sufficiently flexible interconnections to eastern carriers to ensure that viable alternative independent routes are available to shippers on these corridors, such that there is no reduction in the number of independent routes from the merger.
86. Finally, there are two corridors in the United States for which the viable alternative route does not depend as obviously on simply interconnecting existing segments to create a new independent route. I review these two corridors in Appendix D and find that the UP/NS merger also does not raise competitive concerns in these corridors.

2. An Analysis of Independent Routes Cannot Reliably Assess the Competitive Options Available to Shippers

87. The independent routes method shows that there is no loss of independent routes once it is modified to consider the full set of shippers' viable options. This result could end the inquiry. However, it is also worth understanding why the entire independent routes approach is not a meaningful way to assess the competitive effects of the proposed merger. Put simply, counting the number of independent routes does not provide a reliable measure of competition: Even if the merger were to reduce the number of independent routes in a corridor, that does not mean that all shippers—or any particular shipper—has worse competitive options due to the merger.
88. As one important example, the algorithm may identify only one independent route on a corridor even in situations where the carriers serving the corridor must compete for

shippers' business. Consider again, the example of traffic moving from a western BEA to an eastern BEA through Chicago. But now suppose that the observed pre-merger routes are: (1) UP-to-CSXT; (2) BNSF-to-CSXT; and (3) BNSF-to-NS, and thus that the post-merger routes would be (1) UPNS-to-CSXT; (2) BNSF-to-CSXT, and (3) BNSF-to-UPNS. The algorithm would identify this as a 2-to-1 reduction in independent routes (because each post-merger route has one carrier in common with each of the other two routes). But taking this reduction to mean that shippers are in a weaker competitive position post-merger ignores the fact that, post-merger, a shipper can threaten to exclude any one of the railroads, including UPNS. For example, a shipper could seek Rule 11 quotes from BNSF and CSXT and then ask UPNS if it would undercut BNSF's price or CSXT's price. BNSF and CSXT would each be induced to compete to avoid being the carrier that gets none of the shipper's business, and UPNS would compete to win the shipper's business.

89. As another example, the algorithm may flag a reduction in independent routes in instances where economic analysis would show no merger-related change in competition because the count of independent routes in a corridor does not properly measure competition available to all shippers in the corridor. For example, this would be the case for a shipper in a corridor that uses a route with a sole-served segment before the merger. The number of independent routes in a corridor would not be competitively relevant to such a shipper because it would be sole served both before and after the merger.

G. OPEN GATEWAY COMMITMENTS

90. As discussed, the proposed merger does not raise any significant concerns with respect to vertical foreclosure. While I will address any theories of foreclosure raised in opposition to the proposed merger in subsequent reports, they will almost surely be edge cases, not well-suited to this industry. Nevertheless, to the extent there remains any concern that some of these edge cases may "slip through" and apply to isolated, atypical transactions, those are precisely the situations open gateway commitments are designed to address.

91. UP/NS is making a series of commitments to maintain open gateways on commercially reasonable terms. These commitments mirror those imposed in the CP-KCS merger and include:⁴⁰
- Keeping all existing gateways open in perpetuity on commercially reasonable terms (including both rates and service), for both existing and new traffic;
 - Offering connecting carriers commercially reasonable rate divisions and negotiating in good faith regarding disagreements;
 - Ensuring no new regulatory bottlenecks that could limit STB rate review;
 - Providing (upon request) written justification of price increases in excess of inflation; and
 - Submitting monthly reports on interchange volumes at gateways during the oversight period.
92. These open gateway commitments provide further support for the conclusion that the merger will not create any material vertical harm. These commitments demonstrate UP/NS’ intention to work with interline partners to maintain efficient competitive alternatives and provide monitoring mechanisms and enforceable obligations with respect to UP/NS’s treatment of shippers and interline partners.

IV. DUE TO ITS COMPLEMENTARY NATURE, THE UP/NS MERGER WILL GENERATE SIGNIFICANT PRO-COMPETITIVE BENEFITS FOR SHIPPERS

93. As an end-to-end combination, the proposed merger will bring complementary rail networks under the control of a single firm and thus generate significant benefits for shippers that cannot be achieved in any other way. These results follow due to the economics of externalities: Because of the enormous amount of interline traffic, pricing, operational, and investment decisions made by one railroad have large effects on the

⁴⁰ See Joint Verified Statement of Kenny Rocker and Claude E. “Ed” Elkins (hereinafter “Rocker-Elkins V.S.”), ¶¶ 162-172.

complementary network. When operating separately, railroads make decisions based on their individual profits rather than the profits for the combined network. They do not take the effects of their decisions on their interline partner into account. Quite simply, then, they consider the wrong profits from the point of view of the combined network, which is the relevant network when it comes to serving the needs of shippers. As a result, prices are set higher than would be optimal when the effects on both networks are considered; too few investments are made relative to what would be optimal for the combined network; and operational decisions are made without regard to the effect on the complementary network. Shippers suffer from each of these outcomes. The merger corrects all of them, and Nobel prize-winning economics proves that no other solution can do so.

94. As discussed below, vertical integration gives optimal incentives to the merged railroad to maximize the value of the combined network. Moreover, the benefits cover all aspects of the operation of the combined network, including pricing that eliminates double marginalization, more efficient scheduling and operations, and greater and better coordinated investment.

A. BENEFITS OF VERTICAL MERGERS

1. Independent railroads operating complementary networks cannot coordinate their operations and investments as efficiently as a single combined railroad

95. Collaborations and cooperation notwithstanding, independent railroads cannot operate complementary railroad networks together as efficiently as a merged railroad can. When operating independently, each railroad maximizes its own profit. Therefore, to provide efficient incentives to engage in costly activities, each railroad would need to receive all of the marginal profit resulting from its efforts to increase the profitability of the railroads' joint movements. However, it is not possible for each railroad to receive *all* of the marginal joint profit—there are two railroads and only one joint profit to share between them. Thus, optimal incentive payments add up to more than the joint profit that they

share.⁴¹ In such a situation, each railroad will maximize its own individual profits at the expense of optimal outcome that maximizes joint profits across the complementary networks. This is often referred to as double moral hazard.

96. Notably, there may be certain decisions in the course of operating separate railroads that rest with UP, while others rest with NS. It may be tempting to say that the incentive problem could be solved by giving all of the marginal profit to the relevant railroad in each case. But such a solution is clearly impossible; the relevant railroad varies from decision to decision, multiple times each day, and thus no division of profits between the railroads can possibly create the right incentives for each of them properly to consider effects on overall rail service. Only a merger that brings the railroads under common control can fully align incentives to maximize joint profits and solve this problem.
97. Nor can the problem be solved with sufficiently rich contracts. In practice, it is impossible to write a complete contingent contract that specifies how the two railroads must manage their interline business on a day-to-day basis. Such a contract would require dictating decisions or rules in every state of the world: every service choice, every investment decision, every price, and so on, accounting for every possible outcome of everything that is uncertain. They would have to say how each railroad should operate under any scheduling circumstance, what investment decisions should be made under all operational and economic conditions, how prices should be set under all demand scenarios, and so on. While economists may be able to talk of such “complete contingent contracts,” they have no relation to industry reality. Once again, only a merger—with its full alignment of incentives—can solve this problem.
98. This intuitive result—that, in the presence of double moral hazard, where each firm takes actions that are not fully observable to the other but which jointly determine the profits of both firms, only a merger can generate optimal outcomes—was developed into a formal proof by Bengt Holmstrom, the winner of the 2016 Nobel Prize for Economics. He showed

⁴¹ Holmstrom B. (1982), “Moral Hazard in Teams,” *The Bell Journal of Economics*, 13(2), 324–340.

that as long as each firm must engage in costly noncontractible activities, there is no profit-sharing rule, transfer price schedule, or contract that implements the fully efficient incentives across the two firms' complementary networks. *Only a merger can generate the benefits described in this section.*

99. The solution enabled by a merger is both simple and elegant. The merged railroad receives the full marginal profit from its management efforts across the combined network, so the resulting incentives are optimal for maximizing the network's value. Bringing the two railroads under common ownership and control is the only solution that corrects the railroads' suboptimal incentives. Thus, there is no question that the merger's benefits are, in fact, the result of the merger itself. They cannot be obtained by other means.

2. Double-moral hazard affects all aspects of decision-making regarding joint movements

100. The theory of incentives described above (*i.e.*, double moral hazard) is powerful because it is quite general. Specific examples of the way double moral hazard can play out in practice—here, when complementary rail networks are operated by separate railroads—include pricing inefficiencies (referred to by economists as “double marginalization”), suboptimal operational and scheduling decisions (*i.e.*, failing to consider the benefits to the complementary network), and insufficient investment.
101. One specific example of an inefficiency created by separate networks is double marginalization. Double marginalization occurs because each railroad raises its price to maximize its own profits without regard for the negative impact of its price on the sales of its partner on joint movements. Double marginalization illustrates the problem that neither railroad has efficient pricing incentives because neither has the optimal *marginal profit incentive*. Each considers only its own marginal profit, rather than the margin of the combined profit on the movement. For example, a carrier negotiating a rate using Rule 11 sets that rate to maximize its own profit. However, an increase in one carrier's rate lowers demand for the service of its interline partner, lowering its partner's profits on the movement. Each carrier sets its price above the optimal level because it does not account for the effect of its price on the full joint profit of the movement. Elimination of double

marginalization from the merger puts downward pressure on prices relative to prices that would exist absent the merger. The same problem of inefficient incentives arises in the context of through rates and investment as well.

102. Suboptimal incentives arising from double moral hazard also affect how railroads coordinate operations over long and short time frames. For example, two railroads' schedules could be optimized to work together, which means neither railroad would have an optimal schedule from its own perspective. However, such optimization is difficult to effect when each railroad seeks to maximize its own profits. The two railroads coordinating schedules will invariably view differently the tradeoffs associated with coordinating schedules.
103. Schedules can also be affected in the very short run, such as when a train is running late and may miss an interconnection, raising the question whether to hold the connecting train. The optimal response to a late train may depend on factors such as whether its shipments are time-sensitive, the degree of congestion on the network, and the potential for creating congestion through the response to the late train. Of course, the response that optimizes joint profits will impose different costs and yield different benefits for the independent railroads, making optimal coordination impossible absent a merger.
104. Investment incentives are also suboptimal because an investment that increases demand on one network will increase demand on the partner railroad's complementary network as well. However, the railroad considering the investment will make its investment decision based solely on the impact on its own profitability. One example, which I discuss in more detail in Section IV.B.5, is the scheduled improvements to the UP mainlines. The merged UP/NS plans to invest in double-tracking much of the mainline, improvements made profitable by the anticipated post-merger increase in traffic. The proposed merger will make a larger number of investments like this one profitable, leading to a redirection and likely increase in investment in the network.

B. THE UP/NS MERGER WILL ENHANCE COMPETITION AND GENERATE SIGNIFICANT PRO-COMPETITIVE BENEFITS

105. The pro-competitive benefits of the merger include (1) costs savings and the elimination of double marginalization, which will put downward pressure on prices relative to a no-merger world, (2) improved scheduling and operations, providing more efficient service to shippers; and (3) greater investment in the rail network. Perhaps the most obvious benefit of this transaction is the improved, single-line, transcontinental service that UP/NS will offer. For shippers, eliminating the need for an interchange is akin to the difference between connecting air travel service and a nonstop option. The introduction of direct, single-line service eliminates the cost, scheduling uncertainty, coordination, and added transit time associated with interchanging traffic, and is a clear benefit to shippers and railroads.

1. Cost Savings

106. I understand that the parties expect the merger will generate substantial operating cost reductions. When fully implemented (i.e., following the merger when UP and NS are fully integrated and the costs and benefits are annual and recurring⁴²), these are expected to total nearly one billion dollars (\$965 million).⁴³ These savings arise from the elimination of redundancies, the adoption of best practices, and the more efficient utilization of resources made possible by bringing both organizations under common control.

107. The anticipated savings come from numerous specific changes in operations designed to optimize the use of existing capital and labor and take advantage of operational changes to provide more efficient transportation services. Examples from the operating plan, as explained by UP/NS, include the following, all of which are consistent with the economic teachings, described above, on the efficiencies that can be unlocked when firms operating complementary networks have the ability and incentive to coordinate their activities.

⁴² Verified Statement of Grant Janke (hereinafter Janke V.S.), ¶ 10.

⁴³ Janke V.S., Table 4. Amounts are expressed in 2023 dollars.

- More efficient use of locomotives and rolling stock. The improved operation of the integrated network is expected to reduce the number of locomotives and amount of rolling stock required to meet service needs following the merger. “The Optimized operating plan improves railcar utilization through more single-line service, decreased handlings and yard work, reduced dwell time, and optimized movements including increased train speeds.”⁴⁴ In addition, more efficient railcar distribution will result in fewer empty car miles, improved cycle times, and higher service levels.⁴⁵
- Consolidation, rationalization, and more efficient use of yards, railcars, and locomotive maintenance facilities. By consolidating and re-optimizing across the combined network UP/NS can achieve required levels of operations with fewer resources and lower costs.⁴⁶
- Detailed changes in operations and systems with respect to maintenance-of-way, repair management, track maintenance, crew management, etc. These entail specific changes involving adoption of best practices and applying better systems across the broader UP/NS network⁴⁷.

108. In addition to changes in the operating plan and operating improvements, there are reductions in annual administrative costs (\$198 million annually) and management costs (\$260 million annually) when fully implemented.⁴⁸

109. Merger-related cost savings and efficiency improvements that reduce the marginal cost of rail service or permit the provision of higher quality service at reduced costs improve the competitive position of UP/NS. Reduced costs should be expected to be passed through to

⁴⁴ See *Gehring-Orr V.S.*, ¶ 382.

⁴⁵ *Gehring-Orr V.S.*, ¶¶ 382-383.

⁴⁶ *Gehring-Orr V.S.*, §4.3. See also, *Gehring-Orr V.S.*, ¶¶ 180, 382-383.

⁴⁷ *Gehring-Orr V.S.*, §10.

⁴⁸ *Janke V.S.*, Tables 1 and 3.

consumers in some form, even in industries that are imperfectly competitive.⁴⁹ The pass through of efficiencies could take the form of price reductions or the provision of higher-quality service without increasing price. Thus, merger-related efficiencies may permit UP/NS to offer rail transportation at lower rates than would otherwise have been possible or provide higher quality service than would otherwise have been available. Merger-related cost reductions are unambiguously procompetitive.

2. Elimination of Double Marginalization

110. Technically speaking, double marginalization refers to the presence of successive markups in vertical settings, where each of the upstream and downstream firms charges a markup over marginal cost. More generally, double markups result from an externality. When setting its rates, the downstream railroad does not consider the impact of its pricing decisions on the upstream railroad's profits, and vice versa.⁵⁰ As a result, under double marginalization prices rise above the price that a vertically integrated firm would charge absent the merger. This is precisely analogous to the Cournot Complements issue, described above, applied to a vertical setting, independent firms selling complements set prices too high because they do not internalize the benefits lower prices convey on one another.
111. Importantly, while the elimination of double marginalization puts downward pressure on rates relative to the state of the world absent the merger, it does not imply that post-merger rates will necessarily be lower than pre-merger levels. Vertical mergers improve pricing incentives and frequently reduce costs, creating downward pressure on rates relative to the state of the world that would exist absent the merger. However, rates regularly go up with inflation, which could offset the elimination of double marginalization, for example. Alternatively, the merged railroad could choose to increase quality without raising prices,

⁴⁹ See, e.g., Miller, N. H., M. Osborne, and G. Sheu (2017), "Pass-Through in a Concentrated Industry: Empirical Evidence and Regulatory Implications," *RAND Journal of Economics*, 48(1), 69–93.

⁵⁰ See, e.g., Davis, P., and E. Garcés (2009), *Quantitative Techniques for Competition and Antitrust Analysis*, Princeton University Press, pp. 505–507.

which is a reduction in the quality-adjusted prices. As described above, these are all versions of the same phenomenon: once combined profits are considered, more costly actions—whether they be lower prices or investments to increase quality—will be undertaken than would be absent the merger. What one can safely say is that the merger puts downward pressure on prices relative to the case with no merger; this pressure may take the form of prices lower than they otherwise would have been, higher quality, or some combination of those, depending on which turns out to be optimal.

3. Empirical demonstration of lower costs and/or elimination of double marginalization

112. To confirm empirically what is known as a matter of economics—that rates will face downward pressure as the result of costs savings and the elimination of double marginalization—I conducted a multivariate regression analysis to test whether prices on comparable routes are lower for single-line service, which the merger is expected to make more broadly available, relative to rates observed on interline traffic. To illustrate in simple terms, the regression compares, for example, UP’s single-line rate on a 1,000-mile shipment of plastic pellets to the total interline rate on a 1,000-mile shipment of plastic pellets that originates with UP and is delivered by another Class I carrier. As with my regressions testing for foreclosure, above, I include controls for other factors that affect pricing, including: commodity, car owner, car type, unit trains, type of pricing arrangement (contract, private quote, etc.), the year-month of the shipments, the median rail distance between the origin and destination, and the average net weight per car.⁵¹ I also include control variables for local conditions at both the origin and destination of the move: the number of Class I railroads, GDP per capita, personal income, and population. These explanatory variables ensure that the measured price differences are the result of interlining and not due to differences in shipment characteristics or costs.

⁵¹ To allow for flexible, non-linear effects, distance and weight are included as both linear and squared terms.

113. The regression sample is based on Class I railroads' waybill data. It is limited to UP and NS single-line movements as well as interline movements involving UP or NS, which originate and terminate within the United States. In the case of Rule 11 traffic, the dataset includes Rule 11 interline traffic between UP or NS and other Class I railroads from 2019 to 2024, for which it has been possible to link up the individual Rule 11 waybills and construct a combined rate that covers both the Eastern and Western portions of the move.

Figure 10
Test for the Presence of Double Marginalization in Interline Rates

Dependent Variable: Ln(Rate per car-mile)						
Combined Waybill Data						
Interline Universe:						
	All Simple Interline Traffic		East<->West Traffic		UP<->NS Traffic	
	Estimate	Effect (%)	Estimate	Effect (%)	Estimate	Effect (%)
Independent Variable	(1)	(2)	(3)	(4)	(5)	(6)
Single-line Rates [Base]	-		-		-	
Through Rates	0.2407**	27%	0.2387**	27%	0.1405**	15%
Std. Err	[0.0116]		[0.0142]		[0.0342]	
P-value	0.000		0.000		0.000	
Rule 11 Rates	0.2519**	29%	0.2543**	29%	0.2039**	23%
Std. Err	[0.0140]		[0.0163]		[0.0326]	
P-value	0.000		0.000		0.000	
Observations	3,289,374		3,191,282		2,811,596	

Source: UP, NS, CSXT, BNSF, CN, and CPKC Waybills 2019-2024, STB Confidential Carload Waybill Sample 2019-2023 (CCWS), AAR Centralized Station Master (CSM), Serving Carrier Reciprocal Switching Data (SCRS).

Notes:

- 1) Fixed Effects: STCC3, car owner, AAR car initial, type of pricing arrangement (contract, private quote, etc.), unit train dummy year-month, reporting railroad dummies. Control variables include distance and distance^2, weight and weight^2, local conditions (at both origin and destination): number of Class Is, (log) GDP per capita, (log) personal income, and (log) population.
- 2) ** P-value<0.05; * p-value<.1. Clustered standard errors in brackets (clustering at the route level).
- 3) Simple interline moves defined as traffic involving two line-haul carriers on routes with no single-line service by UP or NS.
- 4) Rule 11 rates reflect rates on interline traffic, for which it has been possible to link up the individual Rule 11 waybills and construct a combined rate that covers both the Eastern and Western portions of the move.
- 5) Competition variables based on "Competition Version 1".
- 6) The effect in % terms is computed as: $\exp(\beta) - 1$.

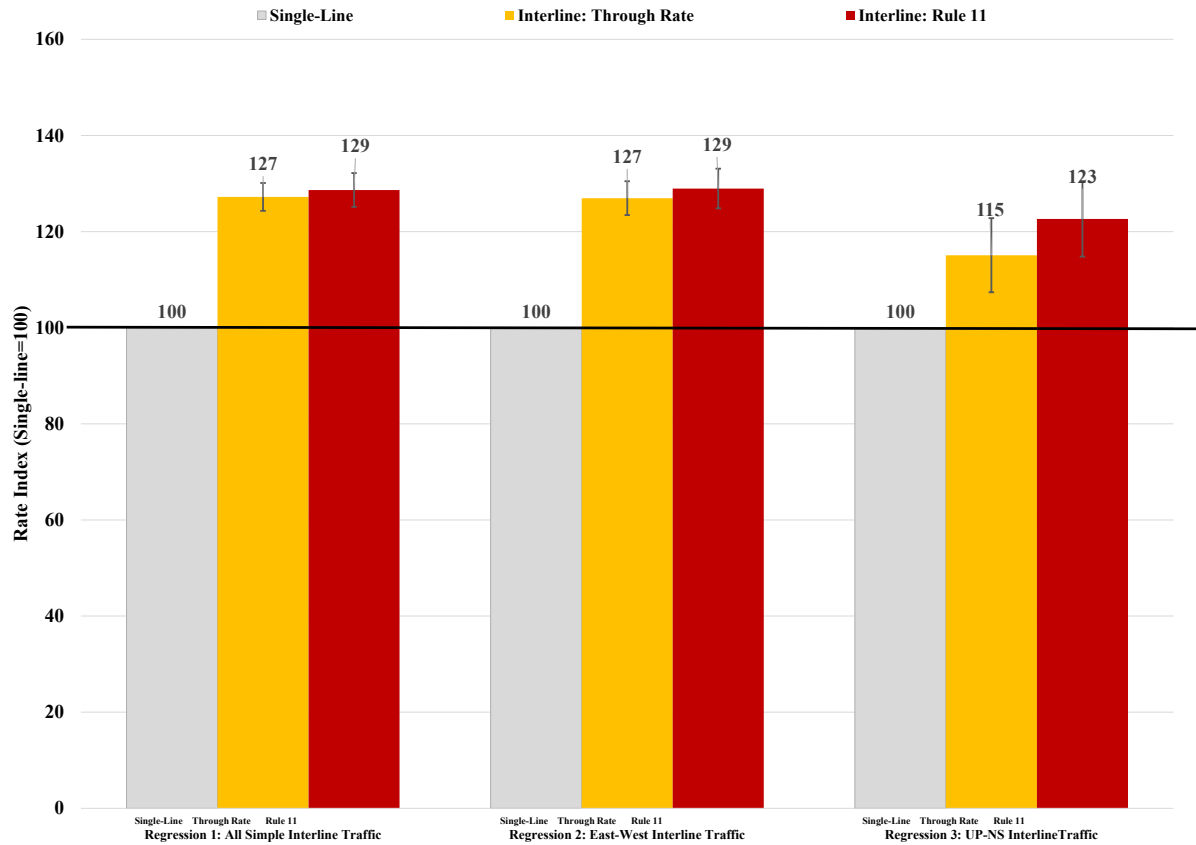
114. The results in Figure 10 demonstrate that interline moves are priced substantially higher than comparable single-line moves, consistent with the combination of lower costs and the absence of double marginalization on such movements. The first two columns report the results from estimating the regression on a sample that includes single-line moves, as well

as all “simple interline” traffic, defined as moves involving two line-haul carriers on routes that do not have single-line service by UP or NS. Column (2) shows that, for comparable shipments, through rates are approximately 27 percent higher than single-line rates and Rule 11 rates are approximately 29 percent higher than single-line rates.⁵²

115. The finding that interline rates are higher than single-line rates persists across multiple variations of this analysis, demonstrating that this result is robust (meaning not sensitive to small changes in the data or the regression specification). As the first alternative, I conduct the same analysis as above but limit the interline shipments in the data to those crossing the Mississippi River. These are routes that originate, for example, in the West on UP or BNSF and are completed by NS or CSX in the East, and vice versa. This limitation focuses the regression on the types of routes that will transition from being interline routes to single-line routes following the merger. Columns (3) and (4) of Figure 10 present the results from this test. I find a significant interline premium. Through rates and Rule 11 rates are again higher than comparable single-line rates by amounts similar to those reported in the initial specification in columns (1) and (2).
116. For the second alternative regression, I conduct the same analysis limiting the interline traffic to only UP-NS interline moves. The results of this analysis are shown in columns (5) and (6) in Figure 10. This analysis once again finds a statistically significant and substantial interline premium: approximately 15 percent for through rates and approximately 23 percent for Rule 11 traffic.
117. In Figure 11, below, I present a graphical summary of the regression estimates reported in in Figure 10.

⁵² As a sensitivity check I have performed the same analysis using rates data from all railroads (not just rates involving UP or NS). Again, I find a significant interline premium—24 percent for through rates and 19 percent for Rule 11 rates—as compared with rates for comparable single-line movements. See my backup materials.

Figure 11
Rate Differentials between Single-Line and Interline Service



Source: UP, NS, CSXT, BNSF, CN, and CPKC Waybills 2019-2024, STB Confidential Carload Waybill Sample 2019-2023 (CCWS), AAR Centralized Station Master (CSM), Serving Carrier Reciprocal Switching Data (SCRS).

Notes:

- 1) Based on regression analysis reported in Figure 10.
- 2) Whiskers indicate 95% confidence interval.

4. Schedule and Operations

118. Merger-related improvements to service and operations will allow UP/NS to offer higher-quality rail transportation than would otherwise have been available. Such improvements are pro-competitive and benefit shippers and the public interest.

119. Shippers will benefit from improved routing and coordination between the formerly separate railroads, yielding higher quality service. In particular, shippers will benefit from: (i) the expansion of single-line service, which will reduce transit times and eliminate costly interchanges; (ii) improved routings that will allow traffic to avoid congested gateways, reducing delays; and (iii) more seamless interactions to schedule and track shipments.⁵³
120. The STB has recognized the benefits of such scheduling and operational improvements from integration, citing service and operational improvements as important benefits of prior rail mergers. For example, in its CPKCS Decision, the Board noted⁵⁴:
- [T]he record indicates that the Transaction should result in qualitative benefits to the shipping public, including more single-line service, new and improved routes, more gateway choices, more reliable service, and reduced terminal delay.
121. In fact, these benefits are borne out in data that show that railroads win a higher percentage of traffic than trucks when single-line service is available versus when it is not available.⁵⁵ One benefit of single-line service is the reduction in transit time that results from the elimination of interchange handlings between railroads.⁵⁶ The benefits of improved routings and more efficient operations are also explained in detail in the Operating Plan filed with this application.⁵⁷ In particular, the parties highlight opportunities to offer faster and more reliable service by eliminating interchanges and implementing new blocking plans.⁵⁸ For example, the operating plan notes transit times on intermodal train routes between Southern California and the Northeast are anticipated to fall by 17 to 19 hours, and

⁵³ Union Pacific and Norfolk Southern “Delivering Benefits to All Stakeholders: For Service,” available at <https://www.up-nstranscontinental.com/benefits/benefits-for-service>. See also, *Gehringer-Orr V.S.*, ¶ 24 and § 4; and *Rocker-Elkins V.S.*, ¶¶ 11-13 and Figure 4.

⁵⁴ CPKCS Decision, p. 24.

⁵⁵ *Rocker-Elkins V.S.*, Figure 2 and Figure 3; Verified Statement of David T. Hunt (hereinafter “Hunts V.S.”), Exhibit 3-1 and Exhibit 3-2.

⁵⁶ *Hunt V.S.*, §3.4.

⁵⁷ *Gehringer-Orr V.S.*, §4.

⁵⁸ *Gehringer-Orr V.S.*, § 4.1.

transit times between Southern California and the Southeast are anticipated to be cut by 70 to 95 hours.⁵⁹

5. Investment Incentives

122. As explained in Section IV.A, above, independent railroads make sub-optimal investment decisions. Vertical integration corrects these incentives and benefits shippers in the form of greater investment. The economics behind this is simple; separate railroads face the full cost of an investment, but only earn the profit on their part of the complementary network, and thus too few investments will pass the internal financial “hurdle rates” require to be undertaken.
123. A simple example may help to illustrate. If a railroad could take an action that generated \$100 of incremental profit for the joint movements across the railroad’s networks at a cost of \$60, the action should be undertaken. However, if the railroad keeps only 50% of the profits on joint movements, the railroad will not take the efficient action because it would keep only \$50 of the benefit, which is less than the \$60 cost of taking the action. The same problem exists in more complex form in reality: Business cases for investments may fail to pass muster when only one firm’s profits are included, but once the full profits of the merged firm are considered, this outcome will be reversed. As discussed, the solution to this incentive problem is to combine the two complementary rail networks so that the single, integrated railroad receives the full marginal profit from its management efforts across the combined network.
124. Examples of the investments that will be affected are particularly easy to see in this case. Railroads operate as integrated networks such that increases in utilization of one part of the network (e.g., east-west flows through the middle of the country) can require investments at distant locations to maintain efficient and fluid flows of traffic throughout the system. Today, however, when UP, for example, makes an investment in the west, it fails to consider the benefits to NS in terms of traffic carried in the east. Post-merger, this failure

⁵⁹ Gehringer-Orr V.S., ¶¶185, 189.

to consider all benefits from investments will be corrected and thus investment incentives will expand.

125. The application provides examples of planned future investments that will facilitate efficient routings and increased rail traffic that is expected to be attracted from other railroads and from trucks. UP/NS plans to increase the line capacity on two UP mainlines, the Sunset Route that connects Southern California to El Paso and the Golden State Route between El Paso and Kansas City.⁶⁰ UP/NS plans to increase capacity on two portions of the NS network, the corridor between Kansas City, Missouri, and Butler, Indiana, and the corridor between New Orleans, Louisiana, and Atlanta, Georgia.⁶¹ These investments involve additional double-tracking and extending sidings to support the additional transcontinental traffic that the transaction is expected to generate.
126. To support the additional traffic and integrated operating plan Applicants will also make further investments totaling \$364.6 million in terminals and yards.⁶² This includes merger-related investments in six intermodal terminals, two manifest yards, and an automotive facility, along with related equipment.⁶³ UP/NS anticipates capital investments of over \$2.1 billion in the first three years following the merger to enable the growth anticipated by the merger and to realize merger synergies and integrate technology.⁶⁴
127. As discussed below, the transaction is expected to divert millions of truckloads from the highways to the UP/NS rail system. The public benefits of moving trucks-to-rail are clear, but the UP/NS system requires additional investments to support the increased volume of intermodal movements. Applicants plan on substantial investments in additional intermodal capacity at numerous locations across the country. On the current UP system, investments in expansion of intermodal facilities are planned at Houston, Texas, Laredo,

⁶⁰ Verified Statement of John W. Turner (hereinafter "Turner V.S."), § 4.B.1.

⁶¹ Turner V.S., § 4.B.1.

⁶² Turner V.S., § 4.B.2.

⁶³ Turner V.S., Table 14.

⁶⁴ Janke V.S., ¶ 12.

Texas, West Colton, California (i.e., California Inland Empire), and Council Bluffs, Iowa.⁶⁵ On the NS system, UP/NS plans to invest in expansion projects at Sharonville, Pennsylvania, and Toledo, Ohio.⁶⁶ Absent the ability to attract additional intermodal volumes from trucks—and the increased investment incentives described above—as a result of the merger, these investments would not occur.

C. EVIDENCE OF THE MERGER’S BENEFITS: MODAL SHARES AND DIVERSIONS

128. As independent railroads, UP and NS carry interline traffic between points in the West and points in the East. Following the proposed merger, that interline service will become single-line service. Some shippers will switch from their current interline option to single-line service on UP/NS, indicating that, as the result of service improvements and investments in the combined UP/NS rail network, the merged carrier offers superior service at lower quality-adjusted prices.
129. Diversions of traffic to the merged carriers from either trucks or other rail carriers are a demonstration of the pro-competitive effects of the merger. Said differently, they are evidence of enhanced competition—of customers “voting with their feet” and shifting business to more efficient and attractive options. Diversions of freight from trucks to rail can only occur as a result of UPNS providing an improved combination of service and pricing that *attracts* traffic from truck-only service to intermodal rail service. Similarly, diversions of rail traffic that had previously been carried by other carriers, but, because of the merger, is expected to travel on UPNS for some or all of the movement, results only from UPNS providing improved combination of price and service sufficient to attract this traffic from the existing carriers. Also, as discussed above, existing rail traffic that will see extended hauls on the combined UPNS will benefit from improved single-line service.
130. Hence, a direct demonstration of the benefits generated by the merger comes from the fact that the merged carrier’s single-line service is expected to attract business from its

⁶⁵ Turner V.S., § 4.B.2.

⁶⁶ Turner V.S., § 4.B.2.

competitors. This follows from the law of demand—a railroad offering lower prices and/or better service, which together mean lower quality-adjusted prices, will make sales at the expense of its competitors. Shippers switching to the merged firm’s service provides direct evidence that the merger has resulted in a lower quality adjusted price. This means that, when merger-related improvements in quality are considered, the merged firm’s offering has become more attractive to customers than other offerings, even if the price has not decreased. For this reason, evidence of customer switching—which I analyze below using modal shares and diversions—is the clearest way to demonstrate the benefits of single-line service that the merger unlocks.

1. Modal Shares

131. The benefits of single-line service—as demonstrated by shippers’ preference for such service—can be assessed by analyzing routes with both single-line and interline options. The Application contains an analysis of rail’s modal share compared to truck for county-to-county routes of merchandise traffic where rail can provide single-line service and where it cannot. The figure shows that rail’s modal share is often higher (e.g., increases from 43% to 60% for lengths of haul between 750 to 999 miles) for routes where single-line service is available compared to routes where only interline service is available.⁶⁷ For long-distance intermodal traffic (i.e., greater than 1,500 miles), when single line service is available, rail obtains approximately 20 percentage points more of the total traffic than it does when only interline service is available.⁶⁸ Such an enormous increase in rail share provides strong evidence of the benefits of single-line service and thus of the benefits from the merger.
132. A similar analysis finds that for inter-watershed lanes (i.e., those lanes with either an origin or destination within the watershed region near the gateways of Chicago, IL; St. Louis, MO; Memphis, TN; and New Orleans, LA) single-line service is chosen by shippers over interline service by a wide margin.⁶⁹ The analysis also shows that, for all lengths of haul,

⁶⁷ Hunt V.S., Exhibit 3-1.

⁶⁸ Hunt V.S., Exhibit 3-2.

⁶⁹ Hunt V.S., Exhibit 4-11.

single-line rail service captures at least 65 percent of rail traffic, and frequently greater than 70 percent.

133. It is important to recognize that options to move rail traffic via single-line service from the west to the east of the U.S. or vice versa today are limited.⁷⁰ This simple fact demonstrates the fundamental improvement in industry performance that the proposed merger unlocks, an improvement that comes with no material risk of foreclosure, as demonstrated above.
134. Each of these analyses demonstrates that shippers prefer single-line service to interline service and will benefit not only from the expansion of single-line options, but from a new and valuable transcontinental single-line service that is not currently available to shippers.

2. Diversions

135. The extent to which shippers will switch to UP/NS single-line service provides a direct indication of the value they place on UP/NS's post-merger single-line service relative to UP and NS's premerger interline service. The *projected diversion* of traffic to UP/NS's single-line service can be used to estimate the value that all shippers (including current UP/NS shippers) place on the improved service. Specifically, with an estimate of price elasticity of demand, one can estimate the percentage change in price that would have generated the same predicted diversions as the merger. Said more simply, one can ask, "what price reduction would have been required to generate a traffic diversion of the same size as that predicted from the merger?" Intuitively, that price reduction provides a monetary equivalent to the value of the merger benefits.⁷¹
136. The economic literature has demonstrated that, under straightforward assumptions, that equivalence is more than intuitive. In fact, this equivalent price reduction can provide a

⁷⁰ Examples of exceptions include BNSF service to Birmingham, Alabama, and NS service to Kansas City, Missouri. See BNSF and NS Rail Network Maps, available at <https://www.bnsf.com/ship-with-bnsf/maps-and-shipping-locations/index.page> and <https://www.norfolksouthern.com/en/ship-by-rail/our-rail-network>.

⁷¹ The hypothetical price change does not indicate whether diversion resulted from lower prices, better service, or both from UP/NS.

precise measure of the consumer welfare gains from the merger. That is, this equivalent price change provides a measure of the increase in the value of UP/NS’s higher-quality single-line service relative to their premerger interline services.⁷²

137. Applicants’ largest category of diversions numerically is the diversion of truckload movements to intermodal containers moving by rail; hence it is natural to use this diversion to estimate the increase in quality from the merger. While I focus on this particular category of diversion, the implication for the quality improvements from the merger apply more generally: The ability to divert intermodal traffic from truck to rail provides a way to quantify the quality improvements that all shippers can benefit from.
138. I rely on the cross-price elasticity of demand between truck and rail options to quantify the benefit. The cross-price elasticity of demand quantifies the percentage change in truck traffic on a route from a 1% change in the price of rail service on the route. Truck traffic increases or decreases depending on whether the rail price goes up or down. Given an estimated cross-price elasticity and quantity of diversions, the shipper benefit resulting from the new UP/NS single-line option can be estimated. Applicants estimate diversions of approximately 1.2 million intermodal containers from truck out of a possible 2.7 million containers.⁷³ This represents a change in the quantity of truck traffic (i.e., diversion share) of 43 percent. I conservatively use a value of 4, reflecting values in the economic literature, for the truck-rail cross-price elasticity.⁷⁴ This cross-price elasticity implies that a 1% price *decrease* in the price of rail intermodal would cause a *decrease* in truck traffic of

⁷² See Willig, R. D. (1978), “Incremental Consumer's Surplus and Hedonic Price Adjustment,” *Journal of Economic Theory*, 17(2), 227–253.

⁷³ Hunt V.S., Section 5.4. The number of potentially divertible containers is the “addressable market” for truck to rail intermodal diversion, see Hunt V.S., Sections 5.1 to 5.2.

⁷⁴ See, e.g., Austin, D. (2018), “Pricing Overland Freight Transport to Account for External Costs,” *Journal of Transport Economics and Policy*, 52(1), 45–67, Table 5. McCullough, G. J. and I. Hadash (2019), “Price Effects in Truck Competitive Railroad Markets,” in *U.S. Freight Rail Economics and Policy: Are We on the Right Track*, J. T. Macher and J. W. Mayo (Eds.), Routledge, 114–126, at Table 5.5 shows truck-rail elasticities generally lower than for rail-truck elasticities.

4%, which would be diverted to the now less-costly (or equivalently in this case, higher-quality) rail service. A cross-price elasticity of 4 reflects a quite high degree of elasticity between truck and rail. Using this cross-price elasticity and the truck diversion share of 44 percent indicates that the *value* provided by the new UP/NS option is estimated to be equivalent to a 11.1% percent reduction in price.⁷⁵ Based on this estimate, it is clear that the projected traffic diversions from the merger imply large benefits to both current and new UP/NS shippers, equivalent in value to substantial reductions in price.

139. Applicants also estimate non-intermodal (i.e., merchandise and auto) Truck-to-Rail diversions of approximately 862,000 trucks or 198,000 equivalent railcars annually.⁷⁶ In aggregate it is estimated that {{ }} percent of divertible trucks tons will be diverted to UP/NS on routes where diversion to rail occurs.⁷⁷ While I do not have cross-price elasticities from the literature to calculate a precise implied value for these diversions, the estimated Truck-to-Rail diversions for non-intermodal traffic are large and provide further evidence of the significant benefits to both current and new UP/NS shippers from the proposed transaction.⁷⁸
140. Applicants also estimate rail-to-rail diversions of 508,000 cars or units across merchandise, intermodal, bulk, and automotive traffic.⁷⁹ The majority of Applicants estimated rail to rail diversions come from BNSF and CSX. Diversions from CSX represent approximately 4 percent of units handled by CSX in 2023, and for BNSF diversions represent approximately 3 percent of units handled by BNSF in 2023.⁸⁰ In aggregate for rail-to-rail

⁷⁵ $(1 / 4) * (1.2 / 2.7) = 0.111$.

⁷⁶ Hunt V.S., Section 4.1.

⁷⁷ See my backup materials.

⁷⁸ In general, the cross-price truck-rail elasticities for these other (non-auto) types of commodities that would be diverted from truck into railcars tend to be lower than for intermodal traffic. The implication is that for the same share of truck traffic of this type diverted, the equivalent price percentage drop is greater.

⁷⁹ Hunt V.S., Exhibit 6-1.

⁸⁰ Hunt V.S., Section 6.1.

diversions, Applicants estimate diversions of {{ }} percent (of divertible carloads or units) for merchandise traffic, {{ }} percent for bulk traffic, {{ }} percent for automotive traffic, and {{ }} percent for intermodal traffic.⁸¹ While I do not have precise cross-price elasticities from the literature to calculate an implied value of these diversions, these estimated diversions are large and further make clear that the levels of diversion projected from the merger imply large benefits to current and new UP/NS shippers.⁸²

141. The benefits demonstrated by the level of diversions accrue to more than just the traffic that is diverted. The diversions demonstrate the anticipated value to shippers from the improved quality—and thus the improved option in the marketplace—that the merged carrier will provide. But this improved service will also be available to existing UP-NS interline shippers on these routes. In addition, to the extent the improvements generated by the merger induce a response from competing railroads and other transportation modes in terms of lower prices or improved service, such competitive responses generate additional benefits induced by the merger, making my quantification of direct benefits from the UP/NS quality improvements conservative.
142. In addition to the private benefits obtained by shippers from higher quality intermodal service to be provided by the Applicants, Truck-to-Rail diversions generate substantial external public benefits beyond that reflected in the improved service quality shippers receive.⁸³ Per ton-mile moved, compared to freight rail transportation, trucks generate more pollution, are more dangerous in terms of injuries and deaths, and create congestion

⁸¹ See my backup materials.

⁸² See, e.g., McCullough, G. J. and I. Hadash (2019), “Price Effects in Truck Competitive Railroad Markets,” in *U.S. Freight Rail Economics and Policy: Are We on the Right Track*, J. T. Macher and J. W. Mayo (Eds.), Routledge, 114–126, at Table 5.5.

⁸³ See Verified Statement of Mathew Graham for a discussion of certain external benefits of diversions of truck to rail arising from the merger.

on highways and roads.⁸⁴ Moreover, trucks utilize publicly funded transportation networks whereas the rail network is privately-owned and operated and receives limited government funding. Diversions from truck to rail generated by the merger create additional unpriced benefits to society that are not captured in the price-equivalent service improvements received by shippers.

D. IMPLICATIONS FOR POTENTIAL FUTURE MERGERS

143. The STB requests parties include an analysis of whether and how potential future mergers of Class I railroads (proposed in response to this proposed transaction), could affect the structure of the industry and the public interest. I understand the Applicants address this requirement in their Application.

144. From an economic perspective, and as I have discussed, the merger of UP and NS will generate significant vertical benefits for shippers. These vertical benefits—including the expansion of single-line service, more efficient service and operations, and increased investment—are unlikely to be undermined by any subsequent mergers. Instead, a future U.S. transcontinental merger would also tend to be predominantly vertical with similar effects. To the extent such a merger generated efficiency improvements it would put more competitive pressure on UP/NS.

145. That said, two points are worth emphasizing:

- Even if no subsequent merger occurs, the analysis of this merger stands on its own. It generates substantial pro-competitive benefits without a realistic risk of foreclosure and thus it is pro-competitive and beneficial to shippers on its own terms.

⁸⁴ Austin, D. (2019), “Accounting for External Costs in Freight Transport: Eight Policy Options,” in *U.S. Freight Rail Economics and Policy: Are We on the Right Track*, J. T. Macher and J. W. Mayo (Eds.), Routledge, 81–113 at Table 4.1. The estimated differential external costs for truck and rail transportation range from 2.32 to 5.04 cents per ton-mile, in 2014 dollars, based on minimum and maximum estimates by mode. Applicants estimate a net reduction of 57 billion truck freight ton-miles due to merger-induced truck-to-rail diversions, see Hunt V.S. Exhibit B-57. Using a simple assumption of 3 cents per ton mile in differential external costs between truck and rail and an equivalent offsetting increase in rail freight ton-miles, the predicted truck diversions reduce unpriced external social costs by \$1.7 billion per year.

- Any proposed future merger must be evaluated on its own merits and would have to be evaluated based on the specific elements of that application, including detailed analysis of how that proposal impacts shippers and the overall rail network. That analysis may indicate that specific conditions should be placed on that future merger that are distinct from those placed on the present transaction due to distinct characteristics of that merger. In addition, that analysis may reveal circumstances that require adjustments to components of (or conditions placed on) this transaction in order to protect shippers and the overall public interest. Such decisions can be made if and when a future transaction is proposed and its details are known.

V. UP/NS'S COMMITTED GATEWAY PRICING IS DESIGNED TO ENHANCE COMPETITION

146. For the reasons I discuss above, the proposed transaction will generate significant benefits for customers and the broader public and enhance competition. Hence, the merger is pro-competitive and shipper-welfare enhancing in its own right.
147. To further enhance these competitive effects, UP and NS have also included in their application a proposal to establish Committed Gateway Pricing designed to enhance competition further, by providing competitive options to certain shippers and routes that would otherwise not directly benefit from the vertical integration of UP and NS.
148. Committed Gateway Pricing accomplishes this by using UP/NS rates—rates that reflect the benefits of improved pricing incentives and cost reductions generated by the merger—to determine the rates that may be used *by CSX and BNSF* to set through rates for eligible traffic. Moreover, because CGP also incorporates rates established on routes with existing intra-modal competition between UP/NS and CSX and BNSF, CGP extends the benefits of that competition to routes that are otherwise sole-served and do not benefit from such competition.

A. THE COMMITTED GATEWAY PRICING METHOD

149. CGP is a market-based mechanism that allows BNSF and CSX to offer the benefits of existing competition, as well as improved pricing incentives and cost reductions flowing

from the merger, to certain shippers and shipments that otherwise would not benefit from either. The CGP method is explained in detail elsewhere in this application, but broadly consists of three steps:⁸⁵

- Identify relevant traffic by commodity and distance, designed to reflect commodity groupings subject to similar market forces and cost structures;⁸⁶
- Identify UP/NS rates for traffic in the relevant commodity and distance categories and set the Committed Gateway Price to the 70th percentile of the UP/NS rate (in dollars per car-mile);⁸⁷ and
- Provide to BNSF and CSX, separately, the Committed Gateway Price for each commodity and distance group.⁸⁸

150. The Committed Gateway Price is the guaranteed rate at which UP/NS will provide service on the UP/NS segment of eligible interline moves. For purposes of CGP, eligible traffic is defined as manifest traffic to or from facilities solely served by UP/NS (or a short line

⁸⁵ See Verified Statement of Katherine N. Novak (hereinafter “Novak V.S.”), including Appendix A, for the description of CGP.

⁸⁶ The comparable traffic groups consist of 23 market categories based on commodity classification and four distance categories, resulting in 92 groupings based on commodity and distance. Certain traffic, such as intermodal, finished vehicles, and unit trains, are not covered by CGP.

⁸⁷ The identified groupings are populated with rates based on UP/NS traffic movements for a twelve-month period. For each commodity-distance grouping, the rate and distance associated with a corresponding UP/NS shipment is collected, and the rate per car-mile is calculated. If there are 100 or more shipments in a grouping during the period, then the rate calculation will be determined based on shipments in that grouping. If fewer than 100 shipments are within a grouping, then aggregated data for the distance range will be used to determine the car-mile rate. Requiring a minimum number of shipments reduces the likelihood that outliers or non-representative observations affect the calculated rates. For purposes of determining shipments, a combination of waybill date and equipment identifier is used, which means that in most cases 100 carloads, not in unit trains, will be sufficient to populate a cell in the table. Fourteen cells, nine for CSX and five for BNSF would potentially fall under the 100-shipment threshold, using 2024 UP and NS waybill data, and would have their CGP rates derived from the aggregated distance groupings without commodity specific information.

⁸⁸ To account for the fixed costs associated with originating or terminating a rail movement, a minimum price based on 250 miles is applied to the car-mile rates for a commodity grouping to otherwise adjust for very short moves. See Novak V.S., § I.B.2.

interchanging traffic solely with UP/NS) that interchanges across one of the east-west gateways—Chicago, St. Louis, Memphis, or New Orleans—and is solely-served by BNSF or CSX (or a short line interchanging traffic solely with BNSF or CSX) at the other end. Because CSX or BNSF can use the Committed Gateway Price to quote a through rate that undercuts a high division or Rule 11 rate offered by UP/NS, the Committed Gateway Price effectively caps the rates that UP/NS can charge for these movements. However, nothing prevents the shipper from utilizing existing options including negotiating for a potentially lower Rule 11 rate from UP/NS and/or a lower total rate for the full movement.

B. COMMITTED GATEWAY PRICING EXTENDS BENEFITS TO ROUTES THAT OTHERWISE WOULD NOT DIRECTLY OBTAIN MERGER BENEFITS

151. The proposed merger brings benefits to shippers by connecting two complementary networks to create a seamless, single-line, rail service connecting the east and west coasts. As described above, the combined UP/NS will provide improved single-line service and will introduce efficiencies throughout the network, benefiting shippers on many east-west routes. While the benefits of the proposed merger extend to the entire US rail industry, only routes served by UP on one end and NS on the other benefit directly.
152. In contrast, routes served by UP on one end but only CSX on the other, or NS on one end but only BNSF on the other, do not benefit as directly from the vertical integration of UP and NS. By providing BNSF and CSX access to the Committed Gateway Price—for routes that are sole-served by them on one end and UP/NS on the other—the CGP provides the benefit of existing rail competition and benefits from the merger to shippers on routes that would not otherwise see such benefits.
153. The CGP proposal also directly addresses concerns that vertical mergers may limit source and geographic competition. CGP’s potential of lower rates—and at least a cap—on the UP/NS portion of interline moves will enhance geographic and source competition for other routes moving the same or similar commodities. The ability of, for example, an industrial chemicals producer sole-served by UP/NS to reach a CSX sole-served consumer, using a Committed Gateway Price that is below the rate that UP/NS otherwise have

charged, provides an enhanced competitive option in both the production and consumption of the industrial chemical.

C. EXPERIENCE FROM THE I-5 CORRIDOR SHOWS SIMILAR RATE AGREEMENTS ENHANCE COMPETITION

154. An existing analogous agreement—the I-5 Agreement between BNSF and UP regarding movements and rates between the Pacific Northwest and the U.S. Southwest—demonstrates the competition-enhancing effects of market-based gateway rates. The I-5 Agreement provides UP the ability to market transportation services directly to BNSF-served shippers for transportation across the Portland gateway without the direct involvement of BNSF.⁸⁹ In this way it is very similar to CGP and served as an inspiration for parts of the CGP proposal, although CGP has been modified to improve the proposal, based on lessons learned from the I-5 Agreement.
155. The I-5 Agreement arose in conjunction with the UP-SP merger and was imposed by the Board as a condition of its approval of that merger. It was not intended, however, to remedy specific competitive harms arising from the transaction. Rather, UP agreed to sell a rail line to BNSF that created single-line BNSF service between western Canada and southern California. This created a single-line competitor to UP along much of the I-5 corridor. The I-5 Agreement then provided UP access to BNSF-served locations in the Pacific Northwest with market-determined rates determined under the agreement. The agreement represents a pro-competitive component of a larger agreement that permanently rationalized ownership and operation of rail lines between California and Washington state.
156. The I-5 Agreement and the CGP proposal share a number of fundamental elements. Both define the range of shippers, locations, and movements to which the guaranteed rates may be applied. Both are limited to movements across a defined gateway or gateways. Each

⁸⁹ The “I-5 Agreement,” also known as BNSF Proportional Rate Agreement, was analyzed by the STB in its approval of the UP-SP merger. See *Union Pacific Corporation, et al.—Control and Merger—Southern Pacific Rail Corporation, et al.*, STB Docket No. FD 32760, Decision No. 44, August 6, 1996 (hereinafter “UPSP Decision”). The agreement also provides UP with access to connections for certain locations in western Canada.

utilizes information on market rates derived from corresponding traffic from the incumbent carrier—BNSF for the I-5 Agreement and UP/NS for the CGP. These rates are then used by the non-incumbent carrier(s) to establish a guaranteed rate for interline service. They also both provide for non-discriminatory service level commitments, means for auditing, rules and schedules for data collection, processing and establishing rates, and mechanisms for managing periods of limited or missing data.

157. Critically for the present transaction, UP’s experience with the I-5 Agreement demonstrates that carefully designed market-based gateway rates can successfully enhance competition, and that this occurs in ways beyond simply sharing rates. The I-5 Agreement also generated significant non-price benefits and resulted in a more competitive overall product. UP was able to respond to new opportunities at BNSF-served locations without being dependent on BNSF to establish a rate to UP destinations. And UP was able to offer shippers the higher-quality customer experience that comes with working with a single railroad.
158. Shippers have made extensive use of this competition under the I-5 Agreement. Figure 12 shows that since 2009 UP has moved over {{ }} carloads under the I-5 Agreement, accounting for nearly {{ }} billion in revenue to UP.⁹⁰ The volume of traffic moving under the I-5 agreement has generally grown over this period, with carload volume in 2024 more than {{ }} of 2010 volume.

⁹⁰ 2009 is the earliest date for which I have data.

Figure 12
UP I-5 Agreement Traffic: 2009 – 2024 {{

}}

Source: UP I-5 History Data

Notes:

1) UP Net Revenue removes the revenue paid to BNSF.

159. UP has used the I-5 Agreement to compete successfully against BNSF for all major commodities moving over the I-5 corridor. Southbound traffic predominates over this corridor, and, as shown in Figure 13, UP has achieved higher volumes than BNSF for {{ }} of the top ten commodities over this corridor. Given the product mix, forest products (largely STCC2 24 and 26) moving southbound from the Pacific Northwest have accounted for a {{ }} of I-5 traffic and UP has achieved {{ }}. ⁹¹

⁹¹ See my backup materials. This traffic reflects movement over the I-5 corridor but includes UP movements not utilizing the I-5 Agreement proportional rate.

Figure 13
BNSF and UP Carloads Over the I-5 Corridor
2023 Top Ten Southbound 2-digit STCCs {{

}}

Source: STB Confidential Carload Waybill Sample

Note: CCWS traffic is limited to Southbound shipments covered under BNSF and UP's 1997 I-5 Agreement. Southbound traffic is defined as BNSF or UP traffic originating in an I-5 Northern region and terminating in the I-5 Southern Region. Based on CCWS and subject to variance arising from sampling. Given limitations of the CCWS, this traffic also includes UP movements not using the I-5 Agreement proportional rate but moving between the areas covered by the Agreement,

160. The I-5 Agreement enhanced geographic competition through improved competitive options to otherwise sole-served shippers; the CGP proposal will do the same.⁹² UP obtains access to BNSF-served shippers located in the Pacific Northwest through gateway prices provided under the I-5 Agreement; CGP provides CSX the ability to market directly to sole-served UP shippers, and BNSF the ability to market directly to sole-served NS

⁹² The I-5 Agreement was not limited to BNSF sole-served locations, but in the region served by BNSF there was little if any additional competitive rail options serving these locations.

shippers, for shipments over the east-west gateways. As explained by the STB, looking at wood products producers in the Pacific Northwest:⁹³

When Oregon lumber moves south to California, competition from the north has been limited because access to California required interline arrangement with [UP-predecessor] SP. The BNSF PRA [the I-5 Agreement] opens that access, thereby intensifying source competition. From the standpoint of destination competition, an Oregon shipper has the choice of directing lumber either to eastern markets or to California depending on product market conditions and transportation options. These forms of geographic competition were highly effective pre-merger, and with the BNSF PRA, will improve post-merger.

161. In the UPSP merger, the primary objection to the I-5 Agreement was from shippers that were not eligible to participate and were concerned about the enhanced competitiveness the I-5 Agreement provided to shippers covered by it.⁹⁴ But this concern is a feature not a bug; it demonstrates the extra competition spurred by the Agreement. CGP provides similar “intensified” source and geographic competition arising from CSX (and BNSF) access to UP (and NS) shippers across the east-west gateways.

D. ANALYSIS OF THE COMMITTED GATEWAY PRICING PROPOSAL

1. Lessons learned from the I-5 Agreement

162. Although the I-5 Agreement has been successful on its own terms, all programs can be improved. UP’s multiple decades of experience with the I-5 Agreement have provided lessons for improving the operation of CGP. These improvements are designed to provide a more stable, useful, and effective mechanism through which CSX and BNSF can utilize the available rates to market to shippers on routes between a UP sole-served location and a CSX sole-served location, or between an NS sole-served location and a BNSF sole-served location.

⁹³ UPSP Decision, p. 403.

⁹⁴ UPSP Decision, pp. 401 and 467-468.

163. One significant improvement in the CGP proposal is how ‘cells’—the category that determines the traffic from which the Committed Gateway Price is calculated and the traffic to which it is applied—are defined. In the I-5 Agreement, cells were entries in a multidimensional matrix, determined based on the 3-digit STCC of the freight, direction (i.e., north- or south-bound), five northern regions, car type, car ownership, and train size. This resulted in thousands of possible cells, most of which remained empty, but still with thousands of different possible rates depending on the traffic characteristics. This enormous number of cells, most of which were either empty or populated by very little data, has created significant logistical challenges in implementing the I-5 rates. CGP, in contrast, is categorized by twenty-three freight groupings and four distance ranges, resulting in fewer than 100 possible rate categories for each interline railroad, a much more manageable setup generating significant benefits, described next.
164. The reduced number of rate cells makes the CGP cells more likely to be populated, stable, and representative of market rates. By aggregating UP/NS price data into fewer cells based on only two criteria—commodity group and distance—the resulting rates are based on much more data, which means they can more reliably reflect current market conditions. The CGP proposal also provides a mechanism by which all cells will always have a rate available for use by BNSF and CSX in serving shippers. In contrast, under the I-5 Agreement, if no movement is made by BNSF in a cell category, no rate exists to be used by UP for the potential benefit of shippers. When no actual rates exist for a given cell, cells are updated using an alternative mechanism that is not based on actual movements, meaning cells populated in this way are not based on relevant market conditions.
165. CGP incorporates several additional improvements over the I-5 Agreement. First, the Committed Gateway Prices are updated annually, while the I-5 Agreement’s prices are updated quarterly. This annual cycle provides greater stability in pricing for other railroads to market to shippers based on the available gateway rates, without the rates quoted to shippers varying wildly. Additionally, CGP includes other elements that make it more practical and reduce potential negative consequences of market-based gateway pricing.

- The movements used to determine the Committed Gateway Prices are distinct from the movements to which the price is applied. This avoids potential unsustainable feedback in rate making (whereby the use of rates under CGP in one year affects the rates available under CGP in future years, potentially leading to instability in the distribution of rates).
- The Committed Gateway Price is based on the 70th percentile (weighted by carloads) of the distribution of rates, rather than the average. As discussed below, using a percentile to establish the Committed Gateway Price rather than an average reduces the incentive of the incumbent railroad (i.e., BNSF for the I-5 Agreement, and UP/NS here) to compete less aggressively for certain traffic and better retains the incentive to pass on the benefits of the merger to shippers. The 70th percentile provides a reasonable balance between the enhancement of competition provided by the availability of CGP and the incentives discussed below.
- Rates are based on car-miles, rather than ton-miles. This is more consistent with current rate making, avoids disputes over car weights, and mitigates the influence of outliers (i.e., lightly-loaded cars) in establishing rates.

166. UP/NS proposes that CGP terminate at the end of the oversight period. Market conditions change over time, therefore, CGP should be reviewed to ensure it continues to operate as intended. UP/NS indicates that if the anticipated public benefits of the merger fail to materialize in a timely manner, the Board could extend the availability of CGP.⁹⁵

2. Mitigation of adverse incentives

167. I find that CGP is welfare enhancing for shippers and the economy. However, using the incumbent carrier's rate (UP/NS in this application) as an input for establishing the gateway rates can potentially create an incentive for the incumbent carrier to compete less aggressively and transact at rates higher than would otherwise occur absent the gateway

⁹⁵ Novak V.S., § I.B.6.

rate mechanism. In this case, the impact of this adverse incentive is limited for several important reasons and, as I show below, the benefit of CGP to shippers outweighs any negative effect of incentives to compete less aggressively for some traffic. So, bottom line, even considering this potential effect on pricing incentives in the markets where prices are set, CGP increases shipper welfare by extending competitive benefits to routes that would not otherwise benefit as directly from the merger.

168. **First**, the adverse incentive is only even potentially relevant with respect to traffic that is used to calculate Committed Gateway Prices, a subset of overall traffic. And critically, as I show below, because the proposal uses a percentile rather than an average to establish the Committed Gateway Prices, the adverse incentive applies to only a small portion of even that traffic.
169. **Second**, the Committed Gateway Prices are calculated using the largest practical group of shipments and is applied narrowly, which means that the potential benefits of competing less aggressively will be small (because they will only apply to the set of traffic where CGP is applied) relative to the loss of profits from doing so (which will apply to the large set of traffic on which the Committed Gateway Prices are computed). Specifically, the Committed Gateway Price (for CSX) is calculated using traffic moving on *all routes* served by UP in the west and interconnecting with NS or CSX in the east. Only traffic between sole-served UP and sole-served CSX locations is excluded. The resulting Committed Gateway Price is available to CSX only to and from its sole-served customers in the east and only on routes that are sole-served by UP in the west. (Corresponding rates available to BNSF are established using traffic between NS locations in the east and UP and BNSF locations in the west.) Using the largest practical traffic group to calculate the Committed Gateway Price also makes it more difficult for the incumbent carrier to manipulate rates effectively, because changing the rate of any particular shipment will have limited to no effect on the Committed Gateway Price.
170. Based on recent UP and NS traffic data, the Committed Gateway Prices available to CSX will be calculated based on nearly {{ }} annual carloads comprised of UP-CSX and UP-NS interline shipments and will be available to approximately {{ }} annual UP-

CSX sole-served interline shipments.⁹⁶ On the BNSF side, the Committed Gateway Prices will be calculated based on nearly {{ }} annual carloads comprised of NS-BNSF and NS-UP interline shipments and will be eligible to only roughly {{ }} annual NS-BNSF sole-served interline shipments. CGP is designed to apply across a broad range of commodities, but shippers of chemical, plastic, agriculture, and food product commodities would have approximately {{ }} annual shipments eligible for CGP.

171. **Third**, the Committed Gateway Price is determined using a percentile rather than an average. If the Committed Gateway Price were established using an average of rates, the incumbent carrier would have the small incentive to price less aggressively on all traffic that goes into the determination of the average gateway rate available to other railroads. However, using the 70th percentile as the basis for CGP means the incentive to price less aggressively is concentrated only on transactions around those that form the 70th percentile of the rate distribution. For most transactions below this level, there is no direct effect of any change in rate on CGP. Instead, the ability to influence the Committed Gateway Price arises only from a change in volume shipped under those rates which then alters which transaction establishes the 70th percentile rate. As shown below, this incentive is small.
172. **Fourth and critically**, the use of the 70th percentile in CGP and UP/NS' incentive to raise the Committed Gateway Price would also create a countervailing incentive for UP/NS to lower the rates for traffic associated with the highest rates on routes that determine the Committed Gateway Price. Similar to the incentive below the 70th percentile, one way to increase the 70th percentile rate is to increase the volume of traffic that would otherwise be transacted at rates above the 70th percentile, thus increasing the price at which the 70th percentile falls (since more traffic in the top of the distribution means a higher price is required such that only 30 percent of traffic moves at prices higher than that level). This can be achieved via *decreasing* the rates that are above the 70th percentile rate and encouraging additional volume from these shippers. Therefore, in addition to lowering the

⁹⁶ My estimations of carloads within the input and eligible segments of CGP are based on defining sole-served stations based on a combination of CSM and SCRS information.

rates potentially offered to shippers for whom CGP applies, CGP may also benefit shippers who face the highest rates on routes from which the Committed Gateway Price is determined.

173. As shown below, the net effect of CGP is to enhance competition and improve the welfare of shippers. Any small incentive for UP/NS to compete less aggressively on some routes is more than offset by the benefits sole-served shippers receive from CGP in capping the rates UP/NS may charge on its portion of the interline shipments to which CGP applies.

E. WELFARE EFFECTS OF THE COMMITTED GATEWAY PRICING PROPOSAL

1. Period in which UP/NS cannot influence CGP Rates

174. In the initial period during which CGP is implemented, rates will be based on historical rates that were transacted prior to the merger and before CGP is implemented. Any adverse incentives for UP/NS to compete less aggressively on routes that determine the Committed Gateway Prices will not be reflected in those rates. During any time when CGP rates are based on rates that UP/NS cannot influence, the effect of CGP will be purely welfare enhancing, benefiting shippers on routes where CGP applies by providing lower rates to interline partners that can be shared with shippers.
175. To estimate the potential savings that CGP will offer during its first year of implementation, I calculate the hypothetical Committed Gateway Prices that will be available to CSX and BNSF separately for each of the commodity and distance groups in the CGP proposal based on UP and NS rates distribution in 2024.⁹⁷ I then calculate the amount of traffic on eligible UP-CSX and NS-BNSF interline routes that had rates on UP or NS in 2024 that are above the calculated Committed Gateway Prices—the volume of

⁹⁷ To calculate rates, I use distances from the UP, NS and BNSF waybills. I find CSXT waybill distances to be unreliable, and substitute in distances for CSXT from PC Miler, which is a rail freight routing software that is commonly used in the industry. I additionally substitute PC Miler distances for waybill distances for a relatively small share of outlier distances. For my regressions in Sections III and IV, I use PC Miler distances for all records, because while CGP rates rely on the distance of each carrier's leg, the regressions rely on a shipment's total distance, which is less commonly found for interline shipments in the waybills.

traffic that could benefit from CGP—and the amount of potential savings that these shippers could receive from CGP. This estimated eligible volume of traffic and potential savings are reported in Figure 14, below. In total, I estimate that a potential savings of up to \$43.1 million from CGP in the first year could be available to shippers.⁹⁸ Note that this estimate represents a lower bound on the total benefits that CGP will offer in the first year, as this calculation does not take into account the output expansion effect of the lower rates offered by CGP; rather it is pure rate reduction on existing traffic with no output expansion.⁹⁹

⁹⁸ The actual savings available to shippers will depend on the responses of BNSF and CSX in through rates offered to shippers as a result of the lower rates provided to them under CGP by UP/NS.

⁹⁹ With regards to the inclusion of sole-served short lines, the calculation of potential benefits uses information provided by UP as well as information from the CSM and SCRS to determine which short lines are served by a single Class I railroad. Shipments from sole-served short lines represent approximately 5,000 of the input carloads, approximately 2,000 of the eligible carloads, and approximately \$474,000 in potential benefit in the first year shown above.

Figure 14
Estimated Potential Benefits from CGP in the First Year of Application

Commodity Group	Carloads Used for Calculation of CGP	Carloads Eligible for the CGP	Carloads Potentially Benefiting from the CGP	Estimated Potential Benefit from the CGP
Sand	20,950	6,664	5,026	\$7,441,424
Refrigerated	6,968	4,732	2,294	\$5,915,859
Specialized Markets	12,849	9,800	2,603	\$5,102,265
Food & Beverage I	7,099	6,324	2,392	\$4,209,673
Industrial Chemicals	59,670	16,779	3,567	\$3,448,612
Grain Products I	21,861	5,161	2,319	\$2,816,182
Plastics	60,301	25,889	2,885	\$2,659,491
Fertilizer & Sulfur	15,470	4,976	1,660	\$1,519,335
Petroleum	17,046	2,316	994	\$1,277,412
Forest Products I	17,889	8,692	2,064	\$1,266,632
Metals & Ores I	21,693	4,484	1,346	\$1,089,483
OTE	2,403	732	155	\$887,725
Grain	12,993	5,252	923	\$860,941
Petcoke	1,141	709	688	\$851,932
Food & Beverage II	8,199	8,338	905	\$823,249
Soda Ash	8,291	5,554	2,970	\$697,332
Forest Products II	7,359	4,375	951	\$687,614
Metals & Ores II	10,383	2,302	683	\$657,196
Grain Products II	11,462	6,392	838	\$390,136
LPG	11,521	1,559	322	\$304,108
Construction	4,066	2,859	144	\$240,166
Auto Parts	4,898	0	0	\$0
Coal & Renewables	96	1	0	\$0
Total	344,608	133,890	35,729	\$43,146,765

Sources: UP, NS, BNSF, and CSX Waybill Data 2024, AAR Centralized Station Master (CSM), Serving Carrier Reciprocal Switching Data (SCRS), UP Short Line Access Information

Note: The carloads used for calculating both the BNSF and CSX CGP include the same set of UP-NS interline shipments. To avoid double counting, duplicate shipments are removed when summarizing the total carloads used for the calculation of CGP.

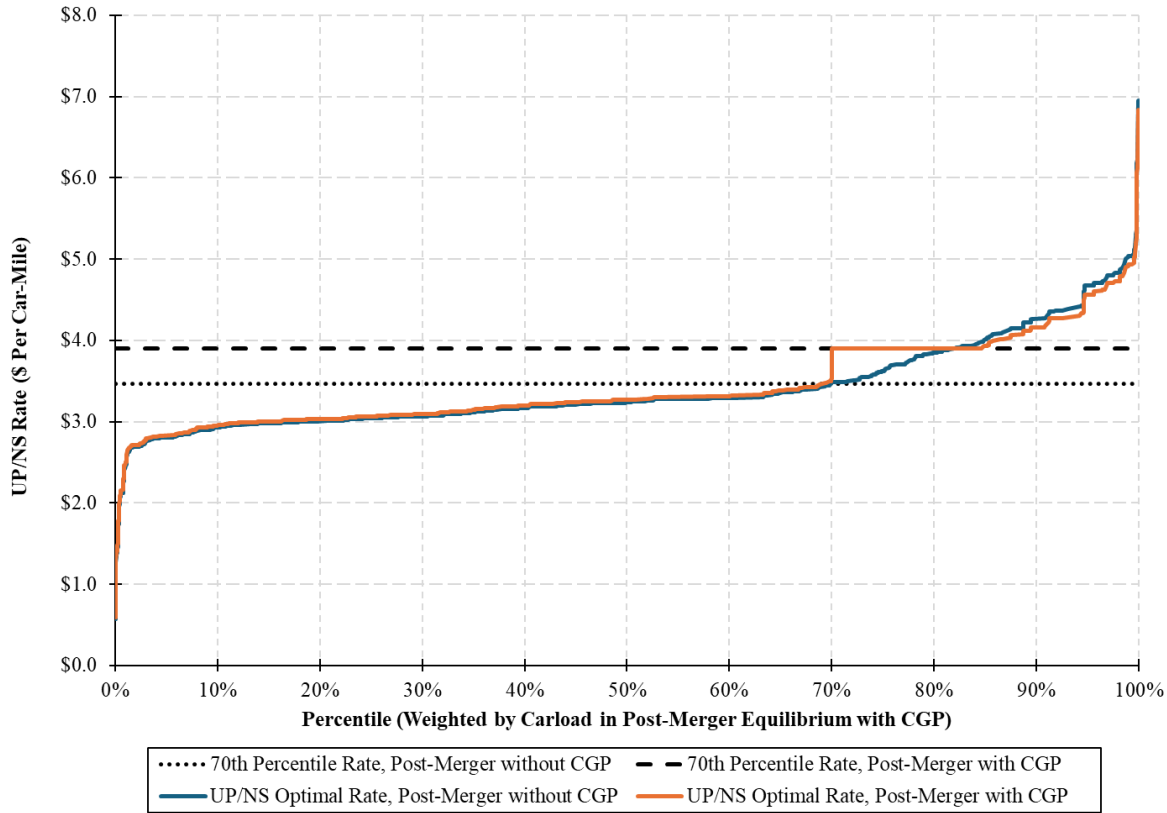
2. Simulation model of CGP effects going forward

176. To evaluate the welfare effects of the CGP proposal on shipper welfare going forward, I have developed a simulation model in which railroads set rates to maximize their profits given shippers' choices of routes and contracting arrangements. The model is calibrated to observed data on rates and volume of traffic from interline shipments that will be used as inputs to calculate the Committed Gateway Prices, as well as from interline shipments eligible to use CGP, along with information on UP's and NS's average margins. I use the model to simulate the profit maximizing rates that UP/NS and the interline partners will set under different post-merger scenarios. I evaluate the welfare effects of CGP on shippers by comparing the rates that UP/NS has the incentive to set with and without CGP. The mathematical and computation details of this simulation model are provided in Appendix C.

177. For interline shipments that are used as *inputs* to calculate the Committed Gateway Prices, CGP has multiple effects that go in different directions, all captured by my model. As explained above, the CGP proposal creates an incentive to compete less aggressively on some of the shipments used in the generation of the Committed Gateway Prices. Most of this incentive is focused around the 70th percentile rate, with *much smaller* incentive to compete less aggressively for rates below the 70th percentile.¹⁰⁰ Notably, however, above the 70th percentile—that is, for the shipments with the highest rates used in generation of Committed Gateway Prices—the incentive is reversed, and the pricing pressure from CGP is downward. UP/NS has an incentive to reduce rates on higher-priced shipments, thereby inducing additional volumes above the CGP percentile threshold. These two opposing incentives are illustrated in Figure 15, below, using as an example the model simulation results for the commodity group “Forest Products I” and the distance band “1,500 Miles or Greater,” focusing on the Committed Gateway Price that would be available to CSX. For this CGP cell, my simulation model estimates that UP/NS will compete less aggressively on the set of shipments that faces rates below {{ }} per car-mile due to CGP, raising the 70th percentile rate from {{ }} per car-mile to {{ }} per car-mile. However, as also shown in the figure, UP/NS will also be pricing more aggressively and lowering rates for about {{ }} percent of traffic, and importantly, this will be for the traffic that faces the highest rates for this set of shipments.

¹⁰⁰ To the extent higher rates below the 70th percentile reduce output, it will tend to shift upward the 70th percentile price.

Figure 15
Simulation Results: UP/NS's Optimal Rates for Shipments
from which the Committed Gateway Price is Calculated



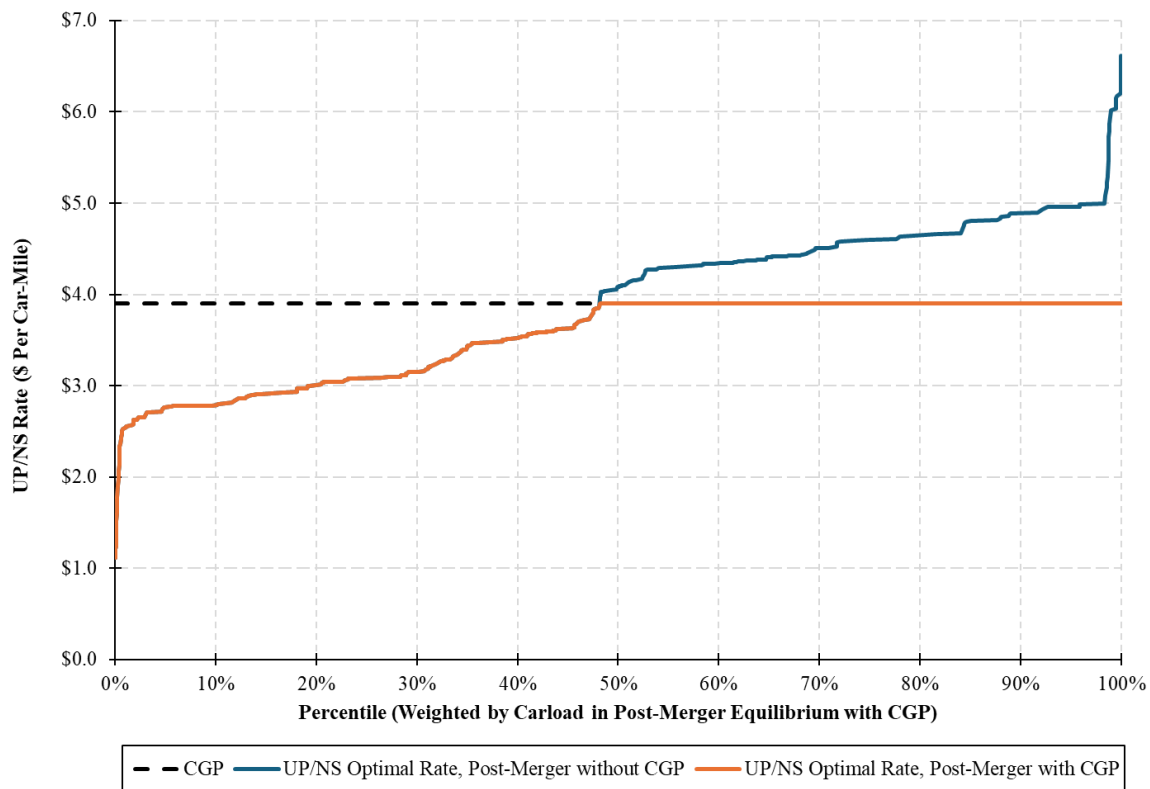
178. Most importantly, for interline shipments that are eligible to utilize CGP, the CGP proposal provides unambiguous shipper-welfare benefits. CGP provides the interchange railroad an option to utilize the lower Committed Gateway Price rather than the rate UP/NS would otherwise provide on its portion of the move. The interchange railroad, with the ability to use CGP, has the incentive to price more aggressively and pass some or all of that reduction in the UP/NS rate due to CGP onto the shipper.¹⁰¹ This provides direct benefits

¹⁰¹ Although the degree to which reductions in UP/NS rate will be passed through from the interchange railroad to shippers generally depends on various supply and demand factors, when

to the shipper, and with a lower through rate, the incentive expands the volume of shipments on that route. Figure 16 demonstrates this benefit for shipments that are eligible to utilize CGP, for the CGP cell that is used as an example in Figure 15 above. For this set of shipments, the Committed Gateway Price of {{ }} per car-mile represents the {{ }} percentile rate, which means that {{ }} percent of the traffic would face a lower rate as a result of CGP.

faced with a marginal cost reduction, a profit maximizing firm typically has an incentive to pass some or all of the savings it receives onto customers in the form of lower prices, just as it has the incentive to raise prices when marginal cost increases. In certain cases, firms may also lower prices by an amount that exceeds the marginal cost savings (i.e., a pass-through rate that exceeds 100 percent). See, e.g., Miller, N. H., M. Osborne, and G. Sheu (2017), “Pass-Through in a Concentrated Industry: Empirical Evidence and Regulatory Implications,” *The RAND Journal of Economics*, 48(1), 69–93.

Figure 16
Simulation Results: UP/NS's Optimal Rates for Shipments to which CGP is Applicable



179. As shown in the above example, except for the volume of traffic concentrated around the 70th percentile rates for interline shipments included in the calculation of the Committed Gateway Price, UP/NS's incentive to compete less aggressively tends to result in rate increases that are much smaller in magnitude compared to the direct benefits that shippers are likely to receive on interline shipments to which CGP is applicable. This suggests that CGP will be beneficial overall. To confirm that intuition, I implement the simulation model that I described above (and in more detail in Appendix C), calibrated to actual data from 2024, to measure the benefits. For the particular example shown in Figure 15 and Figure 16 above, I find that the direct benefits of CGP dominate any potential upward price pressure in the input markets, resulting in an increase in overall shippers' consumer surplus by \$945,618 a year.

180. I perform the simulation described above for 140 CGP cells where I have sufficient data to estimate shippers' demand and margins of railroads reliably.¹⁰² Consistent with the simulation results in the example discussed above—I find that the direct benefits of CGP outweigh any potential welfare reductions in 111 of these 140 CGP cells, and the CGP is welfare-neutral in 15 CGP cells, resulting in a total net increase in shippers' consumer surplus of about \$29 million a year.
181. The welfare effect estimated by my simulation model is almost surely an underestimate of welfare benefits of CGP to shippers, however. Although my simulation model accounts for the response of existing shippers on existing routes to changes in rates as a result of CGP, the model does not account for new interline traffic that CSX or BNSF may be able to attract as a result of CGP. The availability of CGP provides CSX and BNSF the opportunity to market directly to UP/NS sole-served shippers and enables them to provide rates to UP/NS sole-served shippers without the concurrence of UP/NS. For example, CSX can approach a UP sole-served shipper directly with a through rate using UP/NS's Committed Gateway Price for delivery to a CSX sole-served location. Thus, CSX can unilaterally compete against UP/NS for a sole-served UP shipper for movement to a CSX destination, in potential geographic competition against a UP/NS alternative, in a manner that was not previously available and is not accounted for in the simulation.
182. The ability of CSX and BNSF to market to shippers using CGP absent any required concurrence from UP/NS can open multiple alternative origins or destinations that may not have otherwise been economically feasible to serve if rates and concurrences from UP/NS were required. Indeed, as seen with the experience of the I-5 Agreement, the ability to market directly to shippers—rather than having to rely on joint negotiation or concurrences—opened up new markets for shippers and permitted substantial volumes of

¹⁰² The 140 CGP cells for which I perform this welfare effect simulation include 98.9 percent of carloads that could potentially be affected by the CGP proposal. I do not perform the simulation for the remaining 44 CGP cells ($92 \times 2 - 140$) either because the data identifies no eligible shipments in those cells or because the information on shipment rates and/or mileages is missing for a large fraction of shipments in those cells.

traffic to compete with the pre-existing markets and locations. Shippers taking advantage of these new market opportunities provided by CGP represent an unambiguous welfare enhancement to shippers and the economy.

VERIFICATION

I, Mark A. Israel, declare under penalty of perjury that the foregoing is true and correct. Further, I certify that I am qualified and authorized to file this statement.

Executed this 24th day of April, 2026.

A handwritten signature in black ink, appearing to read "Mark A. Israel", written over a horizontal line.

Mark A. Israel

Appendix A

This Appendix explains in more detail, including reference to the economics literature, the basis for my conclusions about the lack of realistic foreclosure concerns from the transaction.

Framework

There are five main ways in which railroad transport service between the eastern and western U.S. is sold:

1. 1*1 routes: both routes are sole served.
2. 2*1 routes: there is customer-facing monopoly on one leg and duopoly on the other.
3. 1*2 routes: there is customer-facing duopoly on one leg and monopoly on the other leg.
4. 2*2 routes: there is duopoly on both legs.
5. Rule 11: the shipper gets quotes for both legs; potentially applies to any of 1-4.

In addition, arrangements vary depending on whether shippers negotiate contractual terms with railroads or whether they are price takers, whether pricing terms are linear or nonlinear, and whether railroads have private cost information. I discuss the scope for harm in cases, 2, 3, and 5, which are the situations where STB has expressed some concern about possible foreclosure.¹

Throughout the discussion I use the terminology “fully integrated price,” “fully integrated outcome,” and “fully integrated wholesale prices” as follows:

Fully integrated price: For routes that are sole served on at least one end, the fully integrated price is the full price (a through rate or the sum of the prices of each leg) the shipper would pay if all sellers were vertically integrated.

Fully integrated outcome: The equilibrium values of all the relevant variables associated with the outcome that generates the fully integrated prices.

Fully integrated wholesale prices: The wholesale prices (*i.e.*, the prices customer facing railroads pay for the other leg) that induce the fully integrated outcome.

Negotiated Nonlinear Contracts with Shippers

As observed in Section III.A, shippers who negotiate nonlinear contracts with railroads in settings with complete information are not harmed and may benefit from the merger. This section provides additional analytical support for that finding.

Consider the following illustration. Suppose a shipper has a demand for shipments from San Francisco to New York and will ship more the lower the price. Suppose the western leg is

¹ Notably, routes on which each segment is sole served (case 1 above) have no foreclosure risk, and shippers would benefit from the proposed merger on the route from the elimination of successive monopoly.

sole served by UP at unit cost c_U , and the eastern leg can be served by CSX at unit cost c_X or by NS at unit cost c_N . Suppose the shipper negotiates the quantity it would like to ship along with a price that divides the surplus with each railroad.

To analyze this problem, the first step is to recognize that the shipper will play CSX and NS against one another to determine the price for the eastern leg. For my first illustration assume that $c_N < c_X$, i.e., NS can supply the eastern leg at lower cost than CSX. In this case, NS will win the competition to serve the eastern leg at a per-unit price approximately equal to $p_E = c_X$.

The second step is to recognize that given an eastern leg price $p_E = c_X$, UP and the shipper will negotiate a western leg price and quantity that maximizes and divides their joint surplus. The quantity that maximizes their joint surplus is the quantity the shipper would purchase if it paid a price equal to UP's cost.² Call this quantity Q , and denote the gross shipper surplus at quantity Q by V . The shipper pays NS $C_X = p_E Q = c_X Q$, and UP incurs cost $C_U = c_U Q$. Therefore, the net surplus divided by the shipper and UP after taking out UP's cost and the eastern leg price is $V - C_X - C_U$. This is the surplus that UP and the shipper divide. Under the standard bargaining solution used in the economic literature, the Nash bargaining solution, UP and shipper will split the surplus equally. The total payment that splits the surplus equally is $P = \frac{V - C_X - C_U}{2}$. If the total cost of the eastern and western legs, $C_X + C_U$, is less than the shipper's valuation V , the shipment will be made, and the shipper's consumer surplus will be $V - C_X - P = \frac{V + C_U - C_X}{2}$.

Now consider what happens if UP and NS merge. The shipper and UP both recognize that NS can supply the eastern leg at lower cost than CSX and that the jointly optimal strategy still has UP and NS supplying the legs. However, whereas prior to the merger the quantity chosen reflected a price for the eastern leg that exceeded NS's cost (because competition between NS and CSX allowed NS to win buy just undercutting CSX's higher cost), after the merger the jointly optimal quantity will reflect NS's lower cost. Thus, the jointly optimal quantity will rise, as will the surplus available for UP and the shipper to divide.³ For this reason, the merging firms and shipper all experience benefits from the merger.

² Conditional on the eastern leg price, negotiations over a nonlinear contract by UP and the shipper lead to a variant of first-degree price discrimination where the shipper shares part of the increase in joint surplus from that strategy. The solution to the first degree price discrimination problem is widely understood: "It is well known that a perfectly discriminating monopolist produces a Pareto efficient amount of output," which means that the output choice maximizes joint surplus (quoting Varian, H. R. (1989), "Price Discrimination," *Handbook of industrial organization*, Vol 1, 597–654). The main nuance surrounding this strategy in the railroad context is that shippers with bargaining power share in the benefits of the strategy.

³ Formally, let the $D(c_U + c)$ be the quantity sold when the marginal price for the UP leg is c_U and the marginal price of the eastern leg is c . The joint surplus of UP and the shipper is then.

Next, consider the case where CSX has the lower cost and wins the competition for the eastern leg. The same logic as above implies that the shipper's pre-merger surplus will now be $\frac{V+C_U-C_N}{2}$, which is the same as before but replacing C_X with C_N because CSX's price reflects its ability to win the eastern leg with a price that just undercuts NS's cost. Post-merger, the merged firm recognizes that the most efficient strategy is to continue using CSX for the eastern leg—since paying CSX will be cheaper than the cost of carrying the goods itself—and in this case, the bargaining situation between the merged firm and the shipper is the same both pre- and post-merger; the surplus that the merged firm and shipper maximize and divide does not change. This means that the outcome for the merged firm and the shipper do not change with the merger. In particular, the merger has no impact on the shipper.

This stylized example illustrates a more general point: In a setting with perfect complements (here two rail networks) where the end customer negotiates nonlinear contracts with suppliers of complementary inputs, a merger benefits shippers in some cases (i.e., in the example, cases where NS has lower costs for the eastern leg than CSX) and has no effect on shippers in other cases (i.e., where NS has higher costs for the eastern leg than CSX).

Non-Negotiated Linear Prices with Shippers

On 2*1 routes, the merger raises no significant risk of competitive harm. If each duopolist writes an efficient contract with the customer facing monopoly, the fully integrated outcome arises with or without the merger.⁴ If firms face contracting frictions, there is double marginalization prior to the merger that leads to a price higher than the fully integrated price. The merger then eliminates double marginalization between the merging firms and lowers final product prices in standard cases. Notably the non-standard case in which the elimination of double marginalization can actually raise the final price is unlikely to apply to the railroad

$$JS(c_U + c) = \int_{c_U+c}^{\infty} D(t)dt.$$

The effect of a small reduction in c on JS is

$$-JS'(c_U + c) = D(c_U + c) > 0.$$

Thus, a reduction in the cost of the eastern leg increases the joint surplus that UP and the shipper split, and under Nash bargaining, they both benefit.

⁴ The generalization of the result that nonlinear contracts induce the fully integrated outcome under bilateral monopoly to the case of two (or more) differentiated upstream sellers and a downstream monopolist appears in O'Brien, D. P. and G. Shaffer (1997), "Nonlinear Supply Contracts, Exclusive Dealing, and Equilibrium Market Foreclosure," *Journal of Economics & Management Strategy*, 6(4), 755–785. See also Bernheim, B. D. and M. D. Whinston (1998), "Exclusive Dealing," *Journal of Political Economy*, 106(1), 64–103. Because the efficient pre-merger contract involves a marginal transfer price equal to marginal cost, a vertical merger does not change incentives when nonlinear contracts are feasible.

industry, as in the benchmark case of linear demand, it never occurs when Slutsky symmetry holds, as it does when customers are firms (e.g., shippers) and contracts are customer specific.⁵

On 1*2 routes, the primary risk arises when bilateral contracting externalities exist that hold price below the fully integrated level.⁶ As a matter of theory, this can occur under two types of circumstances: (i) when contracts are bilateral and private information⁷, and/or (ii) when downstream firms have sufficient bargaining power.⁸ However, the frequent choices by shippers

⁵ An “edge” case where the elimination of double marginalization can raise the final price is “Edgeworth Tax Paradox,” which is an oddity in which a reduction in the marginal cost of one of a multiproduct downstream monopolist’s products leads to increases in the final prices of all products. (See Edgeworth, F. (1925), “The Pure Theory of Monopoly,” in *Papers Relating to Political Economy*, Vol 1, New York: Burt Franklin; and Salinger, M. A. (1991), “Vertical Mergers in Multi-Product Industries and Edgeworth’s Paradox of Taxation,” *The Journal of Industrial Economics*, 39(5), 545–556. In the benchmark case of linear demand, this paradox never occurs when Slutsky symmetry holds, as it does when customers are firms (e.g., shippers) and contracts are customer specific.

⁶ Bilateral contracting externalities arise when the contract between one pair of complements affects the profits of third parties. See Segal, I. (1999), “Contracting with Externalities,” *The Quarterly Journal of Economics*, 114(2), 337–388. In this report, I highlight cases where bilateral contracting externalities lead to marginal transfer prices such that final prices are below the fully integrated level, as those are the cases in the literature on bilateral contracting where harm vertical mergers can occur.

⁷ In a series of papers in the early 90s, researchers showed that if downstream firms have private information about their contract offers and each downstream firm believes that offers to rivals do not change when the supplier makes an unexpected (off-equilibrium path) offer, the equilibrium marginal transfer price equals marginal cost. See Hart, O. and J. Tirole (1990), “Vertical Integration and Market Foreclosure,” *Brookings Papers on Economic Activity. Microeconomics*, 205–286 (downstream Cournot competition); O’Brien, D. P. and G. Shaffer (1992), “Vertical Control With Bilateral Contracts,” *The RAND Journal of Economics*, 23(3), 299–308 (downstream Bertrand competition); and McAfee, R. P. and M. Schwartz (1994), “Opportunism in Multilateral Vertical Contracting: Nondiscrimination, Exclusivity, and Uniformity,” *The American Economic Review*, 84(1), 210–230 (examines the role of alternative off-equilibrium path beliefs and discusses how commitments to contract uniformity can solve the problem.). For a survey that covers these papers, see Rey, P. and J. Tirole (2007), “A Primer on Foreclosure,” *Handbook of Industrial Organization*, Vol 3, 2145–2220. When the pre-merger marginal transfer price is marginal cost, a vertical merger raises downstream prices. As noted in the text, the fact that shippers choose the 2*1 arrangement much more frequently than the 1*2 arrangement rejects the presences of these effects.

⁸ When firms bargain over linear prices, two circumstances can lead to wholesale prices below the fully integrated wholesale prices. First, when the wholesale price is negotiated before downstream prices are set, the equilibrium wholesale prices are below the fully integrated level if downstream competition is sufficiently intense. See O’Brien, D. P. (2014), “The Welfare Effects of Third-Degree Price Discrimination in Intermediate Good Markets: The Case of Bargaining,” *The RAND Journal of Economics*, 45(1), 92–115, and Daniel O’Brien (1989), *The Uniform Settlements Policy in International Telecommunications: A Non-Cooperative Bargaining Model of Intermediate Product Third Degree Price Discrimination*, (Doctoral Dissertation), Northwestern University. O’Brien showed that under linear demand and downstream Cournot competition, price exceeds the fully integrated level if there are two or fewer downstream firms. For downstream Bertrand competition, see Panhans, M. (2024), “Vertical Integration in a Sequential Model of a Supply Chain with Bargaining,” Bureau of Economics Working Paper No. 349, Federal Trade Commission and Moresi, S. (2020), “Vertical Mergers and Bargaining Models: Simultaneous Versus Sequential Pricing,” Working Paper available at SSRN 3541099. Second, when wholesale prices are negotiated at the same time as downstream prices are set, if downstream firms have sufficiently higher bargaining power as measured by their Nash bargaining weights, the pre-merger wholesale prices will be less than the fully integrated wholesale prices. See Sheu, G. and C. Taragin (2021), “Simulating Mergers in a Vertical Supply Chain with Bargaining,” *The RAND Journal of Economics*, 52(3), 596–632. See also Moresi (2020). As noted in the text, the fact that shippers choose the 2*1 arrangement much more frequently than the 1*2 arrangement rejects the presence of bilateral contracting externalities that hold price below the fully integrated level.

to seek through rates from the customer facing monopolist indicates the absence of bilateral contracting externalities that hold price below the fully integrated level. The reason is that through rates obtained from customer facing monopolists cannot be lower than the fully integrated rate except in edge cases (discussed in the following paragraph). If shippers could get a lower price by seeking a through rate from customer facing duopolists, they would do so, but they typically do not do so, which rejects the assumption that bilateral contracting externalities hold price below the fully integrated level. In this case, this theory of harm is inapplicable. Further, the direct empirical evidence finds that prices in 1*2 situations are *not* lower than in 2*1 situations, further rejecting this theory of harm.

As a matter of theory, there can be edge cases in the 1*2 setting where a vertical merger can have anticompetitive effects in the absence of bilateral contracting externalities that hold pre-merger prices below the fully integrated level. Under linear contracting, this can happen when the demand for duopoly products is asymmetric and has asymmetric cross derivatives.⁹ However, this situation does not apply to the railroad industry because the cross derivatives are equal when customers are firms and contracts are firm specific as they typically are in railroads.

In both the 1*2 and 2*1 structures, Rule 11 allows the customer to obtain bids for each leg directly from railroads rather than a rate from railroad(s) serving only the upstream or downstream leg. In settings with nonlinear contracting between the shipper and the railroads, the effect of a merger under Rule 11 is to leave price unchanged or lower it, as discussed above.

In Rule 11 settings with no shipper bargaining and linear pricing, Rule 11 creates a Cournot complements setting where independent firms tend to price too high.¹⁰ The high price caused by independent pricing in the Cournot complements setting is analogous to double marginalization that arises in vertical contracting.¹¹ The merger, which leads to joint pricing of the complements, mitigates or eliminates this Cournot complements concern and thus creates direct benefits.

An edge case in the Cournot complements setting in which a complements merger can have foreclosure effects can arise if the merged firm can engage in pure bundling of the merging

⁹ See Lu, S., S. Moresi, and S. Salop (2007), “A Note on Vertical Mergers with an Upstream Monopolist: Foreclosure and Consumer Welfare Effects,” Working Paper.

¹⁰ See Cournot, A. (1838), *Researches into the Mathematical Principles of the Theory of Wealth*, New York: Macmillan; Economides, N. and S. C. Salop (1992), “Competition and Integration Among Complements, and Network Market Structure,” *The Journal of Industrial Economics*, 40(1), 105–123; Vives, X. (1999), *Oligopoly Pricing: Old Ideas and New Tools*, MIT Press, pp. 176–177.

¹¹ Vertical contracting via linear prices is formally equivalent to a Cournot complements pricing game with sequential rather than simultaneous timing. For a formal proof, see O’Brien, D. P. (2008), “The Antitrust Treatment of Vertical Restraints: Beyond the Possibility Theorems,” in *The Pros and Cons of Vertical Restraints*, Konkurrensverket, Swedish Competition Authority, Stockholm, p. 50, footnote 19.

complements following the merger.¹² Pure bundling means selling the complements only as a package, which in the interline rail service context would mean refusing to offer Rule 11 rates (i.e., UPNS would refuse to quote UP and NS legs separately). However, it is unlikely that UP and NS could pursue such a strategy given regulation in the railroad industry. A shipper can compel a Rule 11 (unbundled) offer whenever it has an offer in hand for the other interline leg. Because unintegrated railroads have incentives to provide such offers if they have a chance of being selected, a shipper is likely to be able to compel a Rule 11 offer from UPNS in cases where unbundling matters, which is when unintegrated carriers have a chance of winning the competition for one of the legs. In this case, the pure bundling edge case would not apply.

Even if one were to assume (counterfactually) that pure bundling were feasible, the theories of harm developed in this paper are ill-suited to the railroad industry. The first of them involves using pure bundling to deter entry. For such a theory to be relevant, one would have to believe that entry by railroads onto routes they do not otherwise serve is an important competitive consideration in the railroad industry, and thus build that reality into competitive analysis of railroad transactions, railroad rates, etc. That is not a commonly held view in this industry, as entry is not generally viewed as an important competitive consideration, and thus entry deterrence is an unlikely theory of harm. Further, even if it were relevant, whether pure bundling could even be used in this way is speculative and the welfare effects are ambiguous.¹³ The other theory of harm requires that BNSF and CSX (the non-merging railroads) legs are systematically less compatible with one another (in providing interline service) than are other combinations. I know of no evidence that this is true, and, given that eastern and western railroads all interchange at common gateways, it is unlikely to hold, meaning this theory is also ill-suited to the railroad industry.

¹² See Kadner-Graziano, A. S. (2023), “Mergers of Complements: On the Absence of Consumer Benefits,” *International Journal of Industrial Organization*, 89, Article 102935.

¹³ Whinston (1990) makes the following observation about the use of pure bundling as an entry deterrence strategy: “Even in the simple models considered here [which are like the model in Kadner-Graziano], which ignore a number of other possible motivations for the practice [pure bundling], the impact of this exclusion on welfare is uncertain.” See Whinston, M. D. (1990), “Tying, Foreclosure, and Exclusion,” *The American Economic Review*, 80(4), 837–859.

Appendix B

Introduction

This appendix presents an analysis of the effects of the merger when there are no bilateral contracting externalities that hold price below the fully integrated level (defined in Appendix A) and duopoly-side railroads have private cost information. In this setting, a vertical merger has two types of effects: (i) standard incentives effects involving the elimination of double marginalization and potential incentives to raise rivals' costs, and (ii) effects due to the information transfer that occurs when the merged railroad gains knowledge of what was previously private information on one of the legs. Importantly, these effects interact.

Established results in the economics of vertical mergers show that in the absence of bilateral contracting externalities that hold price below the fully integrated level, vertical mergers tend to be pro-competitive. A challenge to that conclusion is presented in a paper by Moresi, Reitman, Salop, and Sarafidis (2021) (hereinafter “MRSS”) on the effects of a vertical merger (in a setting where bilateral contracting externalities do not hold price below the fully integrated level) when downstream railroads have private cost information.¹ They find that when the shipper is a single customer (or a set of identical customers) with perfectly inelastic demand and known reservation price, a vertical merger reduces expected shipper surplus (although it increases output and total surplus). This appendix shows that that unambiguous conclusion from their model is an artifact of the inelastic demand assumption. In a benchmark case with linear demand and uniformly distributed downstream costs, we find that a vertical merger reduces expected price and increases expected output, total surplus, and shipper surplus.

Background and Motivation

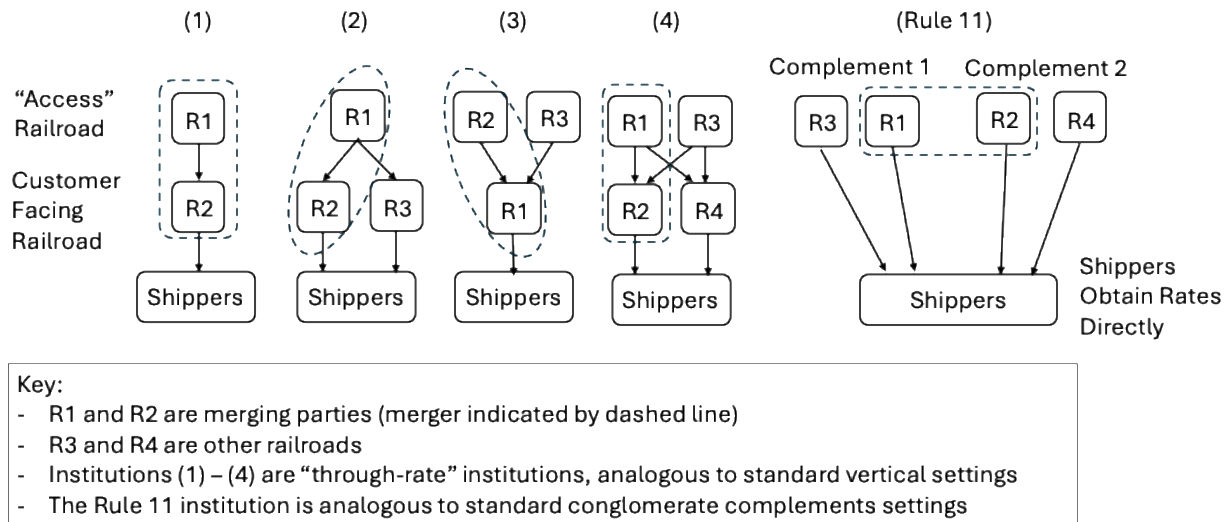
There are five main pricing institutions discussed in the economic literature on vertical and conglomerate complements mergers, shown in Figure 1: four “through-rate” institutions (borrowing that term from the railroad context), and the “Rule 11” institution (also borrowing that term the railroad context). Although Figure 1 could apply to any industry with vertical or conglomerate complements relationships, I will describe it in the context of railroad transportation service and this merger. R1 and R2 are the merging railroads, and R3 and R4 are their rivals. R1 and R3 operate in one part of the country (e.g., the west), and R2 and R4 operate in the other part (e.g., the east). Two railroads from different parts of the country are

¹ Moresi, S., D. Reitman, S. C. Salop, and Y. Sarafidis (2021), “Vertical Mergers in a Model of Upstream Monopoly and Incomplete Information,” *Review of Industrial Organization*, 59, 363–380.

complements because transport legs across the west and across the east are required inputs into rail transport between the west and the east.

The through-rate institutions (1) – (4) in Figure 1 are interpreted as follows. The “Customer Facing Railroad” is the one that offers a through rate to the customer for shipping between east and west (in either direction). The “Access Railroad” supplies the leg of the route not supplied by the customer facing railroad. For example, in institution (2), railroad R1 supplies access to its leg to duopoly railroads R2 and R3, who compete to supply the leg in the other part of the country in quoting through rates to shippers. The four through rate institutions correspond to the two-stage game framework with upstream/downstream railroads (with the customer facing railroads being downstream) used in the economic literature to analyze vertical mergers.

Figure 1: Railroad Through-Rate Pricing Institutions



The Rule 11 institution is interpreted as follows. The shipper seeks bids from suppliers on each leg directly rather than obtaining a through rate quote from railroads operating on either leg. This institution corresponds to the conglomerate complements framework used in the economic literature to examine conglomerate complements mergers. The shipper effectively assembles a product—rail transport between the east and the west—by purchasing the required components and putting them together, much like a datacenter server producer combines hardware and software components in producing servers.

In through rate institutions (1) – (3), a vertical merger very often eliminates double marginalization (a benefit) or is benign (the “one-monopoly rent” idea), and in through rate institution (4), competition at both levels constrains pricing both pre- and post-merger, working

against harmful effects.² Analogous arguments apply to the Rule 11 institutions where the shipper obtains quotes for each leg directly.³ In settings with complete information and without contracting externalities holding prices below the fully integrated level, a single vertical merger tends to be pro-competitive in all five pricing institutions.⁴

When firms have private cost information, however, a vertical merger has more complex effects. MRSS showed that a vertical merger in institution (2) can reduce shipper surplus when the duopoly side railroads have private cost information, even when bilateral contracting externalities are absent (which is true in MRSS). However, a strong and unrealistic assumption in that model is that the shipper has perfectly inelastic demand with a willingness to pay that is known by all sellers. In the remainder of this Appendix, I show that modifying that assumption to allow downward sloping demand, using a linear demand curve (a common benchmark case) and uniformly distributed costs (also a common benchmark), leads to a different conclusion: a vertical merger reduces the expected price and raises shipper welfare in institution (2), and in fact, in all 5 institutions.

Model and Notation

I focus my analysis on through rate institutions (2) and (3) and the Rule 11 institution, as the merger does not raise significant concerns under through rate institutions (1) (where EDM is the only price effect) and (4) (where competition on both legs constrains prices). I consider different assumptions about the timing of information revelation post-merger, as discussed below. I model the effects of a vertical merger in each case under the same set of assumptions about costs, demand, and private cost information. Notation for each case is the following:

Duopoly side marginal costs: $c_i \sim U[0,1]$ ($i = 1, 2$)

Distribution of c_i : $F(c_i) = c_i, c \in [0,1]; f(c_i) = 1$

Maximum of two draws: $c = \max\{c_1, c_2\}$

Distribution of c : $G(c) = c^2, c \in [0,1]; g(c) = 2c$

Duopoly side price: p^D

Duopoly side profit: π_i^D

Sole-serving side cost: 0

Sole-serving side price: p^M

Sole-serving side profit: π^M

Full price: $p^F = p^M + p^D$

Shipper Demand: $D(p^F) = 1 - p^F$

² See the main body of the report and Appendix A for a discussion of edge cases in which vertical mergers can have harmful effects and why they do not apply to this merger.

³ *Id.*

⁴ *Id.*

Throughout this appendix, I assume that the merger is between railroad 1 on the duopoly side and the sole-serving railroad. I examine the following six cases.

Case 1: Rule 11, the sole-serving railroad makes a take-it-or-leave-it (“TIOLI”) offer at the same time as the duopoly side second price auction takes place.

- *Pre-merger*, the sole-serving railroad does not observe the private costs of the duopolists or the outcome of the duopoly side auction before making the TIOLI offer.
- *Post-merger*, the sole-serving railroad observes the private cost of the integrated duopolist, but not the outcome of the duopoly side auction, before making the TIOLI offer on the access leg of the route.

Case 2: Rule 11, the duopoly side second price auction takes place first, and then the sole-serving railroad makes a TIOLI offer.

- *Pre-merger*, the sole-serving railroad does not observe the private costs of the duopolists or the outcome of the duopoly side auction before making the TIOLI offer.
- *Post-merger*, the sole-serving railroad observes the private cost of the integrated duopolist and the outcome of the duopoly side auction before making the TIOLI offer.

Case 3: Rule 11, the sole-serving railroad makes a TIOLI offer first, and then the duopoly side second price auction takes place.

- *Pre-merger*, the sole-serving railroad does not observe the private costs of the duopolists or the outcome of the duopoly side auction before making the TIOLI offer.
- *Post-merger*, the sole-serving railroad observes the private cost of the integrated duopolist, but not the outcome of the duopoly side auction, before making the TIOLI offer.

Case 4: 2*1 Routes, the duopoly side second price auction takes place first, and then the sole-serving railroad makes a TIOLI offer. The sole-serving railroad sets the full price.

- *Pre-merger*, the sole-serving railroad observes the outcome of the duopoly side auction, but not the private costs of the duopolists, before making the TIOLI offer.
- *Post-merger*, the sole-serving railroad observes the private cost of the integrated duopolist and the outcome of the duopoly side auction before making TIOLI offer.

Case 5: 1*2 Routes, the sole-serving railroad makes a TIOLI offer first, and then the duopoly side second-price auction takes place. The winner of the duopoly side auction sets the full price equal to the sum of the sole-serving railroad’s TIOLI offer and the auction price.

- *Pre-merger*, the sole-serving railroad does not observe the private costs of the duopolists or the outcome of the duopoly side auction before making the TIOLI offer.

- *Post-merger*, the sole-serving railroad observes the private cost of the integrated duopolist, but not the outcome of the duopoly side auction, before making the TIOLI offer.

Case 6: 1-Up/2-Down. This case is the same as case 5, but the shipper has inelastic demand $D(p^F) = 1\{p^F \leq 1\}$ (i.e., the MRSS case).

Summary of Results

In this section, I summarize my main results and the intuition that drives them.

Table 2 summarizes the pre- and post-merger prices, quantities, profits, shipper- and total surplus values, and the change in these values caused by the merger. Observe first that the merger reduces the expected full price and increases expected output, shipper surplus, and total surplus in every case except Case 6, where the merger reduces shipper surplus. Case 6 assumes that the shipper has perfectly inelastic demand with a known reservation price, as in MRSS. A conclusion from Table 2 is that the unambiguous finding that a vertical merger reduces shipper surplus in Case 6 is an artifact of the assumption that the customer has perfectly inelastic demand with known reservation price.

To understand the relevance of the inelastic demand assumption, I first discuss the results in Cases 5 and 6, which differ only in the demand assumption—downward sloping demand in case 5, and perfectly inelastic in case 6.

Prior to the merger, in both cases downstream competition yields an expected downstream mark-up over the wholesale price equal to the maximum of the competing railroads' marginal costs. Each downstream railroad's profit is zero if it loses the auction, so it maximizes its expected profit conditional on winning. The dominant strategy under the second price auction rule for each railroad is to bid marginal cost, which for each railroad is the wholesale price plus its production marginal cost. Under the second price auction rule, this leads to a mark-up over the wholesale price equal to second lowest downstream production marginal cost. The full price is random (because the second lowest cost is random), and when positive sales occur, the full price is less than the shipper's reservation price in Case 6 and less than its the shipper's choke price in Case 5. Therefore, shipper surplus is positive in each case.

Figure 2: Summary of Results

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
	Rule 11: Simultaneous Timing	Rule 11: Duopoly Auction → sole-serving RR TIOLI Offer	Rule 11: sole- serving RRTIOLI Offer → Duopoly Auction	2*1 Routes: Duopoly Auction → sole-serving RR TIOLI Offer	1*2 Routes: sole-serving RR TIOLI Offer → Duopoly Auction	1*2 Routes: sole-serving RR TIOLI Offer → Duopoly Auction (Inelastic Demand)
Pre-Merger						
$E[p^D]$	0.6667	0.6667	0.6667	0.6667	0.6094	0.3975
$E[p^M]$	0.2500	0.2500	0.2500	0.1667	0.2500	0.5574
$E[p^F]$	0.9167	0.9167	0.9167	0.8333	0.8594	0.9748
$E[\pi_1^D]$	0.0132	0.0132	0.0132	0.0208	0.0132	0.0642
$E[\pi_2^D]$	0.0132	0.0132	0.0132	0.0208	0.0132	0.0642
$E[\pi^M]$	0.0352	0.0352	0.0352	0.0417	0.0352	0.3849
$E[\pi^{Joint}]$	0.0483	0.0483	0.0483	0.0625	0.0483	0.4491
$E[D(p^F)]$	0.1406	0.1406	0.1406	0.1667	0.1406	0.6667
$E[CS]$	0.0264	0.0264	0.0264	0.0208	0.0264	0.0252
$E[TS]$	0.0879	0.0879	0.0879	0.1042	0.0879	0.5384
Post-Merger						
$E[p^D]$	0.5394	0.5266	0.5394	0.5266	0.5000	0.2500
$E[p^M]$	0.2605	0.1837	0.2605	0.1837	0.2605	0.7500
$E[p^F]$	0.7999	0.7104	0.7999	0.7104	0.7605	1.0000
$E[\pi_1^D]$	0.0160	0.0557	0.0160	0.0557	0.0160	-0.1667
$E[\pi_2^D]$	0.0141	0.0096	0.0141	0.0096	0.0141	0.0417
$E[\pi^M]$	0.0514	0.0468	0.0514	0.0468	0.0514	0.7500
$E[\pi^{Joint}]$	0.0674	0.1025	0.0674	0.1025	0.0674	0.5833
$E[D(p^F)]$	0.2395	0.2896	0.2395	0.2896	0.2395	1.0000
$E[CS]$	0.0533	0.0513	0.0533	0.0513	0.0533	0.0000
$E[TS]$	0.1348	0.1633	0.1348	0.1633	0.1348	0.6250
Delta						
$E[p^D]$	-0.1273	-0.1401	-0.1273	-0.1401	-0.1094	-0.1475
$E[p^M]$	0.0105	-0.0663	0.0105	0.0170	0.0105	0.1926
$E[p^F]$	-0.1168	-0.2063	-0.1168	-0.1229	-0.0989	0.0252
$E[\pi_1^D]$	0.0028	0.0425	0.0028	0.0349	0.0028	-0.2309
$E[\pi_2^D]$	0.0009	-0.0036	0.0009	-0.0112	0.0009	-0.0225
$E[\pi^M]$	0.0162	0.0116	0.0162	0.0051	0.0162	0.3651
$E[\pi^{Joint}]$	0.0191	0.0542	0.0191	0.0400	0.0191	0.1342
$E[D(p^F)]$	0.0989	0.1490	0.0989	0.1229	0.0989	0.3333
$E[CS]$	0.0269	0.0249	0.0269	0.0305	0.0269	-0.0252
$E[TS]$	0.0469	0.0754	0.0469	0.0591	0.0469	0.0866

After the merger, it remains a dominant strategy for the unintegrated rival to bid cost in each case, but this is not true for the vertically integrated downstream railroad, *i.e.*, the standard second price auction result (bid cost) no longer holds. Post-merger, the merged railroad's expected profit depends not only on its profit conditional on winning the downstream auction, but also on its profit conditional on losing because in that event its profit comes from selling the input to the downstream rival. Conditional on winning, the merged railroad's profit is unaffected by its bid to the downstream rival (under the second price auction rule), but conditional on losing, its profit is what it extracts from the rival in selling the access leg. In this case, the demand assumptions matter a lot—in particular, the extreme assumption that the shipper has perfectly inelastic demand (meaning a reservation price that is known by the railroad) drives the result that the merger harms shipper welfare.

When the shipper has inelastic demand (Case 6), the merged railroad's profit upon losing equals its wholesale margin times a fixed quantity of inelastic demand. The profit that the merged railroad can capture from the rival without making the rival's participation unprofitable is higher the more surplus the rival captures from the shipper. Under the second price auction rule, the merged railroad maximizes this downstream surplus capture (and thus its profit) by bidding a price equal to the shipper's reservation price. This strategy implies that the unintegrated rival wins the auction with a bid just slightly below the shipper's reservation price, effectively leaving the buyer with no surplus in the event the rival wins. That is, by raising its bid to the sole-served price (the shipper's reservation price), the merged railroad ensures that if the rival wins the auction, it captures the entire shipper surplus given the second-price auction setup. Note as well that when the merged railroad wins the auction with that bid, it also collects the entire shipper surplus because the rival will have bid price that is weakly higher price.⁵ Either way, the shipper earns zero surplus after the merger, and it is profit-maximizing for the merged railroad to bid in a way that ensures this. Thus, a vertical merger in Case 6 with inelastic demand reduces expected shipper surplus from a positive level pre-merger to zero post-merger.

This result is an artifact of the inelastic demand assumption, as I now explain. When the shipper has downward sloping demand, the merged railroad recognizes that conditional on losing the auction, it earns more if the rival sells more. Starting from the pre-merger wholesale price, the merged railroad has an incentive to shade its bid downward so that conditional on losing, the price charged by the rival is lower and the merged railroad sells more. This effect, which tends to lower the merged railroad's price to the downstream rival does not exist in the inelastic-demand case. In the linear demand/uniformly distributed cost case that we examine, the merged firm does raise the wholesale price post-merger, but the desire to sell more in the event it loses the auction combined with the elimination of double marginalization together dominate the higher wholesale price in determining ultimate effect on the shipper. This result mirrors the prediction of the effects of vertical mergers in full information settings with one upstream firm,

⁵ Implicitly, the shipper's reservation price is a reserve price in the second price auction.

two downstream railroads, linear demand and Slutsky symmetry: a vertical merger in that setting is always procompetitive. My analysis shows that the presence of private cost information for the downstream railroads does not overturn this standard result.

Derivations

Case 1: Rule 11, the sole-serving railroad makes a TIOLI offer at the same time as the duopoly side second price auction takes place.

Pre-Merger

The price on the duopoly side is determined in a standard second price auction, in which both railroads bid their true costs, the lowest bid wins, and the duopoly side price is equal to the highest of the two costs:

$$p^{D,Pre} = c,$$

and its expectation is

$$E[p^{D,Pre}] = \int_0^1 c g(c) dc = \int_0^1 2c^2 dc = \frac{2}{3} \quad (\text{or } 0.6667).$$

The sole-serving railroad sets its price p to maximize its expected profit, which is given by

$$\begin{aligned} E[\pi^{M,Pre}(p)] &= \int_0^{1-p} p(1-p-c) g(c) dc \\ &= -\frac{1}{3}p^4 + p^3 - p^2 + \frac{1}{3}p. \end{aligned}$$

Note that demand, and therefore the sole-serving railroad's profit, is 0 if $p + c > 1$ (i.e., $c > 1 - p$). The first order condition with respect to p is

$$\frac{\partial E[\pi^{M,Pre}(p)]}{\partial p} = -\frac{4}{3}p^3 + 3p^2 - 2p + \frac{1}{3} = 0.$$

The roots to this equation are 1 and $\frac{1}{4}$. Therefore, the profit maximizing price is

$$p^{M,Pre} = \frac{1}{4} \quad (\text{or } 0.25),$$

and the sole-serving railroad's expected profit is

$$E[\pi^{M,Pre}(p^{M,Pre})] = \frac{9}{256} \quad (\text{or } 0.0352).$$

The duopolists' expected profits are given by:

$$E[\pi_1^{D,Pre}] = E[\pi_2^{D,Pre}]$$

$$\begin{aligned}
 &= \int_0^{1-p^{M,Pre}} \left(\int_{c_1}^{1-p^{M,Pre}} (c_2 - c_1) \left(1 - \frac{1}{4} - c_2 \right) f(c_2) dc_2 \right) f(c_1) dc_1 \\
 &= \int_0^{\frac{3}{4}} \left(-\frac{1}{6} c_1^3 + \frac{3}{8} c_1^2 - \frac{9}{32} c_1 + \frac{9}{128} \right) dc_1 \\
 &= \frac{27}{2048} \quad (\text{or } 0.0132),
 \end{aligned}$$

and the expected joint profit of the sole-serving railroad and the integrating duopolist is

$$\begin{aligned}
 E[\pi^{Joint,Pre}] &= E[\pi^{M,Pre}] + E[\pi_1^{D,Pre}] \\
 &= \frac{9}{256} + \frac{27}{2048} = \frac{99}{2048} \quad (\text{or } 0.0483).
 \end{aligned}$$

The expected full price is

$$E[p^{F,Pre}] = p^{M,Pre} + E[p^{D,Pre}] = \frac{1}{4} + \frac{2}{3} = \frac{11}{12} \quad (\text{or } 0.9167),$$

and expected output is

$$\begin{aligned}
 E[D(p^{F,Pre})] &= \int_0^{1-\frac{1}{4}} \left(1 - \frac{1}{4} - c \right) g(c) dc \\
 &= \int_0^{\frac{3}{4}} \left(\frac{3}{4} - c \right) 2c dc \\
 &= \frac{9}{64} \quad (\text{or } 0.1406).
 \end{aligned}$$

Expected shipper surplus is

$$\begin{aligned}
 E[CS^{Pre}] &= \int_0^{1-p^{M,Pre}} \left(\frac{1}{2} \right) (1 - c - p^{M,Pre})^2 g(c) dc \\
 &= \frac{1}{2} \int_0^{\frac{3}{4}} \left(\frac{3}{4} - c \right)^2 2c dc \\
 &= \int_0^{3/4} \left(c^3 - \frac{3}{2} c^2 + \frac{9}{16} c \right) dc \\
 &= \frac{9}{32} \left(\frac{3}{4} \right)^2 - \frac{1}{2} \left(\frac{3}{4} \right)^3 + \frac{1}{4} \left(\frac{3}{4} \right)^4 \\
 &= \frac{27}{1024} \quad (\text{or } 0.0264),
 \end{aligned}$$

and expected total surplus is

$$\begin{aligned}
 E[TS^{Pre}] &= E[CS^{Pre}] + E[\pi_1^{D,Pre}] + E[\pi_2^{D,Pre}] + E[\pi^{M,Pre}] \\
 &= \frac{27}{1024} + \frac{27}{2048} + \frac{27}{2048} + \frac{9}{256} \\
 &= \frac{45}{512} \quad (\text{or } 0.0879).
 \end{aligned}$$

Post-Merger

On the duopoly side, it is still the dominant strategy for the unintegrated railroad to bid its true cost, c_2 . The integrated duopolist, however, internalizing the profit of the vertically integrated railroad, will optimally bid $b \leq c_1$.

The monopolist learns the realization of the integrated duopolist, c_1 , prior to making the TIOLI offer. However, it does not observe the outcome of the duopoly side auction. Therefore, the merged railroad chooses the sole-served side price p and the duopoly side bids b to maximize the expected joint profit of the merged railroad, conditional on c_1 .

Let p be the price of the sole-serving railroad. If the integrated duopolist bids $b \leq c_2$, then it wins the auction, and the joint profit of the merged railroad is

$$\pi_{Win}^{Post}(p) = (p + c_2 - c_1)(1 - p - c_2)$$

provided that $c_2 \leq 1 - p$ (otherwise the profit is 0). Note that this does not depend on b . If the integrated duopolist bids $b > c_2$, then it loses the auction, and the joint profit of the merged railroad is

$$\pi_{Lose}^{Post}(p, b) = p(1 - p - b)$$

as long as $b \leq 1 - p$. If $b > 1 - p$, the joint profit is guaranteed to be 0 and therefore the integrated duopolist would never bid above $1 - p$.

The expected joint profit of the merged railroad, conditional on c_1 , is given by

$$\begin{aligned}
 &E[\pi^{Joint,Post}(p, b) \mid c_1] \\
 &= \Pr[c_2 < b] \pi_{Lose}^{Post}(p, b) + \Pr[b \leq c_2 \leq 1 - p] E[\pi_{Win}^{Post}(p) \mid c_1, b \leq c_2 \leq 1 - p] \\
 &= bp(1 - p - b) + (1 - p - b) \int_b^{1-p} (p + c_2 - c_1)(1 - p - c_2) \frac{1}{(1 - p - b)} dc_2 \\
 &= bp(1 - p - b) + \int_b^{1-p} (p + c_2 - c_1)(1 - p - c_2) dc_2
 \end{aligned}$$

$$= bp(1 - p - b) + \frac{1}{6}(b + p - 1)^2(2b - 3c_1 + 2p + 1).$$

The FOCs for the profit-maximizing values of b and p are

$$\frac{\partial E[\pi^{Joint,Post}(p, b) | c_1]}{\partial b} = b^2 - (1 + c_1)b + (1 - p)c_1 = 0$$

and

$$\frac{\partial E[\pi^{Joint,Post}(p, b) | c_1]}{\partial p} = p^2 - (1 + c_1)p + (1 - b)c_1 = 0,$$

and the solutions to this system of equations are

$$(p, b) = (0, 1), (1, 0), \text{ and } \left(c_1 + \frac{1}{2} \pm \frac{\sqrt{4c_1^2 + 1}}{2}, c_1 + \frac{1}{2} \pm \frac{\sqrt{4c_1^2 + 1}}{2} \right).$$

Note that $(p, b) = (0, 1)$ and $(p, b) = (1, 0)$ guarantee a profit of 0 and, therefore, cannot be the optimal solution. Similarly,

$$\frac{1}{2} + \frac{\sqrt{4c_1^2 + 1}}{2} \geq 1,$$

which means that $c_1 + \frac{1}{2} + \frac{1}{2}\sqrt{4c_1^2 + 1}$ cannot be the optimal solution. Finally, note that $c_1 + \frac{1}{2} - \frac{1}{2}\sqrt{4c_1^2 + 1}$ is increasing in c_1 and it is equal to $\frac{3}{2} - \frac{\sqrt{5}}{2} = 0.3820$ when $c_1 = 1$, which means that

$$(p^{M,Post}, b^{D,Post}) = \left(c_1 + \frac{1}{2} - \frac{\sqrt{4c_1^2 + 1}}{2}, c_1 + \frac{1}{2} - \frac{\sqrt{4c_1^2 + 1}}{2} \right)$$

satisfies $b^{D,Post} \leq 1 - p^{M,Post}$ and is the optimal solution. The expected joint profit of the merged railroad is therefore

$$\begin{aligned} & E[\pi^{Joint,Post}(p^{M,Post}, b^{D,Post})] \\ &= \int_0^1 E[\pi^{Post}(p^{M,Post}, b^{D,Post}) | c_1] f(c_1) dc_1 \\ &= \int_0^1 \left(b^{D,Post} p^{M,Post} (1 - p^{M,Post} - b^{D,Post}) \right. \\ &\quad \left. + \frac{1}{6}(b^{D,Post} + p^{M,Post} - 1)^2(2b^{D,Post} - 3c_1 + 2p^{M,Post} + 1) \right) dc_1 \\ &= \int_0^1 \left(2c_1^2 \frac{\sqrt{4c_1^2 + 1}}{3} - \frac{1}{2}c_1 - \frac{4}{3}c_1^3 + \frac{\sqrt{4c_1^2 + 1}}{6} \right) dc_1 \end{aligned}$$

$$= \frac{\log(\sqrt{5} + 2)}{32} + \frac{13\sqrt{5}}{48} - \frac{7}{12} \quad (\text{or } 0.0674).$$

The expected profit of the merged railroad on the duopoly side is

$$\begin{aligned} E[\pi_1^{D,Post}] &= \int_0^1 \left(\int_{b^{D,Post}}^{1-p^{M,Post}} (c_2 - c_1) (1 - p^{M,Post} - c_2) f(c_2) dc_2 \right) f(c_1) dc_1 \\ &= \int_0^1 \left(-\frac{4}{3} c_1^3 + \left(\frac{2\sqrt{4c_1^2 + 1}}{3} + 2 \right) c_1^2 - \left(\sqrt{4c_1^2 + 1} \right) c_1 - \frac{\sqrt{4c_1^2 + 1}}{12} + \frac{1}{4} \right) dc_1 \\ &= \frac{2}{3} - \frac{13\sqrt{5}}{48} - \frac{\log(\sqrt{5} + 2)}{32} \quad (\text{or } 0.0160). \end{aligned}$$

The expected profit of the merged railroad on the sole-served side is

$$\begin{aligned} E[\pi^{M,Post}] &= E[\pi^{Joint,Post}] - E[\pi_1^{D,Post}] \\ &= \frac{\log(\sqrt{5} + 2)}{16} + \frac{13\sqrt{5}}{24} - \frac{5}{4} \quad (\text{or } 0.0514), \end{aligned}$$

and the expected profit of the unintegrated duopolist is

$$\begin{aligned} E[\pi_2^{D,Post}] &= \int_0^{\frac{3}{2} - \frac{\sqrt{5}}{2}} \left(\int_{c_1: b^{D,Post}=c_2}^1 (b^{D,Post} - c_2) (1 - p^{M,Post} - b^{D,Post}) f(c_1) dc_1 \right) f(c_2) dc_2 \\ &= 0.0141. \end{aligned}$$

The expected sole-served side price is

$$\begin{aligned} E[p^{M,Post}] &= \int_0^1 \left(c_1 + \frac{1}{2} - \frac{\sqrt{4c_1^2 + 1}}{2} \right) f(c_1) dc_1 \\ &= 1 - \frac{\sqrt{5}}{4} - \frac{\log(\sqrt{5} + 2)}{8} \quad (\text{or } 0.2605), \end{aligned}$$

and the expected duopoly side price is

$$\begin{aligned} E[p^{D,Post}] &= \int_0^1 (\Pr[c_2 \leq b^{D,Post}] b^{D,Post} + \Pr[c_2 > b^{D,Post}] E[c_2 | c_2 > b^{D,Post}]) f(c_1) dc_1 \\ &= \int_0^1 \left((b^{D,Post})^2 + \int_{b^{D,Post}}^1 c_2 f(c_2) dc_2 \right) f(c_1) dc_1 \end{aligned}$$

$$\begin{aligned}
 &= \int_0^1 \left((b^{D,Post})^2 + \frac{1}{2} - \frac{1}{2} (b^{D,Post})^2 \right) dc_1 \\
 &= \frac{11}{8} - \frac{\sqrt{5}}{3} - \frac{\log(\sqrt{5} + 2)}{16} \quad (\text{or } 0.5394).
 \end{aligned}$$

The expected full price is therefore

$$E[p^{F,Post}] = E[p^{M,Post}] + E[p^{D,Post}] = \frac{19}{8} - \frac{7\sqrt{5}}{12} - \frac{3\log(\sqrt{5} + 2)}{16} \quad (\text{or } 0.7999),$$

and the expected output is

$$\begin{aligned}
 &E[D(p^{F,Post})] \\
 &= \int_0^1 (\Pr[c_2 < b^{D,Post}] (1 - p^{M,Post} - b^{D,Post}) + \Pr[b^{D,Post} \leq c_2 \leq 1 - p^{M,Post}] E[(1 \\
 &\quad - p^{M,Post} - c_2) | c_1, b^{D,Post} \leq c_2 \leq 1 - p^{M,Post}]) f(c_1) dc_1 \\
 &= \int_0^1 \left(b^{D,Post} (1 - p^{M,Post} - b^{D,Post}) + \int_{b^{D,Post}}^{1-p^{M,Post}} (1 - p^{M,Post} - c_2) dc_2 \right) dc_1 \\
 &= \frac{\log(\sqrt{5} + 2)}{8} + \frac{\sqrt{5}}{4} - \frac{1}{2} \quad (\text{or } 0.2395).
 \end{aligned}$$

Expected shipper surplus is

$$\begin{aligned}
 &E[CS^{Post}] \\
 &= \frac{1}{2} \int_0^1 (\Pr[c_2 < b^{D,Post}] (1 - p^{M,Post} - b^{D,Post})^2 + \Pr[b^{D,Post} \leq c_2 \leq 1 - p^{M,Post}] E[(1 \\
 &\quad - p^{M,Post} - c_2)^2 | c_1, b^{D,Post} \leq c_2 \leq 1 - p^{M,Post}]) f(c_1) dc_1 \\
 &= \frac{1}{2} \int_0^1 \left(b^{D,Post} (1 - p^{M,Post} - b^{D,Post})^2 + \int_{b^{D,Post}}^{1-p^{M,Post}} (1 - p^{M,Post} - c_2)^2 dc_2 \right) dc_1 \\
 &= \frac{23}{12} - \frac{5\sqrt{5}}{6} \quad (\text{or } 0.0533),
 \end{aligned}$$

and expected total surplus is

$$\begin{aligned}
 E[TS^{Post}] &= E[CS^{Post}] + E[\pi_1^{D,Post}] + E[\pi_2^{D,Post}] + E[\pi^{M,Post}] \\
 &= 0.1348.
 \end{aligned}$$

Case 2: Rule 11. The duopoly side second price auction takes place first, and then the sole-serving railroad makes a TIOLI offer.

Pre-Merger

The per-merger outcome on the duopoly side is the same as the outcome in Case 1, with prices given by

$$p^{D,Pre} = c$$

$$E[p^{D,Pre}] = \frac{2}{3} \quad (\text{or } 0.6667),$$

and the duopolists' expected profits are

$$E[\pi_1^{D,Pre}] = E[\pi_2^{D,Pre}] = \frac{27}{2048} \quad (\text{or } 0.0483).$$

The pre-merger outcome on the sole-served side is also the same as the outcome in Case 1. The sole-serving railroad does not observe the outcome of the duopoly side auction, and it sets price to maximize its expected profit. The profit maximizing price is

$$p^{M,Pre} = \frac{1}{4} \quad (\text{or } 0.25).$$

The sole-serving railroad's expected profit is

$$E[\pi^{M,Pre}(p^{M,Pre})] = \frac{9}{256} \quad (\text{or } 0.0352),$$

and the expected joint profit of the sole-serving railroad and the integrating duopolist is

$$E[\pi^{Joint,Pre}] = \frac{99}{2048} \quad (\text{or } 0.0483).$$

The expected full price is

$$E[p^{F,Pre}] = \frac{11}{12} \quad (\text{or } 0.9167),$$

and the expected output is

$$E[D(p^{F,Pre})] = \frac{9}{64} \quad (\text{or } 0.1406).$$

Expected shipper surplus is

$$E[CS^{Pre}] = \frac{27}{1024} \quad (\text{or } 0.0264),$$

and expected total surplus is

$$E[TS^{Pre}] = \frac{45}{512} \quad (\text{or } 0.0879).$$

Post-Merger

On the duopoly side, it is still the dominant strategy for the unintegrated railroad to bid its true cost, c_2 . The integrated duopolist, however, internalizing the profit of the merged railroad, will optimally bid $b \leq c_1$.

The sole-serving railroad learns the realization of the integrated duopolist, c_1 , and the outcome of the duopoly side auction prior to making its TIOLI offer. Therefore, the sole-serving railroad chooses the sole-served side price p to maximize the joint profit of the merged railroad, conditional on c_1 and the outcome of the duopoly side auction.

Let p be the price on the sole-served side. If the integrated duopolist bids $b \leq c_2$, then it wins the auction, and the joint profit of the merged railroad is

$$\pi_{Win}^{Post}(p) = (p + c_2 - c_1)(1 - p - c_2)$$

provided that $c_2 \leq 1 - p$ (otherwise the profit is 0). Note that this does not depend on b .

The profit maximizing FOC with respect to p is

$$\frac{\partial \pi_{Win}^{Post}(p)}{\partial p} = 1 - 2p + c_1 - 2c_2 = 0,$$

and the profit maximizing sole-served side price is

$$p_{Win}^{M,Post} = \frac{1 + c_1 - 2c_2}{2}.$$

The full price, conditional on the integrated duopolist winning the auction, is

$$p_{Win}^{F,Post} = \frac{1 + c_1 - 2c_2}{2} + c_2 = \frac{1 + c_1}{2}$$

which does not depend on c_2 . Therefore, the joint profit of the merged railroad, conditional on the integrated duopolist winning the duopoly side auction, is

$$\pi_{Win}^{Post}(p_{Win}^{M,Post}) = \left(\frac{1 + c_1 - 2c_2}{2} + c_2 - c_1 \right) \left(1 - \frac{1 + c_1 - 2c_2}{2} - c_2 \right) = \left(\frac{1 - c_1}{2} \right)^2.$$

If the integrated duopolist bids $b > c_2$, then it loses the auction, and the joint profit of the merged railroad is

$$\pi_{Lose}^{Post}(p, b) = p(1 - p - b)$$

as long as $b \leq 1 - p$. If $b > 1 - p$, the joint profit is guaranteed to be 0 and, therefore, the integrated duopolist would never bid above $1 - p$. The profit maximizing FOC with respect to p is

$$\frac{\partial \pi_{Lose}^{Post}(p, b)}{\partial p} = 1 - 2p - b = 0,$$

and the profit maximizing sole-served side price, conditional on the integrated duopolist losing the duopoly side auction, is

$$p_{Lose}^{M,Post} = \frac{1 - b}{2}.$$

The full price, conditional on the integrated duopolist losing the auction, is

$$p_{Lose}^{F,Post} = \frac{1 - b}{2} + b = \frac{1 + b}{2}.$$

The joint profit of the merged railroad, conditional on the integrated duopolist losing the duopoly side auction and the bid b , is

$$\pi_{Lose}^{Post}(p_{Lose}^{M,Post}, b) = \left(\frac{1 - b}{2}\right) \left(1 - \frac{1 - b}{2} - b\right) = \left(\frac{1 - b}{2}\right)^2.$$

Now consider the optimal bid for the integrated duopolist in the duopoly second price auction. Conditional c_1 , the expected joint profit of the merged railroad is

$$\begin{aligned} & E[\pi^{Joint,Post}(p_{Win}^{M,Post}, p_{Lose}^{M,Post}, b) | c_1] \\ &= \Pr(c_2 > b) \pi_{Win}^{Post}(p_{Win}^{M,Post}) + \Pr(c_2 \leq b) \pi_{Lose}^{Post}(p_{Lose}^{M,Post}, b) \\ &= (1 - b) \left(\frac{1 - c_1}{2}\right)^2 + b \left(\frac{1 - b}{2}\right)^2 \\ &= \frac{1}{4}b^3 - \frac{1}{2}b^2 + \left(\frac{1}{4} - \left(\frac{1 - c_1}{2}\right)^2\right)b + \left(\frac{1 - c_1}{2}\right)^2, \end{aligned}$$

and the profit maximizing FOC with respect to b is

$$\frac{\partial E[\pi^{Joint,Post}(p_{Win}^{M,Post}, p_{Lose}^{M,Post}, b) | c_1]}{\partial b} = \frac{3}{4}b^2 - b + \frac{1}{4} - \left(\frac{1 - c_1}{2}\right)^2 = 0.$$

The roots to this equation are

$$b = \frac{2}{3} \pm \frac{\sqrt{4 - 6c_1 + 3c_1^2}}{3}.$$

Note that $\sqrt{4 - 6c + 3c^2}$ is decreasing in c_1 in the interval $[0,1]$ and it is equal to 1 when $c_1 = 1$, which means the $\frac{2}{3} + \frac{1}{3}\sqrt{4 - 6c_1 + 3c_1^2}$ cannot be the optimal bid. Therefore, the optimal bid for the integrated duopolist is

$$b^{D,Post} = \frac{2}{3} - \frac{\sqrt{4 - 6c_1 + 3c_1^2}}{3}.$$

The expected joint profit of the merged railroad is therefore

$$\begin{aligned} & E[\pi^{Joint,Post}(p_{Win}^{M,Post}, p_{Lose}^{M,Post}, b^{D,Post})] \\ &= \int_0^1 E[\pi^{Joint,Post}(p_{Win}^{M,Post}, p_{Lose}^{M,Post}, b^{D,Post}) | c_1] f(c_1) dc_1 \\ &= \int_0^1 \left(\frac{1}{4} (b^{D,Post})^3 - \frac{1}{2} (b^{D,Post})^2 + \left(\frac{1}{4} - \left(\frac{1-c_1}{2} \right)^2 \right) b^{D,Post} + \left(\frac{1-c_1}{2} \right)^2 \right) dc_1 \\ &= \frac{\sqrt{3} \log(\sqrt{3} + 2)}{432} + \frac{7}{72} \quad (\text{or } 0.1025). \end{aligned}$$

The expected profit of the merged railroad on the duopoly side is

$$\begin{aligned} E[\pi_1^{D,Post}] &= \int_0^1 \left(\int_{b^{D,Post}}^1 (c_2 - c_1) (1 - p_{Win}^{M,Post} - c_2) f(c_2) dc_2 \right) f(c_1) dc_1 \\ &= \int_0^1 \left(\int_{b^{D,Post}}^1 (c_2 - c_1) \left(\frac{1-c_1}{2} \right) dc_2 \right) dc_1 \\ &= \frac{79}{1296} - \frac{\sqrt{3} \log(\sqrt{3} + 2)}{432} \quad (\text{or } 0.0557). \end{aligned}$$

The expected profit of the merged railroad on the sole-served side is

$$\begin{aligned} E[\pi^{M,Post}] &= E[\pi^{Joint,Post}] - E[\pi_1^{D,Post}] \\ &= \frac{\sqrt{3} \log(\sqrt{3} + 2)}{216} + \frac{47}{1296} \quad (\text{or } 0.0468). \end{aligned}$$

and the expected profit of the unintegrated duopolist is

$$\begin{aligned} & E[\pi_2^{D,Post}] \\ &= \int_0^{\frac{1}{3}} \left(\int_{c_1: b^{D,Post}=c_2}^1 (b^{D,Post} - c_2) (1 - p_{Lose}^{M,Post} - b^{D,Post}) f(c_1) dc_1 \right) f(c_2) dc_2 \end{aligned}$$

$$\begin{aligned}
 &= \int_0^{\frac{1}{3}} \left(\int_{c_1: b^{D,Post}=c_2}^1 (b^{D,Post} - c_2) \left(1 - \frac{1 + b^{D,Post}}{2} \right) dc_1 \right) dc_2. \\
 &= 0.0096.
 \end{aligned}$$

The expected sole-served side price is

$$\begin{aligned}
 E[p^{M,Post}] &= \int_0^1 \left(\Pr[c_2 \leq b^{D,Post}] p_{Lose}^{M,Post} + \Pr[c_2 > b^{D,Post}] E[p_{Win}^{M,Post} | c_2 > b^{D,Post}] \right) f(c_1) dc_1 \\
 &= \int_0^1 \left(b^{D,Post} \left(\frac{1 - b^{D,Post}}{2} \right) + \int_{b^{D,Post}}^1 \left(\frac{1 + c_1 - 2c_2}{2} \right) dc_2 \right) f(c_1) dc_1 \\
 &= \frac{1}{2} \int_0^1 (b^{D,Post}(1 - b^{D,Post}) + (b^{D,Post} - c_1)(b^{D,Post} - 1)) f(c_1) dc_1 \\
 &= \frac{\sqrt{3} \log(\sqrt{3} + 2)}{36} + \frac{13}{108} \quad (\text{or } 0.1837),
 \end{aligned}$$

and the expected duopoly side price is

$$\begin{aligned}
 E[p^{D,Post}] &= \int_0^1 \left(\Pr[c_2 \leq b^{D,Post}] b^{D,Post} + \Pr[c_2 > b^{D,Post}] E[c_2 | c_2 > b^{D,Post}] \right) f(c_1) dc_1 \\
 &= \int_0^1 \left((b^{D,Post})^2 + \int_{b^{D,Post}}^1 c_2 f(c_2) dc_2 \right) f(c_1) dc_1 \\
 &= \int_0^1 \left((b^{D,Post})^2 + \frac{1}{2} - \frac{1}{2} (b^{D,Post})^2 \right) dc_1 \\
 &= \frac{11}{18} - \frac{\sqrt{3} \log(\sqrt{3} + 2)}{27} \quad (\text{or } 0.5266).
 \end{aligned}$$

The expected full price is therefore

$$E[p^{F,Post}] = E[p^{M,Post}] + E[p^{D,Post}] = \frac{79}{108} - \frac{\sqrt{3} \log(\sqrt{3} + 2)}{108} \quad (\text{or } 0.7104).$$

Expected output is

$$E[D(p^{F,Post})]$$

$$\begin{aligned}
 &= \int_0^1 \left(\Pr[c_2 < b^{D,Post}] (1 - p_{Lose}^{F,Post}) + \Pr[b^{D,Post} \leq c_2] (1 - p_{Win}^{F,Post}) \right) f(c_1) dc_1 \\
 &= \int_0^1 \left(b^{D,Post} \left(1 - \frac{1 + b^{D,Post}}{2} \right) + (1 - b^{D,Post}) \left(1 - \frac{1 + c_1}{2} \right) \right) dc_1 \\
 &= \frac{29}{108} + \frac{\sqrt{3} \log(\sqrt{3} + 2)}{108} \quad (\text{or } 0.2896).
 \end{aligned}$$

Expected shipper surplus is

$$\begin{aligned}
 &E[CS^{Post}] \\
 &= \frac{1}{2} \int_0^1 \left(\Pr[c_2 < b^{D,Post}] (1 - p_{Lose}^{F,Post})^2 + \Pr[b^{D,Post} \leq c_2] (1 - p_{Win}^{F,Post})^2 \right) f(c_1) dc_1 \\
 &= \frac{1}{2} \int_0^1 \left(b^{D,Post} \left(1 - \frac{1 + b^{D,Post}}{2} \right)^2 + (1 - b^{D,Post}) \left(1 - \frac{1 + c_1}{2} \right)^2 \right) dc_1 \\
 &= \frac{7}{144} + \frac{\sqrt{3} \log(\sqrt{3} + 2)}{864} \quad (\text{or } 0.0513),
 \end{aligned}$$

and expected total surplus is

$$\begin{aligned}
 E[TS^{Post}] &= E[CS^{Post}] + E[\pi_1^{D,Post}] + E[\pi_2^{D,Post}] + E[\pi^{M,Post}] \\
 &= 0.1633.
 \end{aligned}$$

Case 3: Rule 11, the sole-served side makes a TIOLI offer first, and then the duopoly side second price auction takes place.

Pre-Merger

The per-merger outcome on the duopoly side is the same as the outcome in Case 1, with prices given by

$$p^{D,Pre} = c$$

$$E[p^{D,Pre}] = \frac{2}{3} \quad (\text{or } 0.6667),$$

and the duopolists' expected profits are

$$E[\pi_1^{D,Pre}] = E[\pi_2^{D,Pre}] = \frac{27}{2048} \quad (\text{or } 0.0132).$$

The pre-merger outcome on the sole-served side is also the same as the outcome in Case 1. The sole-serving railroad does not observe the outcome of the duopoly side auction, and it sets price to maximize its expected profit. The profit maximizing price is

$$p^{M,Pre} = \frac{1}{4} \quad (\text{or } 0.25).$$

The sole-serving railroad's expected profit is

$$E[\pi^{M,Pre}(p^{M,Pre})] = \frac{9}{256} \quad (\text{or } 0.0352),$$

and the expected joint profit of the sole-serving railroad and the integrating duopolist is

$$E[\pi^{Joint,Pre}] = \frac{99}{2048} \quad (\text{or } 0.0483).$$

The expected full price is

$$E[p^{F,Pre}] = \frac{11}{12} \quad (\text{or } 0.9167),$$

and expected output is

$$E[D(p^{F,Pre})] = \frac{9}{64} \quad (\text{or } 0.1406).$$

Expected shipper surplus is

$$E[CS^{Pre}] = \frac{27}{1024} \quad (\text{or } 0.0264),$$

and expected total surplus is

$$E[TS^{Pre}] = \frac{45}{512} \quad (\text{or } 0.0879).$$

Post-Merger

The post-merger outcomes on both the duopoly side and the sole-served side are the same as the outcomes in Case 1.

On the duopoly side, it is still the dominant strategy for the unintegrated duopolist to bid its true cost. The integrated duopolist, on the other hand, would optimally bid

$$b^{D,Post} = c_1 + \frac{1}{2} - \frac{\sqrt{4c_1^2 + 1}}{2}.$$

The expected price on the duopoly side is

$$E[p^{D,Post}] = \frac{11}{8} - \frac{\sqrt{5}}{3} - \frac{\log(\sqrt{5} + 2)}{16} \quad (\text{or } 0.5394).$$

On the sole-served side, the optimal TIOLI offer is

$$p^{M,Post} = c_1 + \frac{1}{2} - \frac{\sqrt{4c_1^2 + 1}}{2},$$

and its expected value is

$$E[p^{M,Post}] = 1 - \frac{\sqrt{5}}{4} - \frac{\log(\sqrt{5} + 2)}{8} \quad (\text{or } 0.2605).$$

The expected profit of the merged railroad on the duopoly side is

$$E[\pi_1^{D,Post}] = \frac{2}{3} - \frac{13\sqrt{5}}{48} - \frac{\log(\sqrt{5} + 2)}{32} \quad (\text{or } 0.0160),$$

and the expected profit of the unintegrated duopolist is

$$E[\pi_2^{D,Post}] = 0.0141.$$

The expected profit of the merged railroad on the sole-served side is

$$E[\pi^{M,Post}] = \frac{\log(\sqrt{5} + 2)}{16} + \frac{13\sqrt{5}}{24} - \frac{5}{4} \quad (\text{or } 0.0514),$$

and the expected joint profit of the merged railroad is therefore

$$E[\pi^{Joint,Post}] = E[\pi_1^{D,Post}] + E[\pi^{M,Post}] = \frac{\log(\sqrt{5} + 2)}{32} + \frac{13\sqrt{5}}{48} - \frac{7}{12} \quad (\text{or } 0.0674).$$

The expected full price is

$$E[p^{F,Post}] = E[p^{M,Post}] + E[p^{D,Post}] = \frac{19}{8} - \frac{7\sqrt{5}}{12} - \frac{3 \log(\sqrt{5} + 2)}{16} \quad (\text{or } 0.7999)$$

and expected output is

$$E[D(p^{F,Post})] = \frac{\log(\sqrt{5} + 2)}{8} + \frac{\sqrt{5}}{4} - \frac{1}{2} \quad (\text{or } 0.2395).$$

Expected shipper surplus is

$$E[CS^{Post}] = \frac{23}{12} - \frac{5\sqrt{5}}{6} \quad (\text{or } 0.0533),$$

and expected total surplus is

$$\begin{aligned} E[TS^{Post}] &= E[CS^{Post}] + E[\pi_1^{D,Post}] + E[\pi_2^{D,Post}] + E[\pi^{M,Post}] \\ &= 0.1348. \end{aligned}$$

Case 4: 2*1 Routes, the duopoly side second price auction takes place first, and then the sole-served side makes a TIOLI offer. The sole-serving railroad sets the full price.

Pre-Merger

On the duopoly side, it is the dominant strategy for the duopolists to bid their costs, as it is in Case 1. The prices on the duopoly side auction are given by

$$p^{D,Pre} = c$$

$$E[p^{D,Pre}] = \frac{2}{3} \quad (\text{or } 0.6667).$$

On the sole-served side, the sole-serving railroad observes the outcome of the auction before making the TIOLI offer. It then sets the full price equal to the sum of the winning price in the duopoly side auction, $p^{D,Pre} = c$, and its TIOILI offer. That is, the sole-serving railroad chooses the sole-served side price p to maximize its profit, which is given by

$$\pi^{M,Pre}(p) = p(1 - p - c) = -p^2 + p - cp.$$

The first order condition with respect to p is

$$\frac{\partial \pi^{M,Pre}(p)}{\partial p} = -2p + 1 - c = 0.$$

Therefore, the profit-maximizing sole-served side price is

$$p^{M,Pre} = \frac{1 - c}{2},$$

and its expectation is

$$E[p^{M,Pre}] = \int_0^1 \frac{1 - c}{2} g(c) dc = \int_0^1 (1 - c)c dc = \frac{1}{6} \quad (\text{or } 0.1667).$$

The expected profit of the sole-serving railroad is

$$\begin{aligned} E[\pi^{M,Pre}(p^{F,Pre})] &= \int_0^1 \left(-\left(\frac{1 - c}{2}\right)^2 + \frac{1 - c}{2} - c \frac{1 - c}{2} \right) g(c) dc \\ &= \int_0^1 \left(\frac{1}{2}c^3 - c^2 + \frac{1}{2}c \right) dc \\ &= \frac{1}{24} \quad (\text{or } 0.0417). \end{aligned}$$

The duopolists' expected profits are given by

$$\begin{aligned} E[\pi_1^{D,Pre}] &= E[\pi_2^{D,Pre}] \\ &= \int_0^1 \left(\int_{c_1}^1 (c_2 - c_1) \left(1 - \frac{1 - c_2}{2} - c_2 \right) f(c_2) dc_2 \right) f(c_1) dc_1 \end{aligned}$$

$$\begin{aligned}
 &= \int_0^1 \left(-\frac{1}{12}c_1^3 + \frac{1}{4}c_1^2 - \frac{1}{4}c_1 + \frac{1}{12} \right) dc_1 \\
 &= \frac{1}{48} \quad (\text{or } 0.0208),
 \end{aligned}$$

and the expected joint profit of the sole-serving railroad and the integrating duopolist is

$$E[\pi^{Joint,Pre}] = \frac{1}{24} + \frac{1}{48} = \frac{1}{16} \quad (\text{or } 0.0625).$$

The expected full price is

$$E[p^{F,Pre}] = E[p^{M,Pre}] + E[p^{D,Pre}] = \frac{1}{6} + \frac{2}{3} = \frac{5}{6} \quad (\text{or } 0.8333),$$

and expected output is

$$\begin{aligned}
 E[D(p^{F,Pre})] &= \int_0^1 \left(1 - \frac{1-c}{2} - c \right) g(c) dc \\
 &= \int_0^1 \left(\frac{1-c}{2} \right) 2c dc \\
 &= \frac{1}{6} \quad (\text{or } 0.1667).
 \end{aligned}$$

Expected shipper surplus is

$$\begin{aligned}
 E[CS^{Pre}] &= \int_0^1 \left(\frac{1}{2} \right) \left(1 - \frac{1-c}{2} - c \right)^2 g(c) dc \\
 &= \int_0^1 \left(\frac{1-c}{2} \right)^2 c dc \\
 &= \int_0^1 \left(\frac{1}{4}c^3 - \frac{1}{2}c^2 + \frac{1}{4}c \right) dc \\
 &= \frac{1}{48} \quad (\text{or } 0.0208),
 \end{aligned}$$

and expected total surplus is

$$\begin{aligned}
 E[TS^{Pre}] &= E[CS^{Pre}] + E[\pi_1^{D,Pre}] + E[\pi_2^{D,Pre}] + E[\pi^{M,Pre}] \\
 &= \frac{1}{48} + \frac{1}{48} + \frac{1}{48} + \frac{1}{24} \\
 &= \frac{5}{48} \quad (\text{or } 0.1042).
 \end{aligned}$$

Post-Merger

The post-merger outcomes on both the duopoly side and the sole-served side are the same as the outcomes in Case 2.

On the duopoly side, it is still the dominant strategy for the unintegrated duopolist to bid its true cost. The integrated duopolist, on the other hand, would optimally bid

$$b^{D,Post} = \frac{2}{3} - \frac{\sqrt{4 - 6c_1 + 3c_1^2}}{3}.$$

The expected price on the duopoly side is

$$E[p^{D,Post}] = \frac{11}{18} - \frac{\sqrt{3} \log(\sqrt{3} + 2)}{27} \quad (\text{or } 0.5266).$$

On the sole-served side, the sole-serving railroad learns the outcome of the duopoly side auction prior to making the TIOLI offer. The optimal TIOLI offer conditional on winning the auction is

$$p_{Win}^{M,Post} = \frac{1 + c_1 - 2c_2}{2},$$

and the optimal TIOLI offer conditional on losing the auction is

$$p_{Lose}^{M,Post} = \frac{1 - b}{2},$$

and its expected sole-served side price is

$$E[p^{M,Post}] = \frac{\sqrt{3} \log(\sqrt{3} + 2)}{36} + \frac{13}{108} \quad (\text{or } 0.1837).$$

The expected profit of the merged railroad on the duopoly side is

$$E[\pi_1^{D,Post}] = \frac{79}{1296} - \frac{\sqrt{3} \log(\sqrt{3} + 2)}{432} \quad (\text{or } 0.0557),$$

and the expected profit of the unintegrated duopolist is

$$E[\pi_2^{D,Post}] = 0.0096.$$

The expected profit of the merged railroad on the sole-served side is

$$E[\pi^{M,Post}] = \frac{\sqrt{3} \log(\sqrt{3} + 2)}{216} + \frac{47}{1296} \quad (\text{or } 0.0468),$$

and the expected joint profit of the merged railroad is therefore

$$E[\pi^{Joint,Post}] = E[\pi_1^{D,Post}] + E[\pi^{M,Post}] = \frac{\sqrt{3} \log(\sqrt{3} + 2)}{432} + \frac{7}{72} \quad (\text{or } 0.1025).$$

The expected full price is

$$E[p^{F,Post}] = E[p^{M,Post}] + E[p^{D,Post}] = \frac{79}{108} - \frac{\sqrt{3} \log(\sqrt{3} + 2)}{108} \quad (\text{or } 0.7104),$$

and expected output is

$$E[D(p^{F,Post})] = \frac{29}{108} + \frac{\sqrt{3} \log(\sqrt{3} + 2)}{108} \quad (\text{or } 0.2896).$$

Expected shipper surplus is

$$E[CS^{Post}] = \frac{7}{144} + \frac{\sqrt{3} \log(\sqrt{3} + 2)}{864} \quad (\text{or } 0.0513),$$

and expected total surplus is

$$\begin{aligned} E[TS^{Post}] &= E[CS^{Post}] + E[\pi_1^{D,Post}] + E[\pi_2^{D,Post}] + E[\pi^{M,Post}] \\ &= 0.1633. \end{aligned}$$

Case 5: 1*2 Routes, the sole-served side makes a TIOLI offer first, and then the duopoly side second price auction takes place. The winner of the duopoly side auction sets the full price equal to the sum of the sole-served railroad's TIOLI offer and the auction price.

Pre-Merger

Suppose the sole-served side TIOLI price is p^M and both railroads on the duopoly side observe this prior to bidding in the duopoly side second price auction. The winner of the auction will combine the products on the sole-served side and the duopoly side and sell it to the shipper at price $p^F = p^M + p^D$, where p^F is determined in the second price auction and p^D is simply the difference between p^F and p^M .

Given p^M , the full cost of duopolist i is $c_i + p^M$. Suppose duopolist i bid b_i in the duopoly side auction and suppose that the buyer has a reserve price of 1 in the second price auction. Then, the bidder with the lowest bid wins the auction and the winning price is

$$p^F = \min\{\max\{b_1, b_2\}, 1\}.$$

If duopolist i loses the auction, its profit is zero. If duopolist i wins the auction, i.e., $b_i < b_j$ where $j \neq i$, its profit is

$$(p^F - p^M - c_i)(1 - p^F) = (\min\{b_j, 1\} - p^M - c_i)(1 - \min\{b_j, 1\}).$$

Pre-merger, duopolist i 's bid b_i does not affect its profit conditional on winning or losing. So, following the standard second price auction logic, it is the dominant strategy for both duopolists to bid their true cost, $c_i + p^M$, and the equilibrium full price pre-merger is

$$p^{F,Pre}(p^M) = \min\{c + p^M, 1\}$$

where $c = \max\{c_1, c_2\}$.

Because the price is capped at 1, duopolist i will not participate in the auction if $c_i > 1 - p^M$, which happens with probability $1 - F(1 - p^M)$. If $c > 1 - p^M$, then there will be no sale, and the probability of this event is

$$\Pr[\text{No Sale}] = 1 - (F(1 - p^M))^2 = p^M(2 - p^M).$$

Given $p^{F,Pre}$ and p^M , the expected output is

$$\begin{aligned} & E[D(p^{F,Pre}(p^M))] \\ &= \int_0^{1-p^M} \left(\int_0^{1-p^M} (1 - p^{F,Pre}(p^M)) f(c_2) dc_2 + \int_{1-p^M}^1 (1 - 1) f(c_2) dc_2 \right) f(c_1) dc_1 \\ & \quad + \int_{1-p^M}^1 \left(\int_0^{1-p^M} (1 - 1) f(c_2) dc_2 + \int_{1-p^{M,Pre}}^1 (0) f(c_2) dc_2 \right) f(c_1) dc_1 \end{aligned}$$

$$\begin{aligned}
 &= - \int_0^{1-p^M} \left(\int_0^{1-p^M} \max\{c_1, c_2\} f(c_2) dc_2 \right) f(c_1) dc_1 + (1-p^M)(F(1-p^M))^2 \\
 &= - \int_0^{1-p^M} \left(c_1 F(c_1) + \int_{c_1}^{1-p^M} c_2 f(c_2) dc_2 \right) f(c_1) dc_1 + (1-p^M)(F(1-p^M))^2 \\
 &= \frac{1}{3}(1-p^M)^3.
 \end{aligned}$$

On the sole-served side, the sole-serving railroad chooses price p^M to maximize its expected profit, which is given by

$$\begin{aligned}
 E[\pi^{M,Pre}(p^M)] &= p^M E[D(p^{F,Pre}(p^M))] \\
 &= \frac{1}{3}p^M(1-p^M)^3 \\
 &= -\frac{1}{3}(p^M)^4 + (p^M)^3 - (p^M)^2 + \frac{1}{3}(p^M).
 \end{aligned}$$

The optimal pre-merger sole-served side price, $p^{M,Pre}$, is the solution to the following profit maximizing FOC

$$\frac{\partial E[\pi^{M,Pre}(p^M)]}{\partial p^M} = -\frac{4}{3}(p^M)^3 + 3(p^M)^2 - 2p^M + \frac{1}{3} = 0.$$

The roots to this equation are 1 and $\frac{1}{4}$. Therefore, the profit maximizing price is

$$p^{M,Pre} = \frac{1}{4} \quad (\text{or } 0.2500),$$

and the sole-serving railroad's expected profit is

$$E[\pi^{M,Pre}(p^{M,Pre})] = \frac{9}{256} \quad (\text{or } 0.0352).$$

The expected full price is

$$\begin{aligned}
 E[p^{F,Pre}] &= \int_0^{1-p^{M,Pre}} (c + p^{M,Pre})g(c) dc + \int_{1-p^{M,Pre}}^1 g(c) dc \\
 &= \int_0^{\frac{3}{4}} \left(c + \frac{1}{4}\right) 2c dc + \int_{\frac{3}{4}}^1 2c dc \\
 &= \frac{55}{64} \quad (\text{or } 0.8594),
 \end{aligned}$$

and the expected duopoly side price is

$$E[p^{D,Pre}] = E[p^{F,Pre}] - E[p^{M,Pre}] = \frac{55}{64} - \frac{1}{4} = \frac{39}{64} \quad (\text{or } 0.6094).$$

The duopolists' expected profits are given by

$$\begin{aligned}
 E[\pi_1^{D,Pre}] &= E[\pi_2^{D,Pre}] \\
 &= \int_0^{1-p^{M,Pre}} \left(\int_{c_1}^{1-p^{M,Pre}} (c_2 - c_1)(1 - p^{M,Pre} - c_2) f(c_2) dc_2 \right) f(c_1) dc_1 \\
 &= \int_0^{\frac{3}{4}} \left(-\frac{1}{6} c_1^3 + \frac{3}{8} c_1^2 - \frac{9}{32} c_1 + \frac{9}{128} \right) dc_1 \\
 &= \frac{27}{2048} \quad (\text{or } 0.0132),
 \end{aligned}$$

and the expected joint profit of the sole-served and the integrating duopolist is

$$\begin{aligned}
 E[\pi^{Joint,Pre}] &= E[\pi^{M,Pre}] + E[\pi_1^{D,Pre}] \\
 &= \frac{9}{256} + \frac{27}{2048} = \frac{99}{2048} \quad (\text{or } 0.0483).
 \end{aligned}$$

Expected output is

$$\begin{aligned}
 E[D(p^{F,Pre})] &= \frac{1}{3} (1 - p^{M,Pre})^3 \\
 &= \frac{9}{64} \quad (\text{or } 0.1406).
 \end{aligned}$$

Expected shipper surplus is

$$\begin{aligned}
 E[CS^{Pre}] &= \int_0^{1-p^{M,Pre}} \left(\frac{1}{2} \right) (1 - c - p^{M,Pre})^2 g(c) dc \\
 &= \frac{1}{2} \int_0^{\frac{3}{4}} \left(\frac{3}{4} - c \right)^2 2c dc \\
 &= \int_0^{3/4} \left(c^3 - \frac{3}{2} c^2 + \frac{9}{16} c \right) dc \\
 &= \frac{9}{32} \left(\frac{3}{4} \right)^2 - \frac{1}{2} \left(\frac{3}{4} \right)^3 + \frac{1}{4} \left(\frac{3}{4} \right)^4 \\
 &= \frac{27}{1024} \quad (\text{or } 0.0264),
 \end{aligned}$$

and expected total surplus is

$$\begin{aligned}
 E[TS^{Pre}] &= E[CS^{Pre}] + E[\pi_1^{D,Pre}] + E[\pi_2^{D,Pre}] + E[\pi^{M,Pre}] \\
 &= \frac{27}{1024} + \frac{27}{2048} + \frac{27}{2048} + \frac{9}{256} \\
 &= \frac{45}{512} \quad (\text{or } 0.0879).
 \end{aligned}$$

Post-Merger

Let p^M be the price on the sole-served side and let b_1 be the bid submitted by the integrated duopolist. First, note that it is still the dominant strategy for the unintegrated duopolist to bid its true cost, $c_2 + p^M$. Second, it is never optimal for the integrated duopolist to bid $b_1 > 1$ as that would guarantee that it loses the auction, and so we can assume $b_1 \leq 1$. Finally, since the profit on the sole-served side is now part of the merged railroad's joint profit, the true cost of the integrated duopolist is c_1 and not $c_1 + p^M$. This means that the integrated duopolist will always participate in the duopoly side auction.

The sole-served railroad learns the realization of the integrated duopolist, c_1 , prior to making the TIOLI offer p^M . However, it does not observe the outcome of the duopoly side auction.

Therefore, the merged firm chooses the sole-served side price p^M and the duopoly side bid b_1 to maximize the expected joint profit of the merged railroad, conditional on c_1 .

If $c_2 \leq 1 - p^M$, then the unintegrated duopolist would participate in the auction. The joint profit of the merged railroad when the integrated duopolist wins the auction is

$$\begin{aligned}\pi_{Win}^{Post}(p^M) &= (\min\{c_2 + p^M, 1\} - c_1)(1 - \min\{c_2 + p^M, 1\}) \\ &= (p^M + c_2 - c_1)(1 - p^M - c_2).\end{aligned}$$

If the integrated duopolist loses the auction, then the joint profit of the merged railroad is

$$\pi_{Lose}^{Post}(p^M, b_1) = p^M(1 - b_1).$$

If $c_2 > 1 - p^M$, then the unintegrated duopolist does not participate in the auction and the integrated duopolist always wins and $p^F = 1$. In this case, the joint profit of the merged railroad is

$$\pi_{Win}^{Post}(p^M) = (1 - c_1)(1 - 1) = 0.$$

The expected joint profit of the merged railroad, conditional on c_1 , is given by

$$\begin{aligned}& E[\pi^{Joint, Post}(p^M, b_1) | c_1] \\ &= \Pr[c_2 < b_1 - p^M] \pi_{Lose}^{Post}(p^M, b_1) \\ &\quad + \Pr[b_1 - p^M \leq c_2 \leq 1 - p^M] E[\pi_{Win}^{Post}(p^M) | c_1, b_1 - p^M \leq c_2 \leq 1 - p^M] \\ &= (b_1 - p^M)p^M(1 - b_1) + \int_{b_1 - p^M}^{1 - p^M} (p^M + c_2 - c_1)(1 - p^M - c_2) dc_2 \\ &= (b_1 - p^M)p^M(1 - b_1) + \frac{1}{6}(b_1 - 1)^2(2b_1 - 3c_1 + 1)\end{aligned}$$

and the profit maximizing FOCs with respect to p^M and b_1 are

$$\frac{\partial E[\pi^{Joint,Post}(p^M, b_1) | c_1]}{\partial p^M} = p^M(2b_1 - 2) - b_1^2 + b_1 = 0,$$

and

$$\frac{\partial E[\pi^{Joint,Post}(p^M, b_1) | c_1]}{\partial b_1} = b_1^2 - (1 + 2p^M + c_1)b_1 + (p^M)^2 + p^M + c_1 = 0.$$

The solutions to this system of equations are

$$(p^M, b_1) = (1,1), (0,1), \text{ and } \left(c_1 + \frac{1}{2} - \frac{\sqrt{4c_1^2 + 1}}{2}, 2 \left(c_1 + \frac{1}{2} - \frac{\sqrt{4c_1^2 + 1}}{2} \right) \right).$$

Note that $(p, b) = (1,1)$ and $(p, b) = (0,1)$ guarantee a profit of 0 and therefore cannot be the optimal solution. Also, note that $c_1 + \frac{1}{2} - \frac{1}{2}\sqrt{4c_1^2 + 1}$ is increasing in c_1 and it is equal to $\frac{3}{2} - \frac{\sqrt{5}}{2} = 0.3820$ when $c_1 = 1$.

The optimal solution to the merged railroad's joint profit maximization problem is therefore

$$p^{M,Post} = c_1 + \frac{1}{2} - \frac{\sqrt{4c_1^2 + 1}}{2} \quad \text{and} \quad b^{D,Post} = 2 \left(c_1 + \frac{1}{2} - \frac{\sqrt{4c_1^2 + 1}}{2} \right),$$

and the expected joint profit of the merged railroad is

$$\begin{aligned} E[\pi^{Joint,Post}(p^{M,Post}, b^{D,Post})] &= \int_0^1 E[\pi^{Joint,Post}(p^{M,Post}, b^{D,Post}) | c_1] f(c_1) dc_1 \\ &= \int_0^1 \left(2c_1^2 \frac{\sqrt{4c_1^2 + 1}}{3} - \frac{1}{2}c_1 - \frac{4}{3}c_1^3 + \frac{\sqrt{4c_1^2 + 1}}{6} \right) dc_1 \\ &= \frac{\log(\sqrt{5} + 2)}{32} + \frac{13\sqrt{5}}{48} - \frac{7}{12} \quad (\text{or } 0.0674). \end{aligned}$$

The expected profit of the merged railroad on the duopoly side is

$$\begin{aligned} E[\pi_1^{D,Post}] &= \int_0^1 \left(\int_{b^{D,Post}-p^{M,Post}}^{1-p^{M,Post}} (c_2 - c_1) (1 - p^{M,Post} - c_2) f(c_2) dc_2 \right) f(c_1) dc_1 \\ &= \int_0^1 \left(-\frac{4}{3}c_1^3 + \left(\frac{2\sqrt{4c_1^2 + 1}}{3} + 2 \right) c_1^2 - \left(\sqrt{4c_1^2 + 1} \right) c_1 - \frac{\sqrt{4c_1^2 + 1}}{12} + \frac{1}{4} \right) dc_1 \\ &= \frac{2}{3} - \frac{13\sqrt{5}}{48} - \frac{\log(\sqrt{5} + 2)}{32} \quad (\text{or } 0.0160). \end{aligned}$$

The expected profit of the merged railroad on the sole-served side is

$$\begin{aligned} E[\pi^{M,Post}] &= E[\pi^{Joint,Post}] - E[\pi_1^{D,Post}] \\ &= \frac{\log(\sqrt{5} + 2)}{16} + \frac{13\sqrt{5}}{24} - \frac{5}{4} \quad (\text{or } 0.0514), \end{aligned}$$

and the expected profit of the unintegrated duopolist is

$$\begin{aligned} E[\pi_2^{D,Post}] &= \int_0^1 \left(\int_0^{b^{D,Post} - p^{M,Post}} (b^{D,Post} - c_2 - p^{M,Post}) (1 - b^{D,Post}) f(c_2) dc_2 \right) f(c_1) dc_1 \\ &= \int_0^1 \left(-\frac{1}{8} \left(2c_1 - \sqrt{4c_1^2 + 1} \right) \left(2c_1 + 1 - \sqrt{4c_1^2 + 1} \right)^2 \right) f(c_1) dc_1 \\ &= \frac{\log(\sqrt{5} + 2)}{32} + \frac{53\sqrt{5}}{48} - \frac{5}{2} \quad (\text{or } 0.0141). \end{aligned}$$

The expected sole-served side price is

$$\begin{aligned} E[p^{M,Post}] &= \int_0^1 \left(c_1 + \frac{1}{2} - \frac{\sqrt{4c_1^2 + 1}}{2} \right) f(c_1) dc_1 \\ &= 1 - \frac{\sqrt{5}}{4} - \frac{\log(\sqrt{5} + 2)}{8} \quad (\text{or } 0.2605), \end{aligned}$$

and the expected full price is

$$\begin{aligned} E[p^{F,Post}] &= \int_0^1 \left(\int_0^{b^{D,Post} - p^{M,Post}} b^{D,Post} f(c_2) dc_2 + \int_{b^{D,Post} - p^{M,Post}}^{1 - p^{M,Post}} (c_2 + p^{M,Post}) f(c_2) dc_2 \right. \\ &\quad \left. + \int_{1 - p^{M,Post}}^1 f(c_2) dc_2 \right) f(c_1) dc_1 \\ &= \int_0^1 \left(c_1 + 1 - \frac{\sqrt{4c_1^2 + 1}}{2} \right) f(c_1) dc_1 \\ &= \frac{3}{2} - \frac{\sqrt{5}}{4} - \frac{\log(\sqrt{5} + 2)}{8} \quad (\text{or } 0.7605). \end{aligned}$$

The expected duopoly side price is therefore

$$E[p^{D,Post}] = E[p^{F,Post}] - E[p^{M,Post}] = \frac{1}{2} \quad (\text{or } 0.5000),$$

and expected output is

$$\begin{aligned}
 E[D(p^{F,Post})] &= \int_0^1 \left(\int_0^{b^{D,Post}-p^{M,Post}} (1 - b^{D,Post}) f(c_2) dc_2 \right. \\
 &\quad \left. + \int_{b^{D,Post}-p^{M,Post}}^{1-p^{M,Post}} (1 - c_2 - p^{M,Post}) f(c_2) dc_2 \right) f(c_1) dc_1 \\
 &= \int_0^1 \left(\frac{\sqrt{4c_1^2 + 1}}{2} - c_1 \right) f(c_1) dc_1 \\
 &= \frac{\log(\sqrt{5} + 2)}{8} + \frac{\sqrt{5}}{4} - \frac{1}{2} \quad (\text{or } 0.2395).
 \end{aligned}$$

Expected shipper surplus is

$$\begin{aligned}
 E[CS^{Post}] &= \frac{1}{2} \int_0^1 \left(\int_0^{b^{D,Post}-p^{M,Post}} (1 - b^{D,Post})^2 f(c_2) dc_2 \right. \\
 &\quad \left. + \int_{b^{D,Post}-p^{M,Post}}^{1-p^{M,Post}} (1 - c_2 - p^{M,Post})^2 f(c_2) dc_2 \right) f(c_1) dc_1 \\
 &= \frac{23}{12} - \frac{5\sqrt{5}}{6} \quad (\text{or } 0.0533),
 \end{aligned}$$

and expected total surplus is

$$\begin{aligned}
 E[TS^{Post}] &= E[CS^{Post}] + E[\pi_1^{D,Post}] + E[\pi_2^{D,Post}] + E[\pi^{M,Post}] \\
 &= \frac{\log(\sqrt{5} + 2)}{16} + \frac{13\sqrt{5}}{24} - \frac{7}{6} \quad (\text{or } 0.1348).
 \end{aligned}$$

Case 6: 1*2 Routes, the sole-served side makes a TIOLI offer first, and then the duopoly side second price auction takes place. The winner of the duopoly side auction sets the full price equal to the sum of the sole-serving railroad's TIOLI offer and the auction price. The shipper has perfectly inelastic demand.

Pre-Merger

Suppose the sole-served side TIOLI price is p^M and both railroads on the duopoly side observe this prior to bidding in the duopoly side second price auction. The winner of the auction will combine the products on the monopoly side and the duopoly side and sell it to the shipper at price $p^F = p^M + p^D$, where p^F is determined in the second price auction and p^D is simply the difference between p^F and p^M .

Given p^M , the full cost of duopolist i is $c_i + p^M$. Suppose duopolist i bid b_i in the duopoly side auction and suppose that the buyer has a reserve price of 1 in the second price auction. Then, the bidder with the lowest bid wins the auction and the winning price is

$$p^F = \min\{\max\{b_1, b_2\}, 1\}.$$

If duopolist i loses the auction, its profit is zero. If duopolist i wins the auction, i.e., $b_i < b_j$ where $j \neq i$, its profit is

$$(p^F - p^M - c_i) = (\min\{b_j, 1\} - p^M - c_i).$$

Pre-merger, duopolist i 's bid, b_i , does not affect its profit conditional on winning or losing. So, following the standard second price auction logic, it is the dominant strategy for both duopolists to bid their true cost, $c_i + p^M$, and the equilibrium full price pre-merger is

$$p^{F,Pre}(p^M) = \min\{c + p^M, 1\}$$

where $c = \max\{c_1, c_2\}$.

Because the price is capped at 1, duopolist i will not participate in the auction if $c_i > 1 - p^M$, which happens with probability $1 - F(1 - p^M)$. If $\min\{c_1, c_2\} > 1 - p^M$, then there will be no sale and the probability of this event is

$$\Pr[\text{No Sale}] = (1 - F(1 - p^M))^2 = (p^M)^2.$$

Given $p^{F,Pre}$ and p^M , the expected output is

$$E[D(p^{F,Pre}(p^M))] = 1 - \Pr[\text{No Sale}] = 1 - (p^M)^2.$$

On the sole-served side, the sole-serving railroad chooses price p^M to maximize its expected profit, which is given by

$$E[\pi^{M,Pre}(p^M)] = p^M(1 - (p^M)^2)$$

$$= -(p^M)^3 + p^M.$$

The optimal pre-merger sole-served side price, $p^{M,Pre}$, is the solution to the following profit maximizing FOC

$$\frac{\partial E[\pi^{M,Pre}(p^M)]}{\partial p^M} = -3(p^M)^2 + 1 = 0.$$

The roots to this equation are $-\frac{1}{\sqrt{3}}$ and $\frac{1}{\sqrt{3}}$. Therefore, the profit maximizing price is

$$p^{M,Pre} = \frac{1}{\sqrt{3}} \quad (\text{or } 0.5574),$$

and the sole-served railroad's expected profit is

$$E[\pi^{M,Pre}(p^{M,Pre})] = \frac{2\sqrt{3}}{9} \quad (\text{or } 0.3849).$$

The expected full price is

$$\begin{aligned} E[p^{F,Pre}] &= \int_0^{1-p^{M,Pre}} (c + p^{M,Pre})g(c) dc + \int_{1-p^{M,Pre}}^1 g(c) dc \\ &= \int_0^{1-\frac{1}{\sqrt{3}}} \left(c + \frac{1}{\sqrt{3}}\right) 2c dc + \int_{1-\frac{1}{\sqrt{3}}}^1 2c dc \\ &= \frac{1}{3} + \frac{10\sqrt{3}}{27} \quad (\text{or } 0.9748), \end{aligned}$$

and the expected duopoly side price is

$$E[p^{D,Pre}] = E[p^{F,Pre}] - E[p^{M,Pre}] = \frac{1}{3} + \frac{\sqrt{3}}{27} \quad (\text{or } 0.3975).$$

The duopolists' expected profits are given by

$$\begin{aligned} E[\pi_1^{D,Pre}] &= E[\pi_2^{D,Pre}] \\ &= \int_0^{1-p^{M,Pre}} \left(\int_{c_1}^{1-p^{M,Pre}} (c_2 - c_1) f(c_2) dc_2 \right. \\ &\quad \left. + \int_{1-p^{M,Pre}}^1 (1 - p^{M,Pre} - c_1) f(c_2) dc_2 \right) f(c_1) dc_1 \\ &= \int_0^{1-\frac{1}{\sqrt{3}}} \left(\frac{1}{2} c_1^2 - c_1 + \frac{1}{3} \right) dc_1 \\ &= \frac{\sqrt{3}}{27} \quad (\text{or } 0.0642), \end{aligned}$$

and the expected joint profit of the sole-served railroad and the integrating duopolist is

$$\begin{aligned} E[\pi^{Joint,Pre}] &= E[\pi^{M,Pre}] + E[\pi_1^{D,Pre}] \\ &= \frac{2\sqrt{3}}{9} + \frac{\sqrt{3}}{27} = \frac{7\sqrt{3}}{27} \quad (\text{or } 0.4491). \end{aligned}$$

Expected output is

$$\begin{aligned} E[D(p^{F,Pre})] &= 1 - (p^{M,Pre})^2 \\ &= \frac{2}{3} \quad (\text{or } 0.6667). \end{aligned}$$

Expected shipper surplus is

$$\begin{aligned} E[CS^{Pre}] &= \int_0^{1-p^{M,Pre}} (1-c-p^{M,Pre})g(c) dc \\ &= \int_0^{1-\frac{1}{\sqrt{3}}} \left(1-c-\frac{1}{\sqrt{3}}\right) 2c dc \\ &= \frac{2}{3} - \frac{10\sqrt{3}}{27} \quad (\text{or } 0.0252), \end{aligned}$$

and expected total surplus is

$$\begin{aligned} E[TS^{Pre}] &= E[CS^{Pre}] + E[\pi_1^{D,Pre}] + E[\pi_2^{D,Pre}] + E[\pi^{M,Pre}] \\ &= \frac{2}{3} - \frac{10\sqrt{3}}{27} + \frac{\sqrt{3}}{27} + \frac{\sqrt{3}}{27} + \frac{2\sqrt{3}}{9} \\ &= \frac{2}{3} - \frac{2\sqrt{3}}{27} \quad (\text{or } 0.5384). \end{aligned}$$

Post-Merger

Let p^M be the price on the sole-served side and let b_1 be the bid submitted by the integrated duopolist. First, note that it is still the dominant strategy for the unintegrated duopolist to bid its true cost, $c_2 + p^M$. Second, it is never optimal for the integrated duopolist to bid $b_1 > 1$ as that would guarantee that it loses the auction, and so we can assume $b_1 \leq 1$. Finally, since the profit on the sole-served side is now part of the merged railroad's joint profit, the true cost of the integrated duopolist is c_1 and not $c_1 + p^M$. This means that the integrated duopolist will always participate in the duopoly side auction.

The sole-served railroad learns the realization of the integrated duopolist, c_1 , prior to making the TIOLI offer p^M . However, it does not observe the outcome of the duopoly side auction.

Therefore, the merged railroad chooses the sole-served side price p^M and the duopoly side bid b_1 to maximize the expected joint profit of the merged railroad, conditional on c_1 .

Suppose $c_1 > 1 - p^M$:

If $c_2 \leq 1 - p^M$, then the unintegrated duopolist would participate in the auction. The joint profit of the merged railroad when the integrated duopolist wins the auction is

$$\pi_{Win}^{Post}(p^M) = \min\{c_2 + p^M, 1\} - c_1 = p^M + c_2 - c_1.$$

If the integrated duopolist loses the auction, then the joint profit of the merged railroad is

$$\pi_{Lose}^{Post}(p^M) = p^M > 1 - c_1.$$

Note that in this case

$$\pi_{Win}^{Post}(p^M) = p^M + c_2 - c_1 < p^M + (1 - p^M) - (1 - p^M) = p^M = \pi_{Lose}^{Post}(p^M)$$

which means that the integrated duopolist would be better off losing the auction.

If $c_2 > 1 - p^M$, then the unintegrated duopolist does not participate in the auction and the integrated duopolist always wins and $p^F = 1$. In this case, the joint profit of the merged railroad is

$$\pi_{Win}^{Post}(p^M) = 1 - c_1,$$

which does not depend on b_1 .

Therefore, the optimal bid for the integrated duopolist when $c_1 > 1 - p^M$ is

$$b_1 = 1,$$

which guarantees that it would lose the auction if the unintegrated duopolist participates in the auction and win the auction if the unintegrated duopolist does not participate.

The expected joint profit of the merged railroad, conditional on $c_1 > 1 - p^M$, is then

$$\begin{aligned} & E[\pi^{Joint,Post}(p^M, b_1) \mid c_1 > 1 - p^M] \\ &= \Pr[c_2 \leq 1 - p^M] \pi_{Lose}^{Post}(p^M) + \Pr[c_2 > 1 - p^M] \pi_{Win}^{Post}(p^M) \\ &= (1 - p^M)p^M + p^M(1 - c_1), \end{aligned}$$

and the profit maximizing FOC with respect to p^M is

$$\frac{\partial E[\pi^{Joint,Post}(p^M, b_1) \mid c_1 > 1 - p^M]}{\partial p^M} = 2 - 2p^M - c_1 = 0,$$

which gives the optimal sole-served side price

$$p^M = 1 - \frac{1}{2}c_1.$$

Suppose now $c_1 \leq 1 - p^M$:

If $c_2 \leq 1 - p^M$, then the unintegrated duopolist participates in the auction. The joint profit of the merged railroad when the integrated duopolist wins the auction is

$$\pi_{Win}^{Post}(p^M) = p^M + c_2 - c_1 \leq p^M + (1 - p^M) - c_1 = 1 - c_1.$$

and the joint profit of the merged railroad when it loses the auction is

$$\pi_{Lose}^{Post}(p^M) = p^M \leq 1 - c_1.$$

If $c_2 > 1 - p^M$, then the unintegrated duopolist does not participate in the auction and the joint profit of the merged railroad is

$$\pi_{Win}^{Post}(p^M) = 1 - c_1.$$

This implies that the merged railroad profit is at most $1 - c_1$ when $c_1 \leq 1 - p^M$. However, as shown above, if the merged railroad chooses p^M such that $c_1 > 1 - p^M$, it earns a profit of $1 - c_1$ when the unintegrated duopolist does not participate in the auction and $p^M > 1 - c_1$ when it does. Therefore, the merged railroad would never choose p^M such that $c_1 \leq 1 - p^M$.

The optimal solution to the merged railroad's joint profit maximization problem is therefore

$$p^{M,Post} = 1 - \frac{1}{2}c_1 \quad \text{and} \quad b^{D,Post} = 1,$$

and the expected joint profit of the merged railroad is

$$\begin{aligned} E[\pi^{Joint,Post}(p^{M,Post}, b^{D,Post})] &= \int_0^1 E[\pi^{Joint,Post}(p^{M,Post}, b^{D,Post}) | c_1] f(c_1) dc_1 \\ &= \int_0^1 ((1 - p^{M,Post})p^{M,Post} + p^{M,Post}(1 - c_1)) dc_1 \\ &= \int_0^1 \left(\frac{1}{4}c_1^2 - c_1 + 1\right) dc_1 \\ &= \frac{7}{12} \quad (\text{or } 0.5833). \end{aligned}$$

The expected profit of the merged railroad on the duopoly side is

$$\begin{aligned} E[\pi_1^{D,Post}] &= \int_0^1 \left(\int_{1-p^{M,Post}}^1 (1 - p^{M,Post} - c_1) f(c_2) dc_2 \right) f(c_1) dc_1 \\ &= \int_0^1 \left(\frac{1}{4}c_1^2 - \frac{1}{2}c_1 \right) dc_1 \\ &= -\frac{1}{6} \quad (\text{or } -0.1667), \end{aligned}$$

the expected profit of the merged railroad on the sole-served side is

$$\begin{aligned} E[\pi^{M,Post}] &= E[\pi^{Joint,Post}] - E[\pi_1^{D,Post}] \\ &= \frac{7}{12} - \left(-\frac{1}{6}\right) = \frac{3}{4} \quad (\text{or } 0.7500), \end{aligned}$$

and the expected profit of the unintegrated duopolist is

$$\begin{aligned} E[\pi_2^{D,Post}] &= \int_0^1 \left(\int_0^{1-p^{M,Post}} (b^{D,Post} - p^{M,Post} - c_2) f(c_2) dc_2 \right) f(c_1) dc_1 \\ &= \int_0^1 \left(\int_0^{\frac{1}{2}c_1} \left(\frac{1}{2}c_1 - c_2 \right) dc_2 \right) dc_1 \\ &= \int_0^1 \left(\frac{1}{8}c_1^2 \right) dc_1 \\ &= \frac{1}{24} \quad (\text{or } 0.0417). \end{aligned}$$

The expected sole-served side price is

$$\begin{aligned} E[p^{M,Post}] &= \int_0^1 \left(1 - \frac{1}{2}c_1 \right) f(c_1) dc_1 \\ &= \frac{3}{4} \quad (\text{or } 0.7500), \end{aligned}$$

and expected full price is

$$\begin{aligned} E[p^{F,Post}] &= \int_0^1 (\Pr[c_2 \leq 1 - p^{M,Post}] b^{D,Post} + \Pr[c_2 > 1 - p^{M,Post}] 1) f(c_1) dc_1. \\ &= 1 \end{aligned}$$

The expected duopoly side price is therefore

$$E[p^{D,Post}] = E[p^{F,Post}] - E[p^{M,Post}] = 1 - \frac{3}{4} = \frac{1}{4} \quad (\text{or } 0.2500),$$

and expected output is

$$E[D(p^{F,Post})] = 1.$$

Expected shipper surplus is

$$E[CS^{Post}] = 0,$$

and expected total surplus is

$$\begin{aligned}
 E[TS^{Post}] &= E[CS^{Post}] + E[\pi_1^{D,Post}] + E[\pi_2^{D,Post}] + E[\pi^{M,Post}] \\
 &= \frac{5}{8} \quad (\text{or } 0.6250).
 \end{aligned}$$

APPENDIX C: COMMITTED GATEWAY PRICING SIMULATION MODEL

I. OVERVIEW

1. This appendix describes the model that I have developed to simulate the shipper-welfare effects of the parties' Committed Gateway Pricing ("CGP") proposal.¹ Throughout this appendix, I use the term "input set" to describe the set of routes where the shipments and their associated rates will be used as inputs in calculating the CGP tables. Similarly, I use the term "application set" to describe the set of routes that are eligible to utilize the CGP.
2. Broadly speaking, the parties' CGP proposal creates two CGP tables—one for CSX and one for BNSF.² Each table consists of 92 cells, based on 23 commodity categories and 4 distance bands.
3. The shipments in the input sets for each table are mutually exclusive of the shipments in the application sets. The input sets for the CSX CGP table includes all UP-NS and legacy UP-CSX interline shipments, except for legacy UP-CSX interline shipments on routes that are sole-served by UP on one end and sole-served by CSX on the other end. The rates derived from these input sets will be utilized to establish Committed Gateway Prices that CSX can apply to shipments on sole-served to sole-served UP-CSX interline routes across the gateways.³
4. Similarly, the input sets for the BNSF CGP table includes all UP-NS and legacy NS-BNSF interline shipments, except for legacy NS-BNSF interline shipments on routes that

¹ See Verified Statement of Katherine R. Novak (hereinafter "Novak V.S."), including Appendix A, for the authoritative description of the CGP proposal.

² The CGP will apply to shipments between customer facilities served solely by UP/NS or a short line interchanging traffic solely with UP/NS, on the one hand, and customer facilities served solely by BNSF or CSX or a short line interchanging traffic solely with BNSF or CSX, on the other hand. See Novak V.S., Appendix A.

³ Certain types of shipments are ineligible for the CGP proposal. These include shipments to or from facilities owned by rail carriers or their affiliates, shipments to and from storage-in transit facilities, finished vehicle shipments, intermodal shipments, unit train shipments, Toxic Inhalation Hazard and Poison Inhalation Hazard materials shipments, and Dimensional Loads. See Novak V.S., Appendix A.

are sole-served by NS and BNSF. The rates derived from these input sets will be utilized to establish the Committed Gateway Prices that BNSF can apply to shipments on the set of sole-served to sole-served interline routes.

5. To estimate the welfare effects of the parties' CGP proposal on shippers, I use a simulation model in which different railroads set rates to maximize their profits given a shipper's choices of shipment routes and railroads. I calibrate the parameters of the model using shipment data, railroads' margins, based on a set of optimality equations implied by the pre-merger equilibrium of the model.
6. Once the model parameters are calibrated, I first use the model to simulate a post-merger equilibrium without the CGP proposal, in which UP and NS set rates as a single entity to maximize their joint profit and eliminate any double marginalization that existed pre-merger. Then, I use the model to simulate the post-merger equilibrium of interest, in which the CGP proposal would create incentives for UP/NS to adjust rates *both* upward and downward in the input sets, but it would only create incentive to lower rates in the application sets. Compared to the post-merger equilibrium without the CGP proposal, the CGP proposal will generally result in higher rates on average in the input set but lower rates in the application set. I use the model to estimate changes in consumer surplus for each shipper going from the equilibrium without CGP to the equilibrium with CGP in both the input and application sets. The overall welfare effects of the CGP proposal can then be calculated by comparing the corresponding changes in shippers' consumer surplus in the input and application sets.
7. I perform the simulation separately for cells in the CSX CGP table and the BNSF CGP table. The welfare effects are simulated for a total of 140 CGP cells, for which I have sufficient data to calibrate the model and perform the simulation.⁴

⁴ The 140 CGP cells for which I perform this welfare effect simulation include 98.9 percent of carloads that could potentially be affected by the CGP proposal. I do not perform the simulation for the remaining 44 CGP cells ($92 \times 2 - 140$) either because the data identifies no eligible shipment in those cells or because the information on shipment rates and/or mileages is missing for a large fraction of shipments in those cells.

8. I find that the CGP proposal will improve overall shippers' welfare in 111 of these 140 CGP cells and that it has no effect on shippers' welfare in 15 CGP cells.⁵ In aggregate, I estimate that the CGP proposal will increase total shippers' consumer surplus by \$29 million per year.

II. TECHNICAL MODEL

A. PRE-MERGER EQUILIBRIUM

1. Input Set

9. Consider an input set with N^I shippers, whose shipments' origins and destinations are operated by two different railroads, railroads r and s , where $r \in \{UP, NS\}$, $s \in \{NS, CSX\}$ if $r = UP$, and $s \in \{UP, BNSF\}$ if $r = NS$. For each shipper $i = 1, \dots, N^I$, let $d_i^I = d_{i,r}^I + d_{i,s}^I$ denote the total mileage of shipper i 's chosen shipment route, where $d_{i,j}^I$ is the mileage of the segment operated by railroad $j \in \{r, s\}$. In this model, each shipper's choice of route and contracting arrangement are treated as exogenously given and I focus on modeling the railroads' pricing incentives after these choices have been made.⁶
10. Shipper i has demand function $q_i^I(p_i^I)$, where p_i^I is the rate per car-mile faced by shipper i , and $q_i^I(p_i^I)$ is the number of carloads associated with shipper i 's shipment given rate p_i^I . I assume that $q_i^I(p_i^I)$ is log-linear in the product of d_i^I and p_i^I :

$$q_i^I(p_i^I) = \exp(a_i^I - b_i^I d_i^I p_i^I)$$

where $a_i^I, b_i^I > 0$. Furthermore, I assume that railroad $j \in \{r, s\}$ has constant marginal cost, $c_{i,j}^I$, of serving shipper i .

⁵ In these 15 CGP cells, UP/NS is already setting rates that are lower than the CGP rate for all shippers in the application sets. Therefore, the CGP proposal does not create any incentive for UP/NS to adjust rates upward in the input sets.

⁶ Routings under the CGP will follow existing routing protocols, so the routes can be treated as fixed for purposes of the model.

11. For any shipment that has origin and destination operated by two different railroads, the rate per car-mile faced by shipper i , p_i^l , can be expressed as the mileage-weighted average of the rates set by railroads r and s . That is,

$$p_i^l = p_i^l(p_{i,r}^l, p_{i,s}^l) \equiv \frac{d_{i,r}^l}{d_i^l} p_{i,r}^l + \frac{d_{i,s}^l}{d_i^l} p_{i,s}^l,$$

where $p_{i,j}^l$ is the rate per car-mile for the segment of the shipment route operated by railroad $j \in \{r, s\}$.

12. Pre-merger, given the demand parameters (a_i^l, b_i^l) and marginal costs $(c_{i,r}^l, c_{i,s}^l)$, which I assume are common knowledge, railroads r and s choose rates $p_{i,r}^l$ and $p_{i,s}^l$ to maximize their profit functions $\pi_{i,r}^l(p_{i,r}^l, p_{i,s}^l)$ and $\pi_{i,s}^l(p_{i,r}^l, p_{i,s}^l)$, respectively. The functional forms of railroads' profits generally depend on whether shipper i chooses to (i) negotiate with one of the two railroads to obtain a through rate for its shipment, or (ii) negotiate with both railroads separately and obtain two separate rates for the two segments of its shipment route using Rule 11. However, as I show below, under the assumption of log-linear demand and the assumption that all negotiations take the form of railroads making linear take-it-or-leave-it offers to the shipper i , the functional forms of railroad profits and their optimal rates do not vary between through rate and Rule 11 negotiations, which greatly simplifies the computation of the model.⁷

(a) *Shipper negotiates a through rate with railroad r*

13. First, I consider the case in which shipper i chooses to negotiate with railroad r to obtain a through rate for its entire shipment route. In this case, railroad r must obtain the rate $p_{i,s}^l$ per car-mile from railroad s for the segment of the shipment route that it operates. Given $p_{i,s}^l$, railroad r chooses $p_{i,r}^l$ to maximize its profit function, which is given by

$$\pi_{i,r}^l(p_{i,r}^l, p_{i,s}^l) = q_i^l \left(p_i^l(p_{i,r}^l, p_{i,s}^l) \right) d_i^l \left(p_i^l(p_{i,r}^l, p_{i,s}^l) - \frac{d_{i,r}^l}{d_i^l} c_{i,r}^l - \frac{d_{i,s}^l}{d_i^l} p_{i,s}^l \right)$$

⁷

This is consistent with the results on Rule 11 and through rates I report in Section III.

$$= q_i^l \left(\frac{d_{i,r}^l}{d_i^l} p_{i,r}^l + \frac{d_{i,s}^l}{d_i^l} p_{i,s}^l \right) d_{i,r}^l (p_{i,r}^l - c_{i,r}^l).$$

14. The first order condition for profit maximization is

$$\frac{\partial \pi_{i,r}^l(p_{i,r}^l, p_{i,s}^l)}{\partial p_{i,r}^l} = \frac{\partial q_i^l(p_i^l)}{\partial p_i^l} \frac{\partial p_i^l(p_{i,r}^l, p_{i,s}^l)}{\partial p_{i,r}^l} d_{i,r}^l (p_{i,r}^l - c_{i,r}^l) + q_i^l(p_i^l) d_{i,r}^l = 0$$

and railroad r 's best response function, given $p_{i,s}^l$ and the log-linear demand assumption, is

$$p_{i,r}^l(p_{i,s}^l) = c_{i,r}^l + \frac{1}{b_i^l d_{i,r}^l}.$$

Note that this best response function does not depend on $p_{i,s}^l$, and therefore the optimal rate for railroad r is

$$p_{i,r}^{l*} = c_{i,r}^l + \frac{1}{b_i^l d_{i,r}^l}.$$

15. Given railroad r 's best response function $p_{i,r}^l(p_{i,s}^l)$, railroad s chooses $p_{i,s}^l$ to maximize its profit function, which is

$$\pi_{i,s}^l(p_{i,r}^l(p_{i,s}^l), p_{i,s}^l) = q_i^l \left(p_i^l(p_{i,r}^l(p_{i,s}^l), p_{i,s}^l) \right) d_{i,s}^l (p_{i,s}^l - c_{i,s}^l).$$

The first order condition for profit maximization is

$$\begin{aligned} \frac{d\pi_{i,s}^l(p_{i,r}^l(p_{i,s}^l), p_{i,s}^l)}{dp_{i,s}^l} &= \frac{\partial q_i^l(p_i^l)}{\partial p_i^l} \frac{d \left(p_i^l(p_{i,r}^l(p_{i,s}^l), p_{i,s}^l) \right)}{dp_{i,s}^l} d_{i,s}^l (p_{i,s}^l - c_{i,s}^l) + q_i^l(p_i^l) d_{i,s}^l \\ &= 0 \end{aligned}$$

and the optimal rate for railroad s , $p_{i,s}^{l*}$, is

$$p_{i,s}^{l*} = c_{i,s}^l + \frac{1}{b_i^l d_{i,s}^l}.$$

(b) Shipper negotiates a through rate with railroad s

16. Next, I consider the case in which shipper i chooses to negotiate a through rate with railroad s , who must first obtain the rate of $p_{i,r}^l$ per car-mile from railroad r for the segment of the shipment route that it operates.

17. This case is symmetrical to the previous case, where railroad r determines the through rate. The profit functions of railroads r and s are

$$\pi_{i,r}^l(p_{i,r}^l, p_{i,s}^l(p_{i,r}^l)) = q_i^l(p_i^l(p_{i,r}^l, p_{i,s}^l(p_{i,r}^l))) d_{i,r}^l(p_{i,r}^l - c_{i,r}^l)$$

and

$$\pi_{i,s}^l(p_{i,r}^l, p_{i,s}^l) = q_i^l\left(\frac{d_{i,r}^l}{d_i^l} p_{i,r}^l + \frac{d_{i,s}^l}{d_i^l} p_{i,s}^l\right) d_{i,s}^l(p_{i,s}^l - c_{i,s}^l),$$

respectively, where $p_{i,s}^l(p_{i,r}^l)$ is railroad s 's best response function given $p_{i,r}^l$.

18. Under the log-linear demand assumption, the profit maximizing rates are

$$p_{i,r}^{l*} = c_{i,r}^l + \frac{1}{b_i^l d_{i,r}^l} \quad \text{and} \quad p_{i,s}^{l*} = c_{i,s}^l + \frac{1}{b_i^l d_{i,s}^l}.$$

(c) Shipper uses Rule 11

19. Finally, I consider the case in which shipper i chooses to use Rule 11 to negotiate with both railroads r and s and obtain rates $p_{i,r}^l$ and $p_{i,s}^l$ for the two segments of its shipping routes separately. I assume these two negotiations take place simultaneously and the two railroads do not observe each other's decision before setting their own rates.

20. Given $p_{i,s}^l$, railroad r chooses $p_{i,r}^l$ to maximize its profit function

$$\pi_{i,r}^l(p_{i,r}^l, p_{i,s}^l) = q_i^l(p_i^l) d_{i,r}^l(p_{i,r}^l - c_{i,r}^l).$$

The first order condition for profit maximization is

$$\frac{\partial \pi_{i,r}^l(p_{i,r}^l, p_{i,s}^l)}{\partial p_{i,r}^l} = \frac{\partial q_i^l(p_i^l)}{\partial p_i^l} \frac{\partial p_i^l}{\partial p_{i,r}^l} d_{i,r}^l(p_{i,r}^l - c_{i,r}^l) + q_i^l(p_i^l) d_{i,r}^l = 0$$

and railroad r 's best response function, given $p_{i,s}^l$, is

$$p_{i,r}^l(p_{i,s}^l) = c_{i,r}^l + \frac{1}{b_i^l d_{i,r}^l}.$$

21. By symmetry, railroad s 's best response function, given $p_{i,r}^l$, is

$$p_{i,s}^l(p_{i,r}^l) = c_{i,s}^l + \frac{1}{b_i^l d_{i,s}^l}.$$

Therefore, the optimal rates, $p_{i,r}^{l*}$ and $p_{i,s}^{l*}$, are

$$p_{i,r}^{l*} = c_{i,r}^l + \frac{1}{b_i^l d_{i,r}^l} \quad \text{and} \quad p_{i,s}^{l*} = c_{i,s}^l + \frac{1}{b_i^l d_{i,s}^l}.$$

2. Application Set

22. Let N^A be the number of shippers in the application set, whose shipments' origins and destinations are operated by two different railroads, railroads r and s , where $(r, s) \in \{(UP, CSX), (NS, BNSF)\}$. For each shipper $i = 1, \dots, N^A$, let $d_i^A = d_{i,r}^A + d_{i,s}^A$ denote the total mileage of shipper i 's chosen shipment route, where $d_{i,j}^A$ is the mileage of the segment of the route operated by railroad $j \in \{r, s\}$.

23. I assume that shipper i in the application set has demand function $q_i^A(p_i^A)$, where p_i^A is the rate per car-mile faced by shipper i , and $q_i^A(p_i^A)$ is the number of carloads associated with shipper i 's shipment given rate p_i^A . I assume that $q_i^A(p_i^A)$ is log-linear in my model and it is given by

$$q_i^A(p_i^A) = \exp(a_i^A - b_i^A d_i^A p_i^A)$$

where $a_i^A, b_i^A > 0$. Railroad $j \in \{r, s\}$ is assumed to have constant marginal cost, $c_{i,j}^A$, of serving shipper i .

24. Similar to the assumption I made regarding the input set, I assume that all negotiations between railroads and shippers take the form of linear take-it-or-leave-it offers, in which case railroads r and s choose per car-mile rates $p_{i,r}^A$ and $p_{i,s}^A$ to maximize their profits $\pi_{i,r}^A(p_{i,r}^A, p_{i,s}^A)$ and $\pi_{i,s}^A(p_{i,r}^A, p_{i,s}^A)$, which can be written as follow under the log-linear demand assumption:

$$\pi_{i,r}^A(p_{i,r}^A, p_{i,s}^A) = q_i^A(p_i^A(p_{i,r}^A, p_{i,s}^A)) d_{i,r}^A (p_{i,r}^A - c_{i,r}^A)$$

and

$$\pi_{i,s}^A(p_{i,r}^A, p_{i,s}^A) = q_i^A(p_i^A(p_{i,r}^A, p_{i,s}^A)) d_{i,s}^A(p_{i,s}^A - c_{i,s}^A),$$

respectively, where

$$p_i^A(p_{i,r}^A, p_{i,s}^A) \equiv \frac{d_{i,r}^A}{d_i^A} p_{i,r}^A + \frac{d_{i,s}^A}{d_i^A} p_{i,s}^A.$$

The optimal rates for railroad r and s , $p_{i,r}^{A*}$ and $p_{i,s}^{A*}$, are

$$p_{i,r}^{A*} = c_{i,r}^A + \frac{1}{b_i^A d_{i,r}^A} \quad \text{and} \quad p_{i,s}^{A*} = c_{i,s}^A + \frac{1}{b_i^A d_{i,s}^A}.$$

B. POST-MERGER EQUILIBRIUM WITHOUT CGP

1. Input Set

25. Post-merger, UP and NS will operate as a single entity and jointly set a through rate to maximize their combined profit on the set of routes that were previously operated by UP on the one end and NS on the other end (shippers will no longer be able to use Rule 11 on this set of routes after the merger). That is, for any shipper i who has chosen a shipment route that was operated by railroads r and s pre-merger, where $(r, s) \in \{(UP, NS), (NS, UP)\}$, the shipper now faces a rate p_i^I per car-mile that is chosen to maximize the joint profit function of UP/NS:

$$\pi_{i,UP/NS}^I(p_i^I) = q_i^I(p_i^I) d_i^I \left(p_i^I - \frac{d_{i,r}^I}{d_i^I} c_{i,r}^I - \frac{d_{i,s}^I}{d_i^I} c_{i,s}^I \right).$$

26. The first order condition for joint profit maximization is

$$\frac{\partial \pi_{i,UP/NS}^I(p_i^I)}{\partial p_i^I} = \frac{\partial q_i^I(p_i^I)}{\partial p_i^I} d_i^I \left(p_i^I - \frac{d_{i,r}^I}{d_i^I} c_{i,r}^I - \frac{d_{i,s}^I}{d_i^I} c_{i,s}^I \right) + q_i^I(p_i^I) d_i^I = 0$$

and the optimal rate, p_i^{I**} , is therefore

$$p_i^{I**} = \frac{d_{i,r}^I}{d_i^I} c_{i,r}^I + \frac{d_{i,s}^I}{d_i^I} c_{i,s}^I + \frac{1}{b_i^I d_i^I}$$

27. For the set of routes that are operated by UP or NS on one end and CSX or BNSF on the other end, the optimal rates will remain unchanged from the pre-merger equilibrium.

That is

$$p_{i,r}^{I**} = p_{i,r}^{I*} \quad \text{and} \quad p_{i,s}^{I**} = p_{i,s}^{I*}$$

where $(r, s) \in \{(UP, CSX), (NS, BNSF)\}$.

2. Application Set

28. The application set, which does not include any UP-NS interline route, is not affected by the proposed merger without the CGP proposal. Therefore, the pre-merger optimal rates in the application set continue to be the optimal rates post-merger. That is,

$$p_{i,r}^{A**} = p_{i,r}^{A*} \quad \text{and} \quad p_{i,s}^{A**} = p_{i,s}^{A*}$$

where $(r, s) \in \{(UP, CSX), (NS, BNSF)\}$.

C. POST-MERGER EQUILIBRIUM WITH CGP

29. Let $r = UP/NS$ and let $p_r^I = (p_{1,r}^I, \dots, p_{N^I,r}^I)$ denote the vector of all UP/NS's rates in the input set. Define $p^{70}(p_r^I)$ as the 70th percentile UP/NS rates in the input set based on the number of carloads. That is, for any UP/NS input set rate vector, p_r^I , $p^{70}(p_r^I)$ is the smallest $\tilde{p}$ such that

$$\frac{\sum_{i=1}^{N^I} 1\{p_{i,r}^I \leq \tilde{p}\} q_i^I(p_i^I)}{\sum_{i=1}^{N^I} q_i^I(p_i^I)} \geq 0.70.$$

30. Under the CGP proposal, when railroad $s \in \{CSX, BNSF\}$ is setting the through rate in the application set, it will have the option to pay UP/NS at a rate of $p^{70}(p_r^I)$ per car-mile for the UP/NS's portion of the shipment associated with shipper i if $p_{i,r}^A > p^{70}(p_r^I)$.⁸

⁸ The CGP proposal also includes a minimum mileage threshold of 250 miles to account for the fixed costs associated rail transportation and prevents disproportionately low rates on short haul movements. Suppose the UP/NS's mileage for a particular shipment is 125 miles and the Committed Gateway Price is \$3 per car-mile for the CGP cell. In this case, the effective Committed Gateway Price for this shipment will be $\$3 \times 250 \div 125 = \6 per car-mile. To implement this minimum mileage threshold calculation, UP/NS will calculate the effective Committed Gateway Price based on the lower of the two Committed Gateway Prices from the “0

Given $p_{i,r}^A$ and p_r^I , railroad s now chooses the through rate $p_{i,s}^A$ for shipper i 's shipment to maximize the following profit function

$$\begin{aligned} \pi_{i,s}^A(p_{i,r}^A, p_{i,s}^A; p_r^I) &= \overbrace{1\{p_{i,r}^A \leq p^{70}(p_r^I)\} q_i^A \left(\frac{d_{i,r}^A}{d_i^A} p_{i,r}^A + \frac{d_{i,s}^A}{d_i^A} p_{i,s}^A \right) d_{i,s}^A (p_{i,s}^A - c_{i,s}^A)}^{\text{UP/NS's rate does not exceed the CGP}} \\ &+ \overbrace{1\{p_{i,r}^A > p^{70}(p_r^I)\} q_i^A \left(\frac{d_{i,r}^A}{d_i^A} p^{70}(p_r^I) + \frac{d_{i,s}^A}{d_i^A} p_{i,s}^A \right) d_{i,s}^A (p_{i,s}^A - c_{i,s}^A)}^{\text{UP/NS's rate exceeds the CGP}} \end{aligned}$$

and railroad s 's best response function, $\tilde{p}_{i,s}^A(p_{i,r}^A; p_r^I)$, is

$$\tilde{p}_{i,s}^A(p_{i,r}^A; p_r^I) = \begin{cases} p_{i,s}^A(p_{i,r}^A) & \text{if } p_{i,r}^A \leq p^{70}(p_r^I) \\ p_{i,s}^A(p^{70}(p_r^I)) & \text{if } p_{i,r}^A > p^{70}(p_r^I) \end{cases}$$

where $p_{i,s}^A(p_{i,r}^A)$ is railroad s 's best response function in the post-merger equilibrium without CGP.

31. Because the Committed Gateway Price, $p^{70}(p_r^I)$, depends on the full distribution of UP/NS's rates in the input set, to maximize profit, UP/NS must choose $p_r^I = (p_{1,r}^I, \dots, p_{N^I,r}^I)$ and $p_r^A = (p_{1,r}^A, \dots, p_{N^A,r}^A)$ jointly to maximize its combined profit in the input and application sets. However, given p_r^I , UP/NS's optimal rates in the application set, $p_{i,r}^{A***}$, is identical to its optimal rates without CGP, $p_{i,r}^{A**}$, as long as $p_{i,r}^{A**} \leq p^{70}(p_r^I)$:

$$p_{i,r}^{A***}(p_r^I) = \begin{cases} p_{i,r}^{A**} & \text{if } p_{i,r}^{A**} \leq p^{70}(p_r^I) \\ p^{70}(p_r^I) & \text{if } p_{i,r}^{A**} > p^{70}(p_r^I) \end{cases}$$

to less than 500 miles" and "500 to less than 1,000 miles" distance bands. See Novak V.S., Appendix A.

For legibility reason, the mathematical notations I use to describe CGP here do not explicitly account for the minimum mileage threshold, but the threshold of 250 miles is implemented in my model. However, because I perform the simulations of my model separately for each CGP cell, I simplify this minimum mileage threshold calculation by using only the Committed Gateway Price from the "0 to less than 500 miles" distance band. The implication of this simplification is that my model will underestimate the welfare benefits in the application set for shipments with UP/NS's mileage below 250 miles.

Although the CGP applies only when a shipper is negotiating a through rate with railroad $s \in \{CSX, BNSF\}$, I assume that it will also constrain UP/NS's rate setting decision in the application set when UP/NS sets the through rate or when the shipper is using Rule 11. That is, I assume that UP/NS will also set its rate according to the strategy $p_{i,r}^{A***}(p_r^I)$ in those cases.

32. Therefore, UP/NS's optimal input set rate vector, p_r^{I***} , is the solution to the following profit maximization problem:

$$\begin{aligned}
 & \max_{p_r^I} \pi_{UP/NS}^{I+A}(p_r^I, p_s^I(p_r^I), p_r^{A***}(p_r^I), \tilde{p}_s^A(p_r^{A***}(p_r^I); p_r^I)) \\
 &= \sum_{i=1}^{N^I} \overbrace{1\{s = UP/NS\} q_i^I(p_{i,r}^I) d_i^I \left(p_{i,r}^I - \frac{d_{i,r}^I}{d_i^I} c_{i,r}^I - \frac{d_{i,s}^I}{d_i^I} c_{i,s}^I \right)}^{\text{Shipment routes in the input set where UP/NS operates on both ends}} \\
 &+ \sum_{i=1}^{N^I} \overbrace{1\{s \neq UP/NS\} q_i^I \left(p_i^I(p_{i,r}^I, p_{i,s}^I(p_{i,r}^I)) \right) d_{i,r}^I(p_{i,r}^I - c_{i,r}^I)}^{\text{Shipment routes in the input set where UP/NS only operates on one end}} \\
 &+ \sum_{i=1}^{N^A} \overbrace{1\{p_{i,r}^{A**} \leq p^{70}(p_r^I)\} q_i^A \left(p_i^A(p_{i,r}^{A**}, \tilde{p}_{i,s}^A(p_{i,r}^{A**}; p_r^I)) \right) d_{i,r}^A(p_{i,r}^{A**} - c_{i,r}^A)}^{\text{Shipment routes in the application set where UP/NS's rate does not exceed the CGP}} \\
 &+ \sum_{i=1}^{N^A} \overbrace{1\{p_{i,r}^{A**} > p^{70}(p_r^I)\} q_i^A \left(p_i^A(p^{70}(p_r^I), \tilde{p}_{i,s}^A(p_{i,r}^{A**}; p_r^I)) \right) d_{i,r}^A(p^{70}(p_r^I) - c_{i,r}^A)}^{\text{Shipment routes in the application set where UP/NS's rate exceeds the CGP}}
 \end{aligned}$$

where $s \in \{CSX, BNSF\}$, $p_{i,s}^I(p_{i,r}^I)$ is railroad s 's best response function in the input set without CGP.⁹ The solution to this profit maximization problem generally do not have any closed-form solution and therefore it must be solved numerically.

⁹ For $s \in \{CSX, BNSF\}$, railroad s will have an incentive to deviate from its optimal strategy in the post-merger equilibrium without CGP in the input set, as the rate that it chooses can influence the distribution UP/NS's optimal input set rates, which may lower the Committed Gateway Price and increases railroad s 's profit in the application set. However, this is a third-order incentive and

33. Note that UP/NS's total profit function $\pi_{UP/NS}^{I+A}(p_r^I, p_s^I(p_r^I), p_r^{A***}(p_r^I), \tilde{p}_s^A(p_r^{A***}(p_r^I); p_r^I))$ is discontinuous in p_r^I because of the percentile function $p^{70}(p_r^I)$ is a discontinuous function. To reduce computational burden and improve numerical accuracy, to solve for UP/NS's profit maximizing input set rate vector, p_r^{I***} , I use the following algorithm to reformulate this discontinuous unconstrained optimization problem into N^I continuous constrained optimization problem:¹⁰

- 1) Compute the post-merger equilibrium without CGP and obtain $p_r^{I**} = (p_{1,r}^{I**}, \dots, p_{N^I,r}^{I**})$.
- 2) Sort the N^I shippers in the input set based on p_r^{I**} such that $p_{k,r}^{I**} \leq p_{k+1,r}^{I**}$ for all $k = 1, \dots, N^I - 1$.
- 3) For $k = 1, \dots, N^I$, numerically solve the following continuous constrained optimization problem:

$$\max_{p_r^I} \pi_{UP/NS}^{I+A}(p_r^I, p_s^I(p_r^I), p_r^{A***}(p_r^I), \tilde{p}_s^A(p_r^{A***}(p_r^I), p_r^I))$$

subject to

- i. $CGP = p_{k,r}^I$;
- ii. $p_{l,r}^I \leq p_{l+1,r}^I$ for all $l = 1, \dots, N^I - 1$;
- iii. $\frac{\sum_{i=1}^k q_i^I(p_i^I)}{\sum_{i=1}^{N^I} q_i^I(p_i^I)} \geq 0.7$;

therefore its effect is likely to be extremely small. For tractability and computational reason, I assume that railroad s will use the same optimal rate setting strategy in the input set with and without the CGP proposal.

¹⁰ I solve this constrained optimization problem using the non-linear optimization solver Artelys KNITRO (<https://www.artelys.com/solvers/knitro/>), which is an optimization solver commonly used and recommended in the economic literature. See, e.g., Dubé, J.-P., J. T. Fox, and C.-L. Su (2012), "Improving the Numerical Performance of Static and Dynamic Aggregate Discrete Choice Random Coefficients Demand Estimation," *Econometrica*, 80(5), 2231–2267, and Conlon, C., and J. Gortmaker (2020), "Best Practices for Differentiated Products Demand Estimation with PyBLP," *The RAND Journal of Economics*, 51(4), 1108–1161.

$$\text{iv. } \frac{\sum_{i=1}^{k-1} q_i^I(p_i^I)}{\sum_{i=1}^{N^I} q_i^I(p_i^I)} < 0.7; \text{ and}$$

$$\text{v. } \sum_{i=1}^{N^I} q_i^I(p_i^I) \geq 100.^{11}$$

- 4) Compare the N^I UP/NS's total profits obtained from the N^I constrained optimization problems in the step 3. Suppose the m -th constrained optimization problem yields the highest profit, then p_r^{I***} is the solution to the m -th constrained optimization problem.
34. Given the optimal rates in the post-merger equilibrium with CGP, (p^{I***}, p^{A***}) , the change in shipper i 's consumer surplus in the input set due the CGP proposal can be calculated as

$$\Delta CS_i^I = 1\{p_i^{I**} > p_i^{I***}\} \int_{p_i^{I***}}^{p_i^{I**}} d_i^I q_i^I(p) dp - 1\{p_i^{I**} < p_i^{I***}\} \int_{p_i^{I**}}^{p_i^{I***}} d_i^I q_i^I(p) dp.$$

Similarly, the change in shipper i 's consumer surplus in the application set due to the CGP proposal can similarly be calculated as

$$\Delta CS_i^A = 1\{p_i^{A**} > p_i^{A***}\} \int_{p_i^{A***}}^{p_i^{A**}} d_i^A q_i^A(p) dp - 1\{p_i^{A**} < p_i^{A***}\} \int_{p_i^{A**}}^{p_i^{A***}} d_i^A q_i^A(p) dp.$$

The overall change in shippers' consumer surplus across the two sets can then be calculated as

¹¹ According to the CGP proposal, for a cell to be eligible to generate a CGP rate, it must have a minimum of 100 carload shipments in the preceding year. If a specific CGP cell does not meet this 100 carloads threshold, then the CGP rate will be calculated by pooling shipments across all commodity categories in the same distance band. See Novak V.S., Appendix A.

For each CGP cell that meets the 100 carload shipments threshold in the post-merger equilibrium without CGP, I use the algorithm described here to determine the optimal input set rate vector and calculate the CGP rate accordingly. For CGP cells that do not meet the 100 carload shipments threshold in the post-merger equilibrium without CGP, I assume that it is optimal for UP/NS to employ the same rate setting strategy that it uses in the post-merger equilibria without CGP, and the CGP rate is calculated by pooling together shipments across all commodity categories in the same distance band.

$$\sum_{i=1}^{N^I} \Delta CS_i^I + \sum_{i=1}^{N^A} \Delta CS_i^A.$$

III. MODEL CALIBRATION AND SIMULATION

35. I calibrate the parameters of the model, $\{a_i^I, b_i^I, c_{i,r}^I, c_{i,s}^I\}_{i=1}^{N^I}$ and $\{a_i^A, b_i^A, c_{i,r}^A, c_{i,s}^A\}_{i=1}^{N^A}$, using observed per car-mile shipment rates, $\{p_{i,r}^I, p_{i,s}^I\}_{i=1}^{N^I}$ and $\{p_{i,r}^A, p_{i,s}^A\}_{i=1}^{N^A}$, carloads, $\{q_i^I\}_{i=1}^{N^I}$ and $\{q_i^A\}_{i=1}^{N^A}$, mileage, $\{d_{i,r}^I, d_{i,s}^I\}_{i=1}^{N^I}$ and $\{d_{i,r}^A, d_{i,s}^A\}_{i=1}^{N^A}$, as well as UP's and NS's average margins, m_{UP} and m_{NS} . This calibration is preformed separately for each CGP cell.
36. I calculate shipment rates, carloads, and mileages separately for each shipper in each CGP cell using UP's and NS's 100 percent Waybill data from 2024. The Waybill data are limited to UP-CSX, NS-BNSF, and UP-NS interline shipments that are included in the input and application sets under the CGP proposal. Within each CGP cell, a shipper in the model is defined as a unique combination of shipper, route (origin SPLC6 to destination SPLC6), contracting railroads, contracting arrangement (e.g., through rate or Rule 11), and time period. I use a time period of six months (from January to June and from July to December) to define shippers in the model. I do so because shippers typically have contracts that dictate their shipment rates over a period of a year, but contract end dates generally do not align with the calendar year, and they differ across shippers. Hence, assuming contract end dates are evenly distributed throughout a year, each observed contract will expire in 6 months on average. I calculate average rate per car-mile, average shipment mileage, and count of carloads separately for each shipper.
37. I calculate UP's and NS's average margins using the total revenue and total variable cost information from the Confidential Carload Waybill Sample for the year 2023, which is the most recent version available from the STB. I limit the sample to non-intermodal Rule 11 shipments, and I calculate average margins separately for each CGP cell, and separately for UP and NS.
38. Because I do not observe the railroads' marginal costs for each individual shipment, simplifying assumptions must be made to calibrate the model parameters. I assume that UP's marginal cost per car mile is the same for all shipments within each CGP cell, i.e.,

$c_{i,UP}^I = c_{UP}$ for all $i = 1, \dots, N^I$ and $c_{i,UP}^A = c_{UP}$ for all $i = 1, \dots, N^A$, and I calibrate c_{UP} using the following equations for all UP-NS and UP-CSX interline shipments:

$$\frac{\sum_{i=1}^{N^I} 1\{r = UP\} q_i^I d_{i,r}^I (p_{i,r}^I - c_{UP}) + \sum_{i=1}^{N^A} 1\{r = UP\} q_i^A d_{i,r}^A (p_{i,r}^A - c_{UP})}{\sum_{i=1}^{N^I} 1\{r = UP\} q_i^I d_{i,r}^I p_{i,r}^I + \sum_{i=1}^{N^A} 1\{r = UP\} q_i^A d_{i,r}^A p_{i,r}^A} = m_{UP}.$$

For NS-BNSF interline shipments, I make the same assumption and use an analogous equation to calibrate c_{NS} from m_{NS} .^{12, 13}

39. The approach described in the previous paragraph allows me to calibrate the marginal cost per car-mile of one of the two railroads, either c_{UP} or c_{NS} , for each shipment included in the model. Once c_{UP} or c_{NS} is calibrated, I calibrate the demand parameters, (a_i^I, b_i^I) and (a_i^A, b_i^A) , as well as the marginal cost of the other railroad, using (i) the demand equation, (ii) the profit maximizing first order condition of railroad r , and (iii) the profit maximizing first order condition of railroad s . Specifically, for the input set, I calibrate these parameters using the following equations:

$$\begin{aligned} b_i^I &= \frac{1}{d_{i,r}^I (p_{i,r}^I - c_r)} \\ a_i^I &= \log(q_i^I) + b_i^I d_i^I \left(\frac{d_{i,r}^I}{d_i^I} p_{i,r}^I + \frac{d_{i,s}^I}{d_i^I} p_{i,s}^I \right) \\ c_{i,s}^I &= p_{i,s}^I - \frac{1}{b_i^I d_{i,s}^I} \end{aligned}$$

¹² If the calibrated marginal cost implies a markup of less than \$0.01 per car-mile for a particular shipment, due to an unusually low observed rate per car-mile, I recalibrate the marginal cost for that shipment such that the UP's (or NS's) margin of that shipment is equal to m_{UP} (or m_{NS}). This is done to prevent extremely large or negative calibrated b_i^I or b_i^A that can lead to numerical instability in the main optimization problem of the simulation. This occurs only for a very small number of shipments in the data.

¹³ Because UP-NS interline shipments represent a non-trivial portion of shipments in the input sets, the simulation results of the model are not invariant to the order of marginal cost calibration. As a sensitivity test, I perform the same welfare effects simulation using an alternative version of the model in which the marginal cost of NS is calibrated first. I find that the increase in shipper's consumer surplus due to the CGP proposal is generally higher in this alternative version of the model. See my backup materials.

where $r \in \{UP, NS\}$. Similarly, I calibrate these parameters for the application set using the following equations:

$$b_i^A = \frac{1}{d_{i,r}^A(p_{i,r}^A - c_r)}$$

$$a_i^A = \log(q_i^A) + b_i^A d_i^A \left(\frac{d_{i,r}^A}{d_i^A} p_{i,r}^A + \frac{d_{i,s}^A}{d_i^A} p_{i,s}^A \right)$$

$$c_{i,s}^A = p_{i,s}^A - \frac{1}{b_i^A d_{i,s}^A}.$$

40. Once I have calibrated these model parameters, I use the numerical algorithm described in the previous section to simulate the welfare effects of the CGP proposal on shippers separately for each cell in the CSX CGP table and the BNSF CGP table.
41. In implementing my model, I focus on the set of CGP cells for which I have sufficient data to calibrate the model to ensure the simulation results are representative. Using UP's and NS's 100 percent Waybill data, as well as the 100 percent Waybill data provided by BNSF and CSX, I am able to determine the total number of carloads shipped in each of the input and application sets, regardless of whether I have sufficient information to include these shipments in the model. I perform the model calibration and simulation on the set of CGP cells where at least 10 percent of the number of carloads in both the input and application sets (before the redistribution of carloads excluded from the model) have sufficient information to be included in the model.¹⁴ For each of these 140 CGP cells, I redistribute the number of carloads excluded from the model, due to missing information, among the set of included shipments.¹⁵ This procedure is done to ensure that the relative and total sizes of the input and application sets in the model are as

¹⁴ The number of carloads in the excluded CGP cells only account for about 1.1 percent of the total number of carloads among all CGP cells.

¹⁵ This redistribution of carloads is applied to shipments in which the identities of the railroads are identical. I do not redistribute excluded carloads associated with UP-CSX Rule 11 shipments to UP-NS shipments that are included in the model, for example. See my backup materials for detail.

close to their true sizes in the data as possible, in order to accurately capture the incentives UP/NS to set rates across both sets.

42. Figure 1 and Figure 2 show the simulation results for each of these CGP cells. I find that the CGP proposal will generate a net increase in total shippers' consumer surplus of \$10.3 million a year across all included BNSF CGP cells and a net increase in total shippers' consume surplus of \$16.3 million a year across all included CSX CGP cells.

Figure 1

Total Welfare Effects of the CGP Proposal on Shippers for Included BNSF CGP Cells

Commodity Group	Distance Band	Change in Shippers' Consumer Surplus (\$ / Year)		
		Input Set	Application Set	Overall
GRAIN PRODUCTS I	500 TO LESS THAN 1,000 MILES	-\$1,988,824	\$3,982,674	\$1,993,849
SPECIALIZED MARKETS	500 TO LESS THAN 1,000 MILES	-\$992,687	\$2,696,362	\$1,703,675
INDUSTRIAL CHEMICALS	500 TO LESS THAN 1,000 MILES	-\$743,329	\$1,951,743	\$1,208,414
FOOD & BEVERAGE I	500 TO LESS THAN 1,000 MILES	-\$1,671,224	\$2,786,343	\$1,115,119
PLASTICS	500 TO LESS THAN 1,000 MILES	-\$252,854	\$1,290,828	\$1,037,974
SAND	500 TO LESS THAN 1,000 MILES	-\$3,636,568	\$4,660,888	\$1,024,320
PETROLEUM	500 TO LESS THAN 1,000 MILES	-\$266,743	\$794,375	\$527,632
PLASTICS	0 TO LESS THAN 500 MILES	-\$146,060	\$490,864	\$344,804
FERTILIZER & SULFUR	500 TO LESS THAN 1,000 MILES	-\$265,367	\$468,917	\$203,550
METALS & ORES I	500 TO LESS THAN 1,000 MILES	-\$296,542	\$495,544	\$199,003
METALS & ORES I	0 TO LESS THAN 500 MILES	-\$143,195	\$300,336	\$157,141
FERTILIZER & SULFUR	1,000 TO LESS THAN 1,500 MILES	-\$217,871	\$338,162	\$120,291
FOOD & BEVERAGE II	500 TO LESS THAN 1,000 MILES	-\$145,314	\$256,033	\$110,719
GRAIN	500 TO LESS THAN 1,000 MILES	-\$258,340	\$361,801	\$103,462
PETROLEUM	0 TO LESS THAN 500 MILES	-\$31,520	\$120,393	\$88,873
GRAIN PRODUCTS II	500 TO LESS THAN 1,000 MILES	-\$102,852	\$176,271	\$73,419
SPECIALIZED MARKETS	1,000 TO LESS THAN 1,500 MILES	-\$24,899	\$97,364	\$72,465
OTE	500 TO LESS THAN 1,000 MILES	-\$101,504	\$173,674	\$72,170
LPG	500 TO LESS THAN 1,000 MILES	-\$163,332	\$230,535	\$67,203
PLASTICS	1,000 TO LESS THAN 1,500 MILES	-\$16,251	\$82,539	\$66,288
PETCOKE	0 TO LESS THAN 500 MILES	-\$70,054	\$126,129	\$56,075
METALS & ORES I	1,000 TO LESS THAN 1,500 MILES	-\$376,358	\$417,328	\$40,970
SPECIALIZED MARKETS	0 TO LESS THAN 500 MILES	-\$392,149	\$427,813	\$35,664
GRAIN PRODUCTS I	1,000 TO LESS THAN 1,500 MILES	-\$28,790	\$63,509	\$34,719
GRAIN PRODUCTS II	0 TO LESS THAN 500 MILES	-\$33,756	\$67,631	\$33,875
REFRIGERATED	500 TO LESS THAN 1,000 MILES	-\$28,476	\$62,103	\$33,627
PETCOKE	500 TO LESS THAN 1,000 MILES	-\$97,131	\$129,465	\$32,334
FOOD & BEVERAGE II	0 TO LESS THAN 500 MILES	-\$40,845	\$67,503	\$26,659
GRAIN PRODUCTS I	0 TO LESS THAN 500 MILES	-\$5,400	\$26,793	\$21,393
GRAIN	0 TO LESS THAN 500 MILES	-\$57,817	\$74,208	\$16,391
INDUSTRIAL CHEMICALS	1,000 TO LESS THAN 1,500 MILES	-\$6,952	\$18,690	\$11,738
FERTILIZER & SULFUR	0 TO LESS THAN 500 MILES	-\$15,709	\$23,523	\$7,814
SODA ASH	0 TO LESS THAN 500 MILES	-\$16,438	\$23,939	\$7,501
METALS & ORES II	0 TO LESS THAN 500 MILES	-\$34,361	\$41,102	\$6,740
PETROLEUM	1,000 TO LESS THAN 1,500 MILES	-\$30,764	\$35,525	\$4,761
SAND	1,000 TO LESS THAN 1,500 MILES	-\$1,555	\$5,021	\$3,466
INDUSTRIAL CHEMICALS	0 TO LESS THAN 500 MILES	-\$10,922	\$13,522	\$2,600
FOREST PRODUCTS II	0 TO LESS THAN 500 MILES	-\$6,457	\$6,784	\$327
FOREST PRODUCTS I	500 TO LESS THAN 1,000 MILES	-\$370,820	\$370,952	\$132
CONSTRUCTION	500 TO LESS THAN 1,000 MILES	-\$27,520	\$27,608	\$87
CONSTRUCTION	1,000 TO LESS THAN 1,500 MILES	\$0	\$0	\$0
FOREST PRODUCTS I	0 TO LESS THAN 500 MILES	\$0	\$0	\$0
GRAIN PRODUCTS II	1,000 TO LESS THAN 1,500 MILES	\$0	\$0	\$0
LPG	0 TO LESS THAN 500 MILES	\$0	\$0	\$0
METALS & ORES II	1,000 TO LESS THAN 1,500 MILES	\$0	\$0	\$0
OTE	0 TO LESS THAN 500 MILES	\$0	\$0	\$0
REFRIGERATED	0 TO LESS THAN 500 MILES	\$0	\$0	\$0
SODA ASH	500 TO LESS THAN 1,000 MILES	\$0	\$0	\$0
FOOD & BEVERAGE II	1,000 TO LESS THAN 1,500 MILES	-\$57,470	\$56,592	-\$877
FOREST PRODUCTS II	500 TO LESS THAN 1,000 MILES	-\$143,839	\$142,724	-\$1,114

FOREST PRODUCTS II	1,000 TO LESS THAN 1,500 MILES	-\$6,695	\$4,231	-\$2,464
LPG	1,000 TO LESS THAN 1,500 MILES	-\$41,994	\$29,479	-\$12,515
CONSTRUCTION	0 TO LESS THAN 500 MILES	-\$134,969	\$122,314	-\$12,655
GRAIN	1,000 TO LESS THAN 1,500 MILES	-\$17,804	\$4,942	-\$12,863
FOOD & BEVERAGE I	0 TO LESS THAN 500 MILES	-\$28,901	\$15,493	-\$13,408
OTE	1,000 TO LESS THAN 1,500 MILES	-\$45,682	\$22,082	-\$23,601
METALS & ORES II	500 TO LESS THAN 1,000 MILES	-\$97,469	\$44,623	-\$52,846
SAND	0 TO LESS THAN 500 MILES	-\$125,536	\$45,952	-\$79,584
FOREST PRODUCTS I	1,000 TO LESS THAN 1,500 MILES	-\$194,421	\$86,507	-\$107,914
Total		-\$14,012,331	\$24,359,733	\$10,347,403

Figure 2

Total Welfare Effects of the CGP Proposal on Shippers for Included CSX CGP Cells

Commodity Group	Distance Band	Change in Shippers' Consumer Surplus (\$ / Year)		
		Input Set	Application Set	Overall
REFRIGERATED	1,500 MILES OR GREATER	-\$4,560,061	\$8,683,396	\$4,123,335
OTE	1,500 MILES OR GREATER	-\$568,668	\$4,054,347	\$3,485,679
INDUSTRIAL CHEMICALS	1,500 MILES OR GREATER	-\$314,295	\$1,471,466	\$1,157,171
FOREST PRODUCTS I	1,500 MILES OR GREATER	-\$1,226,535	\$2,172,153	\$945,618
FOOD & BEVERAGE II	1,500 MILES OR GREATER	-\$2,633,141	\$3,370,872	\$737,731
SPECIALIZED MARKETS	1,000 TO LESS THAN 1,500 MILES	-\$94,645	\$660,195	\$565,550
INDUSTRIAL CHEMICALS	500 TO LESS THAN 1,000 MILES	-\$550,426	\$895,855	\$345,429
SPECIALIZED MARKETS	500 TO LESS THAN 1,000 MILES	-\$184,926	\$518,806	\$333,880
METALS & ORES II	1,500 MILES OR GREATER	-\$328,878	\$659,065	\$330,186
FERTILIZER & SULFUR	1,000 TO LESS THAN 1,500 MILES	-\$184,789	\$476,231	\$291,442
CONSTRUCTION	1,500 MILES OR GREATER	-\$75,434	\$336,599	\$261,165
LPG	500 TO LESS THAN 1,000 MILES	-\$201,247	\$444,494	\$243,248
FERTILIZER & SULFUR	1,500 MILES OR GREATER	-\$187,442	\$421,057	\$233,615
METALS & ORES II	1,000 TO LESS THAN 1,500 MILES	-\$111,282	\$342,784	\$231,502
FERTILIZER & SULFUR	500 TO LESS THAN 1,000 MILES	-\$111,182	\$336,249	\$225,067
METALS & ORES I	1,000 TO LESS THAN 1,500 MILES	-\$123,597	\$323,976	\$200,380
FOOD & BEVERAGE I	1,500 MILES OR GREATER	-\$457,547	\$624,611	\$167,064
GRAIN PRODUCTS II	500 TO LESS THAN 1,000 MILES	-\$135,891	\$297,720	\$161,829
INDUSTRIAL CHEMICALS	0 TO LESS THAN 500 MILES	-\$308,779	\$465,428	\$156,649
PLASTICS	0 TO LESS THAN 500 MILES	-\$288,621	\$445,038	\$156,417
SPECIALIZED MARKETS	1,500 MILES OR GREATER	-\$606,101	\$749,801	\$143,700
METALS & ORES I	1,500 MILES OR GREATER	-\$199,862	\$334,654	\$134,792
FOREST PRODUCTS II	1,500 MILES OR GREATER	-\$926,928	\$1,049,981	\$123,054
PETROLEUM	500 TO LESS THAN 1,000 MILES	-\$122,673	\$241,910	\$119,238
GRAIN PRODUCTS II	1,500 MILES OR GREATER	-\$564,491	\$674,903	\$110,412
FOREST PRODUCTS I	500 TO LESS THAN 1,000 MILES	-\$281,607	\$380,566	\$98,958
PLASTICS	1,500 MILES OR GREATER	-\$32,204	\$130,286	\$98,082
METALS & ORES I	0 TO LESS THAN 500 MILES	-\$118,537	\$207,647	\$89,109
GRAIN PRODUCTS II	1,000 TO LESS THAN 1,500 MILES	-\$77,302	\$161,231	\$83,928
PLASTICS	500 TO LESS THAN 1,000 MILES	-\$16,529	\$96,106	\$79,576
INDUSTRIAL CHEMICALS	1,000 TO LESS THAN 1,500 MILES	-\$49,265	\$126,196	\$76,930
SPECIALIZED MARKETS	0 TO LESS THAN 500 MILES	-\$20,144	\$89,719	\$69,575
REFRIGERATED	1,000 TO LESS THAN 1,500 MILES	-\$57,413	\$125,527	\$68,114
GRAIN PRODUCTS I	1,000 TO LESS THAN 1,500 MILES	-\$44,270	\$110,954	\$66,684
GRAIN PRODUCTS I	500 TO LESS THAN 1,000 MILES	-\$36,747	\$101,419	\$64,672
GRAIN PRODUCTS I	1,500 MILES OR GREATER	-\$106,323	\$164,119	\$57,796
FOREST PRODUCTS I	1,000 TO LESS THAN 1,500 MILES	-\$127,215	\$177,873	\$50,658
GRAIN	500 TO LESS THAN 1,000 MILES	-\$87,283	\$132,482	\$45,199
METALS & ORES I	500 TO LESS THAN 1,000 MILES	-\$106,733	\$145,556	\$38,823
SODA ASH	1,000 TO LESS THAN 1,500 MILES	-\$163,629	\$202,226	\$38,597
SAND	0 TO LESS THAN 500 MILES	-\$4,124	\$40,937	\$36,813
PETROLEUM	1,000 TO LESS THAN 1,500 MILES	-\$33,006	\$67,791	\$34,785
SODA ASH	0 TO LESS THAN 500 MILES	-\$51,582	\$82,540	\$30,958
PETROLEUM	0 TO LESS THAN 500 MILES	-\$61,521	\$90,436	\$28,915
LPG	1,000 TO LESS THAN 1,500 MILES	-\$14,928	\$42,271	\$27,343
GRAIN PRODUCTS I	0 TO LESS THAN 500 MILES	-\$47,250	\$73,808	\$26,558
PETROLEUM	1,500 MILES OR GREATER	-\$50,354	\$76,843	\$26,489
FOOD & BEVERAGE I	500 TO LESS THAN 1,000 MILES	-\$55,388	\$81,788	\$26,400
FERTILIZER & SULFUR	0 TO LESS THAN 500 MILES	-\$76,061	\$97,954	\$21,893
GRAIN	0 TO LESS THAN 500 MILES	-\$78,561	\$97,772	\$19,211

REFRIGERATED	500 TO LESS THAN 1,000 MILES	\$0	\$17,510	\$17,510
OTE	500 TO LESS THAN 1,000 MILES	-\$92,470	\$107,904	\$15,435
METALS & ORES II	0 TO LESS THAN 500 MILES	-\$25,698	\$40,548	\$14,850
FOOD & BEVERAGE I	0 TO LESS THAN 500 MILES	-\$48,277	\$63,029	\$14,752
FOOD & BEVERAGE I	1,000 TO LESS THAN 1,500 MILES	-\$7,252	\$19,816	\$12,564
FOOD & BEVERAGE II	500 TO LESS THAN 1,000 MILES	-\$6,222	\$18,714	\$12,492
FOREST PRODUCTS II	0 TO LESS THAN 500 MILES	-\$19,283	\$27,146	\$7,863
GRAIN	1,000 TO LESS THAN 1,500 MILES	-\$3,799	\$11,453	\$7,654
FOREST PRODUCTS I	0 TO LESS THAN 500 MILES	-\$26,995	\$34,259	\$7,264
FOREST PRODUCTS II	1,000 TO LESS THAN 1,500 MILES	-\$52,292	\$59,370	\$7,078
PETCOKE	1,500 MILES OR GREATER	-\$10,359	\$13,561	\$3,201
FOOD & BEVERAGE II	0 TO LESS THAN 500 MILES	-\$2,554	\$5,623	\$3,069
GRAIN	1,500 MILES OR GREATER	-\$4,574	\$7,462	\$2,888
OTE	0 TO LESS THAN 500 MILES	-\$19,219	\$22,025	\$2,806
GRAIN PRODUCTS II	0 TO LESS THAN 500 MILES	-\$12,297	\$15,015	\$2,718
CONSTRUCTION	1,000 TO LESS THAN 1,500 MILES	-\$2,202	\$3,532	\$1,330
FOREST PRODUCTS II	500 TO LESS THAN 1,000 MILES	-\$45,408	\$46,494	\$1,086
SAND	500 TO LESS THAN 1,000 MILES	-\$382	\$1,430	\$1,048
LPG	1,500 MILES OR GREATER	-\$2,506	\$2,667	\$162
PETCOKE	0 TO LESS THAN 500 MILES	\$0	\$142	\$142
SODA ASH	500 TO LESS THAN 1,000 MILES	-\$910	\$1,032	\$122
FOOD & BEVERAGE II	1,000 TO LESS THAN 1,500 MILES	\$0	\$0	\$0
LPG	0 TO LESS THAN 500 MILES	\$0	\$0	\$0
PETCOKE	1,000 TO LESS THAN 1,500 MILES	\$0	\$0	\$0
PLASTICS	1,000 TO LESS THAN 1,500 MILES	\$0	\$0	\$0
SAND	1,000 TO LESS THAN 1,500 MILES	\$0	\$0	\$0
SAND	1,500 MILES OR GREATER	\$0	\$0	\$0
SODA ASH	1,500 MILES OR GREATER	\$0	\$0	\$0
CONSTRUCTION	500 TO LESS THAN 1,000 MILES	-\$40,611	\$40,237	-\$373
METALS & ORES II	500 TO LESS THAN 1,000 MILES	-\$133,597	\$127,452	-\$6,145
CONSTRUCTION	0 TO LESS THAN 500 MILES	-\$185,378	\$112,741	-\$72,637
Total		-\$17,607,704	\$33,954,800	\$16,347,096

43. The overall welfare impact of the CGP proposal is presented in Figure 3 below. Because the input sets for BNSF CGP cells and the input sets for CSX CGP cells both include the same set of UP-NS interline shipments, these duplicated shipments must be removed to avoid double counting when estimating the overall welfare effects of the CGP proposal. After removing these duplicated shipments, I estimate that the CGP proposal will generate a net increase of \$28.7 million per year in total shippers' consumer surplus among all CGP cells that I am able to include in my simulation model.

44. To extrapolate this total welfare effects estimate to all CGP cells, I multiply the estimated total change in shippers' consumer surplus among the set of CGP cells included in the model by the following ratio:

$$\frac{\text{Total Number of Carloads in the Data}}{\text{Total Number of Carloads Included in the Model}}$$

In aggregate, I estimate that the CGP proposal will increase total shippers' consumer surplus by \$29 million per year.

Figure 3

Total Welfare Effects of the CGP Proposal on Shippers

	Total Number of Carloads
Number of Carloads in Data	478,484
Number of Carloads Included in Model	473,078
Ratio	1.011
	Change in Shippers' Consumer Surplus (\$ / Year)
Welfare Effects on Included BNSF CGP Cells	\$10,347,403
Welfare Effects on Included CSX CGP Cells	\$16,347,096
	\$26,694,499
Remove Duplicated Shipments in Input Sets	\$1,963,796
	\$28,658,295
Add Excluded Carloads ($\$28.66 \text{ Million} \times (1.011 - 1)$)	\$327,487
Total	\$28,985,782

APPENDIX D: DETAILED ANALYSIS OF INDEPENDENT ROUTES

I. OVERVIEW

1. As discussed in Section III.F of my Verified Statement, in response to comments on UP/NS's initial application, I have applied an independent-route algorithm (the "algorithm") based on and consistent with the one used in CPKC's merger proceeding.¹ When the this algorithm is run on waybill data, 74 corridors are identified as potentially losing an independent route due to the UP/NS merger. Of the 74 corridors that the algorithm flags, all but two have a viable alternative route using existing viable interchanges that connect existing rail segments. Hence, as explained more fully below, when all these viable alternatives are considered, 72 of the 74 corridors are no longer flagged by the algorithm. For the two corridors that continue to be flagged, I provide a more detailed economic analysis that shows that the UP/NS merger does not raise competitive concerns in those corridors.

II. THE ALGORITHM TO COUNT INDEPENDENT ROUTES

2. As stated in Section III.F of my Verified Statement, I perform an initial count of independent routes using the following method:
 - Using Waybill data from the six Class I railroads, identify all corridors (i.e., BEA pairs) with rail traffic at any point between 2019 and 2024 in which UP and NS serve different legs of the movement and do not overlap at either end of the corridor.
 - For each corridor that averages at least one car per day, list each of the unique combinations of Class I railroads (i.e., 'routes') observed moving traffic in the corridor.

¹ See Israel VS, § III.F. This is consistent with the approach taken in the CP-KCS proceeding. I utilize the CPKC method of counting the number of independent routes. However, I use six years of waybill of data, rather than a single test year for identifying relevant routes; I consider routes with traffic of ten cars per year or more in at least one year and corridors with traffic of at least one car per day on average; I determine independent routes based on Class I railroads only, rather than considering all carriers.

- The algorithm identifies the observed route that has the fewest overlaps with other routes in the corridor and treats this as the initial independent route in the corridor.
 - The algorithm adds additional routes (with successively more overlaps) to the set of independent routes if they are independent of previously selected routes.
3. The algorithm described above considers only routes observed in the railroads' waybill data. However, there are often alternative independent routes that the algorithm should consider, even if they are not observed in the waybill data.² Ignoring a viable alternative independent route causes the algorithm incorrectly to identify a reduction in independent routes available to shippers when, in fact, there is none. Hence, for corridors that are flagged by the algorithm described above, I add an additional step that considers whether there are any viable alternative independent routes available in each corridor. If there is such a route, the algorithm is run again on the expanded set of routes.
4. As a concrete example, consider traffic moving between the San Francisco, CA, and Greensboro, NC, BEAs.³ On average, {{ }} cars per year move between San Francisco and Greensboro, using various gateways, including Chicago. Table D-3 shows that traffic moved on nine routes (i.e., combinations of carriers) between San Francisco and Greensboro. The algorithm finds two independent routes before the merger (BNSF-NS and CSXT-UP) and one independent route (UPNS single-line service) following the merger. The combination of carriers that is not observed in the waybill data is BNSF and CSXT. However, BNSF-to-CSXT—with an interchange over Chicago—is, in fact, a viable independent route to serve this corridor. BNSF carries on average {{ }} cars from San Francisco to Chicago each year as part of interline movements, and it interchanges cars destined for Greensboro with NS.⁴ CSXT carries {{ }} cars, on average, from Greensboro to Chicago each year as part of interline movements.⁵ Some of these cars are

² The issue that all viable routes are not observed in the waybill data is particularly acute for corridors with small volumes of traffic.

³ The full names of the BEAs are San Francisco-Oakland-San Jose, CA, and Greensboro-Winston-Salem-High Point, NC-VA.

⁴ See Table D - 1; see my backup materials.

⁵ See Table D - 1; see my backup materials.

destined for San Francisco and are interchanged with UP.⁶ Moreover, BNSF and CSXT regularly interchange cars in Chicago for other corridors. Hence, the BNSF-CSXT route is a viable option for shippers and should be treated as such.

5. For the 74 corridors flagged as losing an independent route post-merger, I add this additional step of assessing whether a viable alternative independent route can be created through the connection of segments currently carrying traffic at the indicated interchange and expand the list of routes that the algorithm considers to account for any such viable alternative options. The results of this analysis are reported below.

III. CORRIDORS WITH ORIGINS AND DESTINATIONS IN THE U.S.

6. Table D - 1 shows the 65 corridors with both origins and destinations in the U.S. that the algorithm flags as losing an independent route from the UP/NS merger based on routes in the waybill data. For these corridors, I take the additional step of assessing whether a viable alternative independent route can be created by an interchange between rail segments that currently carry traffic. I run the algorithm again on the expanded list of routes in the corridor to determine whether the corridor should be flagged as losing an independent route following the merger.
7. Table D - 1 shows that all but two U.S. corridors flagged by the algorithm as losing an independent route—based on routes found in the waybill data—actually have viable alternative independent routes created by connecting existing rail segments of Class I carriers (even if not all those routes are reflected in the waybill data).⁷ As a result, the transaction does not reduce independent routes in these corridors. I analyze the two other corridors in Section V below and explain why the transaction also does not raise competitive concerns due to a loss of independent routes in either of these corridors.

⁶ See my backup materials.

⁷ There may be other viable alternative routes available that make use of other interchanges. Because independent routes are defined by railroads, not interchanges, the availability of more than one viable interchange does not affect the results, but does provide shippers with additional options.

The two corridor exceptions are Indianapolis, IN-IL -to- Springfield, IL-MO, and Birmingham, AL -to- Little Rock-North Little Rock, AR, as indicated by footnote [2] in Table D - 1. These corridors have alternative routes, but they are not created by the interconnection of existing segments.

8. The columns in Table D - 1 are defined as follows:

- **BEA Characteristics**
 - **Numbers:** numeric identifiers of the BEAs that define the corridor.
 - **BEA 1 Name** and **BEA 2 Name:** names of the BEAs that define the corridor.
- **Pre- and Post- Merger Independent Routes**
 - **Waybill Only:** number of independent routes (pre-merger)-to-(post-merger), using the routes observed in the waybill data.
 - **With Alternative Routes:** number of independent routes (pre-merger)-to-(post-merger) including all viable routes.
- **Corridor Characteristics**
 - **Interchange:** interchange where currently operated rail segments that comprise a route in the corridor meet to create an independent route.
 - **Alternative Independent Route:** alternative independent route created by connecting segments currently carrying traffic at the indicated interchange. *This is the viable route used to expand the list of routes that the algorithm considers.*
 - **Volume:** average annual railcars/units moved in the corridor (non-directional).
- **Total Through Traffic between BEA1 (BEA2) and Interchange:** Annual average volume of through traffic moved by the indicated carrier between the indicated BEA and the indicated interchange.⁸

⁸ I exclude from these columns all traffic that terminates at the BEA where the interchange is located. Traffic that goes through the interchange but does not change carriers is not observed and not included in the traffic figures. In addition, the waybill data does not show the interchange point for all interline traffic. I do not allocate traffic from these routes to any interchange. As a result, the car counts in Table D - 1 do not show all interchanged traffic.

Table D - 1
Flagged Corridors with Origins and Destinations in the U.S. {}

}}

Source: Waybill data; see backup for details.

Notes: The additional independent route column shows an alternative route found in PC Miler that, in conjunction with other routes that appear in the waybill data, ensures that the algorithm finds no reduction in the number of independent routes as the result of the merger. [1] The traffic reported for CPKC between Chicago and the Casper WY-ID-UT BEA includes an interchange with RCPE, a Class II railroad. [2] These corridors have a viable alternative independent route that connects the BEAs that define the corridor, but the alternative is not built by the interconnection of existing rail segments at large interchange location.

IV. CORRIDORS WITH TRAFFIC ORIGINATING OR TERMINATING IN MEXICO

9. The US Bureau of Economic Analysis does not define economic areas (“BEAs”) in Mexico, so I use Mexican states in place of BEAs to define corridors. There are two Mexican railroads, FXE and KCSM. FXE moves transborder traffic between locations in Mexico and the Eagle Pass border crossing, and KCSM, which is 100% owned by CPKC, moves transborder traffic from locations in Mexico to the Laredo border crossing. To apply the algorithm on traffic crossing the border with Mexico, I treat KCSM as CPKC and treat FXE in the same manner as a Class I railroad.
10. Table D - 2 shows that nine corridors with an endpoint in Mexico are identified as losing an independent route when the algorithm considers only routes observed in the Waybill data.⁹
11. Eight of those nine corridors have service from FXE over the Eagle Pass border crossing and from CPKC over the Laredo border crossing, which implies that each of these Mexican states has at most two independent routes, one over each border crossing, prior to the UP/NS merger. For these corridors to have two independent routes, the routes from Eagle Pass and Laredo to the U.S. BEA must be independent of each other. Finding two routes that are independent of each other on the U.S. side of the Eagle Pass and Laredo border crossings is always possible because UP and BNSF reach the U.S. side of the Eagle Pass border crossing and UP and CPKC reach the U.S. side of the Laredo border crossing. Thus, there are three carriers available for the first northward segment from the border, where only two are needed to form two independent routes.
12. Moreover, UP and BNSF reach all the major east-west U.S. gateways, as well as other established interchange locations, and CPKC’s network reaches the New Orleans and East St. Louis gateways. In addition, CPKC interchanges traffic at other locations with Eastern railroads. This flexibility allows for efficient routes from the Eagle Pass and Laredo border crossings to the BEAs at the U.S. end of the corridors that are independent of one another,

⁹ The columns in Table D - 2 are analogous to those in Table D - 1, except that the columns showing traffic for UP, BNSF, and CPKC show the number of cars moved from the border to the U.S. interchange used in the alternative viable route (*e.g.*, Chicago, East St. Louis, etc.). For CN, CSX, and NS the columns show the number of cars moved from the indicated U.S. interchange to the BEA at the U.S. end of the corridor.

meaning that the proposed merger results in no loss of independent routes in these corridors.

13. The ninth corridor between Birmingham, AL, and the State of Mexico has service from FXE to Eagle Pass, CPKC to Laredo, and from a rail ferry, CGR, that moves traffic from Mobile, AL, to the Port of Coatzacoalcas in Veracruz, Mexico with continuing service to state of Mexico on Ferrocarril del Sureste.¹⁰ I treat this as a third independent option in that corridor.

Table D - 2
Flagged Corridors with Origins or Destinations in Mexico {{

}}

Source: Waybill data; see backup for details.

Notes: The additional independent route column shows an alternative route found in PC Miler that, in conjunction with other routes that appear in the waybill data, ensures that the algorithm finds no reduction in the number of independent routes as the result of the merger. [1] For the Birmingham, AL-Mexico, MX corridor, the BNSF column presents total traffic between Birmingham and Eagle Pass carried by BNSF.

14. Table D - 2 shows that by connecting existing rail segments at major gateways, U.S. railroads can combine to create two independent routes from the border to the U.S. ends of

¹⁰ See my backup. Ferrocarril del Sureste is owned by Grupo Mexico, which owns a majority interest in FXE. See International Railway Journal, “Grupo Mexico Mulls Sale of Rail Business Stake,” available at <https://www.railjournal.com/financial/grupo-mexico-mulls-sale-of-rail-business-stake/>. See also, Grupo Mexico, “About Us,” available at <https://www.gmexico.com/en/transportation/>. Treating them as one railroad for purposes of the algorithm would imply only two independent routes pre-merger, and the same viable route identified below would restore two independent routes.

the nine corridors involving Mexico. The columns are analogous to those in Table D - 1, except that the columns showing traffic for UP, BNSF, and CPKC show the number of cars moved from the border to the U.S. interchange used in the alternative viable route (*e.g.*, Chicago, East St. Louis, etc.). For CN, CSX, and NS the columns show the number of cars moved from the indicated U.S. interchange to the BEA at the U.S. end of the corridor. Table D - 2 demonstrates that each corridor flagged (using the set of routes from the waybill data) as losing an independent route has a viable alternative route that ensures the routes from Eagle Pass and Laredo to the U.S. BEA are independent.

15. In addition, the table shows that the Birmingham, AL-Mexico, MX corridor retains three independent routes following the merger, with an alternative single-line route from Eagle Pass to Birmingham on BNSF.
16. For several of these corridors, most of the traffic moves from Mexico to one border crossing or the other. In these cases, there may actually be only one independent route both before and after the merger for many shippers from the state at the Mexican end of the corridor. That is, shippers that bear significant costs to substitute between FXE and CPKC in Mexico effectively have only one route to the border and, thus, effectively only one independent route both before and after the merger rather than the two assumed here. In such cases, there is clearly no loss of independent routes from the merger.

V. ECONOMIC ANALYSIS DEMONSTRATES NO COMPETITIVE HARM IN REMAINING CORRIDORS

17. As noted above, there are two U.S. corridors for which the modified algorithm, described above, still did not identify a viable alternative route at a major gateway. However, additional analysis shows there is no valid competitive concern about these corridors.
18. **Indianapolis, IN-IL - Springfield, IL-MO.** As shown in bold in the left-hand panel of Figure D - 1, before the UP/NS merger, the Indianapolis-to-Springfield, IL corridor has three independent routes: (1) NS; (2) CPKC-CSXT; and (3) IMRR-UP-INRD. As seen in the figure, NS's single-line service carries more than {{ }} of the cars in the corridor. Thus, despite several alternative interline routings, the corridor is nearly sole-served by NS prior to the UP/NS merger.

19. The route that loses independence post-merger is the IMRR-UP-INRD route, which carried 0 cars per year, on average. However, CN also interconnects with the IMRR and INRD, so an IMRR-CN-INRD route is also viable but does not connect at a major gateway. In addition, CN reaches the Indianapolis, IN and Springfield, IL BEAs with no interconnections with other railroads. Adding either of these routes to the set considered by the algorithm would allow the corridor to retain three independent routes following the UP/NS merger.
20. Figure D - 2 shows maps of the independent routes in the corridor before and after the merger.

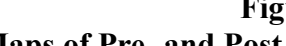
Figure D - 1
Traffic Through Pre- and Post-Merger Routes {{

}}

Source: Waybill data; see Table D - 3.

Figure D - 2
Maps of Pre- and Post-Merger Independent Route

Pre-Merger

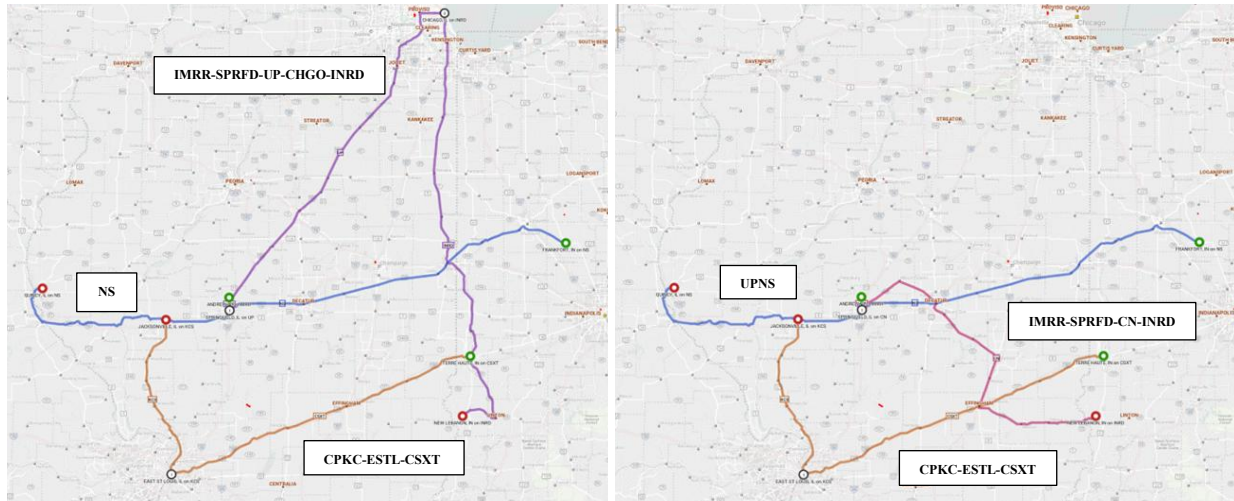


This map shows the independent route for the Pre-Merger scenario. It features a network of roads with various colored segments (red, blue, green, yellow) indicating different route types or priorities. The route starts at a central point and branches out to several destinations, with some segments highlighted in red to indicate the primary independent route.

Post-Merger



This map shows the independent route for the Post-Merger scenario. It displays a similar network of roads as the Pre-Merger map, but with different segment colorings and route highlights. The red segments, which were prominent in the Pre-Merger map, are now more fragmented, suggesting a change in the primary independent route due to the merger.



Source: PCMiler Rail 31.

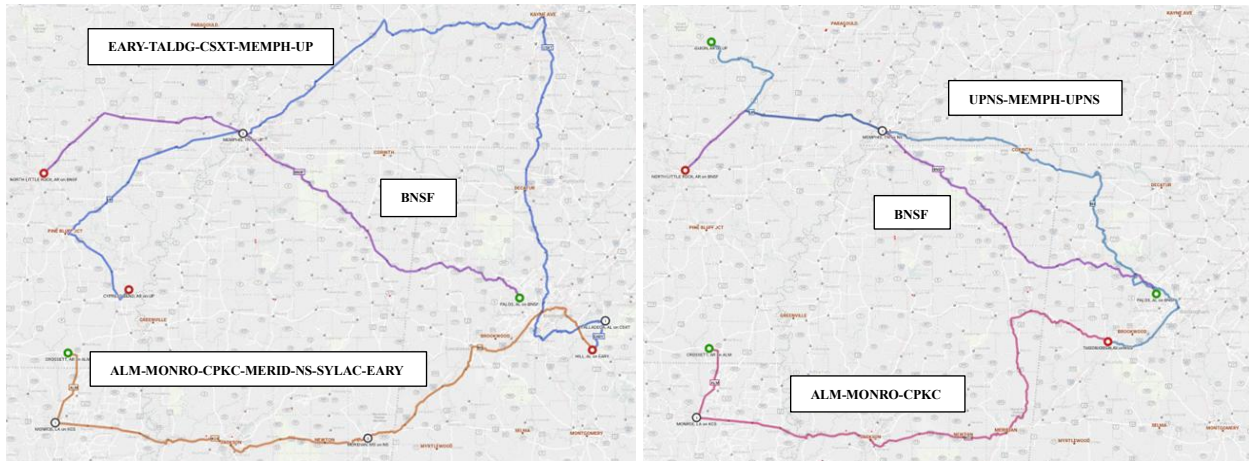
21. **Birmingham, AL - Little Rock-North Little Rock, AR.** As shown in bold in Figure D - 3, the algorithm finds three independent routes in the Birmingham-to-Little Rock corridor prior to the UP/NS merger and two independent routes post-merger. The route that loses independence post-merger involves NS and three other railroads and carries only {{ }} of the corridor's traffic. However, additional options are, in fact, available. For example, ALM and CPKC can exchange traffic at Monroe, and CPKC reaches the Birmingham BEA from Monroe, without connecting with NS or other railroads. As the right-hand panel of Figure D-3 shows, once the ALM-CPKC route is accounted for, there is no reduction in the number of independent routes in the corridor as the result of the UP/NS merger.
22. Figure D - 4 shows maps of pre-merger and post-merger independent routes in the corridor.

Figure D - 3
Traffic Through Pre- and Post-Merger Routes {{

}}

Source: Waybill data; see Table D - 3.

Figure D - 4
Maps of Pre- and Post-Merger Independent Route
Pre-Merger **Post-Merger**



Source: PCMiller Rail 31.

VI. ROUTE DETAILS BY CORRIDOR

23. For each corridor listed in Tables D - 1 and D - 2, Table D - 3 shows all routes, both before and after the UP/NS merger, with the independent routes in bold, as well as the underlying route details.

Table D - 3
Traffic Through Pre- and Post-Merger Routes in all Flagged Corridors {}

}}

Source: Waybill data; see backup for details.

Notes: The Post-merger Routes column shows an alternative route constructed by the interconnection of existing rail segments at a major gateway and validated by PC Miler in the bottom row of each corridor. This route, in conjunction with other routes that appear in the waybill data, ensures that the algorithm finds no reduction in the number of independent routes as the result of the merger or that the algorithm finds the corridor to have three or more independent routes post-merger. A set of pre- and post-merger independent routes is highlighted in bold for each corridor. The set of independent routes in a corridor need not be unique.

ATTACHMENT 1

Mark A. Israel
Founding Partner, Econic Partners

April 2026

655 New York Avenue, NW
Suite 800
Washington, DC 20001
(301) 938-5094 (mobile)

Email: misrael@econicpartners.com

Bio: <https://econicpartners.com/people/mark-a-israel>

AREAS OF EXPERTISE

- Industrial organization economics; Antitrust and Competition economics
- Applied econometrics
- Economic and econometric analysis of horizontal and vertical mergers
- Economic and econometric analysis of antitrust litigation topics, including: Class certification, damages, and liability issues in cases involving price fixing, exclusive dealing, monopolization, bundling, price discrimination, and exclusionary practices

INDUSTRIES OF EXPERTISE AND CASE HIGHLIGHTS

- Particular expertise in industries including: Wireline and wireless telecommunications; Digital advertising; Internet and other high technology markets; Media; Sports; Airlines; Railroads; Consumer Packaged Goods; Distribution services; Financial exchanges; Biotech; Healthcare; Hotels; Rental Cars; Insurance markets; Credit Cards; Energy markets; Retail
- Selected litigation highlights: CCB v. Rogers/Shaw; FTC v. Tempur Sealy/Mattress Firm; FTC v. Sysco/US Foods; DOJ and Private Google AdTech Litigation; DOJ v. Google Search Litigation; Various matters against Reynolds & Reynolds and CDK Global; 10X v. Vizgen; Various litigation matters involving Acthar; Rail Fuel Surcharge Litigation; NFL Sunday Ticket Antitrust Litigation; PGA Tour v. LIV Golf; Viamedia v. Comcast; Capacitors Price Fixing Jury Trial; Verizon-Tracfone Hearings; Sprint-T-Mobile Hearings; DOJ v. AT&T/Time Warner; Determination of Cable Royalty Funds
- Research published in leading peer-reviewed journals including *The American Economic Review*, *Economics Letters*, *The Rand Journal of Economics*, *The Journal of Law and Economics*, *The Journal of Industrial Economics*, *The International Journal of Industrial Organization*, *The Review of Industrial Organization*, *The Journal of Competition Law and Economics*, and *The Review of Network Economics*
- Co-author of the chapter on Econometrics and Regression Analysis in the ABA Treatise, *Proving Economic Damages: Legal and Economic Issues*, 2017

EDUCATION

- Ph.D., Economics, Stanford University, June 2001
- M.S., Economics, University of Wisconsin-Madison, August 1992
- B.A., Economics, Illinois Wesleyan University, Summa Cum Laude (4.0), May 1991

EMPLOYMENT HISTORY

Econic Partners

Founding Partner: April 2025 – Present

Compass Lexecon

President: December 2023 – March 2025

Head of North American Antitrust Practice: January 2016 – December 2023

Executive Vice President: April 2013 – December 2015

Senior Vice President: January 2009 – March 2013

Vice President: January 2008 – December 2008

Economist: January 2006 – December 2007

Kellogg School of Management, Northwestern University

Associate Professor of Management and Strategy: 2007 – 2008

Assistant Professor of Management and Strategy: 2000 – 2006

State Farm Insurance

Research Administrator: August 1992 – August 1995

RECENT PROFESSIONAL RECOGNITIONS

Global Competition Review, *Economist of the Year*, 2023

Who's Who Legal, *Global Elite Thought Leader in Competition*: 2022, 2023, 2024, 2025, 2026

Who's Who Legal, *Recommended Expert Witness in Arbitration*: 2024, 2026

LIVE TESTIMONIAL EXPERIENCE

Live testimony in front of arbitration panel in confidential arbitration regarding wholesale roaming rate for wireless telecommunications: October 21, 2025.

Testimony as Economic Expert on behalf of Hattie Mitchell et al., In the Matter of *Arrieona Beal v. Hattie Mitchell et al. v. NL Industries, Inc. and John Does 1-50*, In the Circuit Court of Milwaukee County State of Wisconsin, Case No. 2021-CV-003276, Deposition: July 22, 2025.

Testimony as Economic Expert on behalf of Google, LLC, In the Matter of *United States of America et al. v. Google LLC*, In the United States District Court for the District of Columbia, CV No. 20-3010, Live Trial Testimony at Remedies Hearing: May 2, 2025.

Testimony as Economic Expert on behalf of Google, LLC, In the Matter of *United States of America et al. v. Google LLC* (Case No. 1:20-cv-03010-APM), and *State of Colorado et al. v. Google LLC* (Case No. 1-20-cv-03715-APM), In the United States District Court for the District of Columbia, Deposition: November 3, 2022; November 4, 2022; Live Trial Testimony: November 2, 2023; November 3, 2023; November 6, 2023; Deposition: April 8, 2025.

Testimony as Economic Expert on behalf of Google LLC, *In Re Google Digital Advertising Antitrust Litigation*, In the United States District Court for the Southern District of New York, Case No. 1:21-md-3010 (PKC), Deposition: March 31, 2025; April 1, 2025.

Testimony as Economic Expert on behalf of 10X Genomics, Inc., In the Matter of *10X Genomics, Inc. and Fellows of Harvard College v. Bruker Spatial Biology, Inc. et al.*, In the United States District Court for the District of Delaware, C.A. No. 22-261-MFK, Deposition: February 25, 2025.

Testimony as Economic Expert on behalf of Tempur Sealy International, Inc., In the Matter of *Federal Trade Commission v. Tempur Sealy International, Inc. and Mattress Firm Group Inc.*, In the United States District Court for the Southern District of Texas Houston Division, Case No. 4:241-CV-02508, Deposition: October 29, 2024; Live Trial Testimony: November 25, 2024.

Testimony as Economic Expert on behalf of 10X Genomics, Inc., In the Matter of *10X Genomics, Inc. and President and Fellows of Harvard College v. Vizgen, Inc.; Vizgen, Inc. v. 10X Genomics, Inc. and President and Fellows of Harvard College (Counterclaim)*, In the United States District Court for the District of Delaware, Civil Action No. 22-595-MFK, Deposition: October 23, 2024.

Testimony as Economic Expert on behalf of The Kroger Company and Albertsons Companies, Inc., In the Matter of the *State of Colorado ex rel. Philip J. Weiser, Attorney General v. The Kroger Co.; Albertsons Companies, Inc.; and C&S Wholesale Groceries, LLC*, In the District Court, City and County of Denver, Colorado, Case No. 24CV30459, Live Trial Testimony: October 17, 2024; October 18, 2024.

Testimony as Economic Expert on behalf of The Kroger Company and Albertsons Companies, Inc., In the Matter of the *State of Washington v. The Kroger Company*, In the United States Superior Court of Washington for King County, Case No. 24-200977-9 SEA, Deposition: August 20, 2024; Live Trial Testimony: October 7, 2024.

- Testimony as Economic Expert on behalf of Google LLC, In the Matter of *United States of America et al. v. Google, LLC*, In the United States District Court for the Eastern District of Virginia Alexandria Division, Case No. 1:23-cv-00108-LMB-JFA, Deposition: March 14, 2024; Live Trial Testimony: September 26, 2024.
- Testimony as Economic Expert on behalf of The Kroger Company and Albertsons Companies, Inc., In the Matter of *FTC et al. v. Kroger and Albertsons*, In the United States District Court District of Oregon Portland Division, Case No. 3:24-cv-00347-AN, Deposition: July 22, 2024; Economic Expert Tutorial: July 26, 2024; Live Trial Testimony: September 11, 2024.
- Testimony as Economic Expert on behalf of Johns Manville Corporation, In the Matter of *Chase Manufacturing, Inc. d/b/a Thermal Pipe Shields v. Johns Manville Corporation*, In the United States District Court for the District of Colorado, Civil Action No. 19-cv-00872-MEH, Live Trial Testimony: May 2, 2024.
- Testimony as Economic Expert on behalf of AT&T, Application of Pacific Bell Telephone Company d/b/a AT&T California (U1001) To Relinquish Its Eligible Telecommunications Carrier Designation, Before the Public Utilities Commission of the State of California, A.23-03-002, Rebuttal Testimony: January 19, 2024; Live Testimony at Evidentiary Hearing: April 9, 2024.
- Testimony as Economic Expert on behalf of Trinity, In the Matter of *Commonwealth of Virginia, Ex. rel. and Joshua Harman v. Trinity Industries, Inc. et al. and Trinity Highway Products, LLC*, In the Circuit Court for the City of Richmond, Case No. CL 13-698, Deposition: January 30, 2024.
- Testimony as Economic Expert on behalf of Authenticom, Inc., *In Re Dealer Management Systems Antitrust Litigation*, United States District Court for the Northern District of Illinois Eastern Division, MDL 2817, Case No. 1:18-CV-864, Deposition: January 16, 2020; January 17, 2020; January 19, 2024.
- Testimony as Economic Expert on behalf of AT&T, Application of Pacific Bell Telephone Company d/b/a AT&T California (U 1001 C) for Targeted Relief from Its Carrier of Last Resort Obligation and Certain Associated Tariff Obligations, Before the Public Utilities Commission of the State of California, A.23-03-003, Opening Testimony: December 19, 2023.
- Testimony as Economic Expert on behalf of Express Scripts, Inc., In the Matter of *Series 17-03-615, a designated series of MSP Recovery Claims, Series LLC et al. v. Express Scripts, Inc. et al.*, In the United States District Court for the Northern District of Illinois Western Division, Case No. 3:20-cv-50056, Deposition: December 7, 2023.
- Testimony as Economic Expert on behalf of IQVIA Holdings Inc. and Propel Media, Inc., In the Matter of *Federal Trade Commission v. IQVIA Holdings Inc. and Propel Media, Inc.*, In the United States District Court for the Southern District of New York, Case No. 1:23-cv-06188-ER, Deposition: November 9, 2023; Live Trial Testimony: November 30, 2023.

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- Second Report of Dr. Mark A. Israel, Between *UK Trucks Claim Limited and (1) – (5) Fiat Chrysler Automobiles NV and (1) – (4) MAN Truck & Bus AG & ORS*, In the Competition Appeal Tribunal, Case No. 1282/7/7/18, April 11, 2019.

- Expert Report of Mark A. Israel, In the Matter between *Ryan Kett, Erik Oun and Jim Wong and Kobe Steel, Ltd., Shinko Metal Products Co., Ltd., Shinko Aluminum Wire Co., Ltd., Shinko Wire Stainless Company, Ltd., Kobelco & Materials Copper Tube Co., and Nippon Koshuha Steel Co., Ltd.*, In the Supreme Court of British Columbia, Case No. S-1710805, March 28, 2019.
- Expert Report of Dr. Mark A. Israel, Between *Road Haulage Association and (1) – (10) MAN SE and Others and (1) Daimler AG, (2) Volvo Lastvagnar Aktiebolag*, In the Competition Appeal Tribunal, Case No. 1289/7/7/18, March 22, 2019.
- Submission of Robert J. Calzaretta, Jr., Mark A. Israel, and Maya Meidan, “Assessing the Effects of ATI and JV Overlaps on Nonstop Fares: An Event Study Approach,” submitted as part of a Supplement to Joint Motion to Amend Order 2010-7-8 for Approval of and Antitrust Immunity for Amended Joint Business Agreement, In the Application of American Airlines, Inc., British Airways PLC, OpenSkies SAS, Iberia Líneas Aéreas de España, S.A., Finnair OYJ, Aer Lingus Group DAC, Before the U.S. Department of Transportation, Washington, DC, Docket DOT-OST-2008-0252-, January 11, 2019.
- Declarations of Mark A. Israel, In the Matter of *Oscar Insurance Company of Florida v. Blue Cross and Blue Shield of Florida, Inc., d/b/a Florida Blue; Health Options Inc., d/b/a Florida Blue HMO; and Florida Health Care Plan Inc., d/b/a Florida Health Care Plans*, In the United States District Court Middle District of Florida Orlando Division, Case No. 6:18-cv-01944, Declaration: November 19, 2018; Supplemental Declaration: December 21, 2018.
- Reply Declaration of Mark Israel, Michael Katz, and Bryan Keating, In the Matter of Applications of T-Mobile US, Inc. and Sprint Corporation, Consolidated Applications for Consent to Transfer Control of Licenses and Authorizations, Federal Communications Commission, WT Docket No. 18-197, September 17, 2018.
- Expert Report of Gustavo Bamberger, Robert Calzaretta, and Mark Israel, In the Joint Application of Hawaiian Airlines, Inc. and Japan Airlines, Co., Ltd., Appendix 6 to “Joint Application for Approval of and Antitrust Immunity for Alliance Agreements,” Department of Transportation, Case No. DOT-OST-2018-0084, June 13, 2018.
- Expert Reports of Mark A. Israel, In the Matter between *Cygnus Electronics Corporation and Sean Allott and Panasonic Corporation et al.*, In the Ontario Superior Court of Justice, Court File No. 3795/14CP, Initial Report: November 17, 2017; Reply Report: February 23, 2018; Supplemental Report: May 22, 2018.
- Expert Report of Mark A. Israel, In the Matter of the *Federal Trade Commission v. Wilh. Wilhelmsen Holding ASA Wilhelmsen Maritime Services As Resolute Fund II, L.P. Drew Marine Intermediate II B.V. and Drew Marine Group, Inc.*, In the United States District Court for the District of Columbia, No. 1:18-cv-00414-TSC, May 11, 2018.
- Declaration of Mark A. Israel, In the Matter between *Robert Foster and Murray Davenport and Sears Canada Inc. et al.*, In the Ontario Superior Court of Justice, Court File No. 766-2010 CP, November 1, 2017.

- Expert Report of Mark Israel and Bryan Keating, “Economic Analysis of Dr. Evans’ Claims as They Relate to *Restoring Internet Freedom*,” Federal Communications Commission, WC Docket No. 17-108, October 31, 2017.
- Declaration of Mark A. Israel, Allan L. Shampine, and Thomas A. Stemwedel, In the Matter of *Restoring Internet Freedom*, Federal Communications Commission, WC Docket No. 17-108, July 17, 2017.
- Expert Report of Dr. Mark A. Israel, In the Matter of *St. Clair County, Illinois, and Macon County, Illinois, Individually and on behalf of all other counties in the State of Illinois, v. Trinity Industries, Inc. and Trinity Highway Products, LLC*, In the United States District Court for the Southern District of Illinois, Civil Action No.: 3:14-cv-1320, April 25, 2017.
- Expert Reports of Mark A. Israel, In the Matter of the *United States of America v. Energy Solutions, Inc., Rockwell Holdco, Inc., Andrews County Holdings, Inc., and Waste Control Specialists, LLC*, In the United States District Court for the District of Delaware, Civil Action No. 16-cv-01056-SLR, Initial Report: March 27, 2017; Rebuttal Report: April 10, 2017.
- Expert Report of Mark A. Israel, In the Matter of *Jackson County, Missouri, Individually and on behalf of a class of others similarly situated, v. Trinity Industries, Inc., and Trinity Highway Products, LLC*, In the Circuit Court of Jackson County, Missouri at Independence, Case No. 1516-CV23684, March 24, 2017.
- Expert Report of Mark A. Israel, In the Matter of *Honeywell International Inc. v. iControl Networks, Inc. and Alarm.com Holdings, Inc.*, In the United States District Court for the District of New Jersey, No. 2:17-cv-01227, February 26, 2017.
- Expert Report of Mark Israel, In the Matter of *Social Ranger, LLC v. Facebook, Inc.*, In the United States District Court for the District of Delaware, C.A. No. 14-1525-LPS, November 23, 2016.
- Expert Report of Mark A. Israel, In the Matter between *Darren Ewert and DENSO Corporation et al.*, In the Supreme Court of British Columbia, Vancouver Registry, No. S-135610, November 15, 2016.
- Expert Reports of Mark A. Israel, In the Matter of the *United States of America et al. v. Anthem Inc. and Cigna Corp.*, In the United States District Court, District of Columbia, No. 16-cv-01493 (ABJ), Initial Report: October 7, 2016; Supplemental and Rebuttal Report: October 28, 2016.
- Verified Statements of Mark Israel and Jonathan Orszag, “Review of Commodity, Boxcar, and TOFC/COFC Exemptions,” Surface Transportation Board, Docket No. EP 704 (Sub-No. 1), Initial Verified Statement: July 26, 2016; Reply Verified Statement: August 26, 2016.
- Declarations of Mark Israel, Daniel Rubinfeld, and Glenn Woroch, “Analysis of the Regressions and Other Data Relied Upon in the Business Data Services FNPRM And a Proposed Competitive Market Test,” Federal Communications Commission, WC Docket Nos. 16-143, 15-247, 05-25, RM-10593, Second Declaration: June 28, 2016; Third Declaration: August 9, 2016.

- Expert Declaration of Mark A. Israel, In the Matter of *Lieberman Broadcasting, Inc. and LBI Media, Inc. v. Comcast Corporation and Comcast Cable Communications, LLC*, Federal Communications Commission, MB Docket No. 16-121, June 7, 2016.
- Expert Report of Mark A. Israel, In the Matter of *La Crosse County, Individually, and on behalf of all others similarly situated v. Trinity Industries, INC. and Trinity Highway Products, LLC*, In the United States District Court, Western District of Wisconsin, Case No. 3:15-cv-00117-scl, May 27, 2016.
- Expert Report of Mark A. Israel, In the Matter between *Darren Ewert and Nippon Yusen Kabushiki Kaisha et al.*, In the Supreme Court of British Columbia, Vancouver Registry, No. S-134895, May 20, 2016.
- Declarations of Mark Israel, Daniel Rubinfeld, and Glenn Woroch, In the Matter of *Special Access Rates for Price Cap Local Exchange Carriers*, Federal Communications Commission, WC Docket No. 05-25, Declaration: February 19, 2016; Supplemental Declaration: March 24, 2016; Second Supplemental Declaration: April 20, 2016.
- Declaration of Mark Israel, Daniel Rubinfeld, and Glenn Woroch, “Competitive Analysis of the FCC’s Special Access Data Collection,” Federal Communications Commission, WC Docket No. 05-25, January 26, 2016.
- Declaration of Dr. Mark Israel, In the Matter of *iPic – Gold Class Entertainment, LLC et al., v. Regal Entertainment Group, AMC Entertainment Holdings, Inc. et al.*, In the District Court of Harris County, Texas, 234th Judicial District, No. 2015-68745, January 18, 2016.
- Declaration of Dennis Carlton, Mark Israel, Allan Shampine & Hal Sider, “Investigation of Certain Price Cap Local Exchange Carrier Business Data Services Tariff Pricing Plans,” Federal Communications Commission, WC Docket No. 15-247, January 7, 2016.
- Declaration of Mark A. Israel, Attached to “Response of AT&T Mobility LLC to Notice of Apparent Liability for Forfeiture,” Federal Communications Commission, File No. EB-IHD-14-00017504, July 17, 2015.
- Reports in the Matter of *Federal Trade Commission et al. v. Sysco Corporation and USF Holding Corp.*, In the United States District Court for the District of Columbia, Civil Action No. 1:15-cv-00256 (APM), Declaration: February 18, 2015; Report: April 14, 2015; Rebuttal Report: April 21, 2015.
- Declaration of Mark A. Israel, Bryan G. M. Keating, and David Weiskopf, “Economic Analysis of the Effect of the Comcast-TWC Transaction on Voice and Broadband Services in California,” December 3, 2014.
- Expert Report of Mark A. Israel, “Economic Analysis of the Effect of the Comcast-TWC Transaction on Broadband: Reply to Commenters,” Federal Communications Commission, MB Docket No. 14-57, September 22, 2014.
- Supplemental Declaration of Mark Israel and Allan Shampine, In the Matter of *Amendment of the Commission’s Rules Related to Retransmission Consent, Appendix A to “Reply Comments of the National Association of Broadcasters,”* Federal Communications Commission, MB Docket No. 10-71, July 24, 2014.

- Declaration of Mark Israel and Allan Shampine, In the Matter of *Amendment of the Commission's Rules Related to Retransmission Consent, Appendix B to "Comments of the National Association of Broadcasters,"* Federal Communications Commission, MB Docket No. 10-71, June 26, 2014.
- Expert Report of Mark A. Israel, "Implications of the Comcast/Time Warner Cable Transaction for Broadband Competition," Federal Communications Commission, MB Docket No. 14-57, April 8, 2014.
- Declaration of Michael L. Katz, Philip A. Haile, Mark A. Israel, and Andres V. Lerner, "Sprint's Proposed Weighted Spectrum Screen Defies Economic Logic and Is Inconsistent with Established Facts," Federal Communications Commission, WT Docket No. 12-269, March 14, 2014.
- Reply Declaration of Mark A. Israel, "Competitive Effects and Consumer Benefits from the Proposed Acquisition of Leap Wireless by AT&T: A Reply Declaration," Federal Communications Commission, WT Docket No. 13-193, October 23, 2013.
- Declaration of Mark A. Israel, "An Economic Analysis of Competitive Effects and Consumer Benefits from the Proposed Acquisition of Leap Wireless by AT&T," Federal Communications Commission, WT Docket No. 13-193, August 1, 2013.
- Supplemental Reply Declaration of Michael L. Katz, Philip A. Haile, Mark A. Israel, and Andres V. Lerner, "Comments on Appropriate Spectrum Aggregation Policy with Application to the Upcoming 600 MHz Auction," Federal Communications Commission, WT Docket No. 12-269, June 13, 2013.
- Reply Declaration of Michael L. Katz, Philip A. Haile, Mark A. Israel, and Andres V. Lerner, "Comment on the Submission of the U.S. Department of Justice Regarding Auction Participation Restrictions," Federal Communications Commission, WT Docket No. 12-269, June 13, 2013.
- Reply Declaration of Michael L. Katz, Philip A. Haile, Mark A. Israel, and Andres V. Lerner, "Spectrum Aggregation Policy, Spectrum-Holdings-Based Bidding Credits, and Unlicensed Spectrum," Federal Communications Commission, GN Docket No. 12-268, March 12, 2013.
- Declaration of Igal Hendel and Mark A. Israel, "Econometric Principles That Should Guide the Commission's Analysis of Competition for Special Access Service," Federal Communications Commission, WC Docket No. 05-25, February 11, 2013.
- Declarations of Mark A. Israel and Michael L. Katz, "Economic Analysis of Public Policy Regarding Mobile Spectrum Holdings," Federal Communications Commission, WT Docket No. 12-269, Declaration: November 28, 2012; Reply Declaration: January 7, 2013.
- Declaration of Mark Israel, "An Economic Assessment of the Prohibition on Exclusive Contracts for Satellite-Delivered, Cable-Affiliated Networks," Federal Communications Commission, MB Docket Nos. 12-68, 07-18, & 05-192, September 6, 2012.
- Expert Report of Mark Israel, "Implications of the Verizon Wireless & SpectrumCo/Cox Commercial Agreements for Backhaul and Wi-Fi Services Competition," Federal Communications Commission, WT Docket No. 12-4, August 1, 2012.

- Expert Report of Mark A. Israel, Michael L. Katz, and Allan L. Shampine, “Promoting Interoperability in the 700 MHz Commercial Spectrum,” Federal Communications Commission, WT Docket No. 12-69, July 16, 2012.
- Affidavits of Dr. Mark A. Israel in the Matter of *Bloomberg L.P. v. Comcast Cable Communications, LLC*, Federal Communications Commission, MB Docket No. 11-104, Declaration: June 21, 2012; Declaration: June 8, 2012; Supplemental Declaration: September 27, 2011; Declaration: July 27, 2011.
- Expert Report of Robert Willig, Mark Israel, Bryan Keating, and Jonathan Orszag, “Response to Supplementary Comments of Hubert Horan,” Docket DOT-OST-2009-1055, October 22, 2010.
- Expert Report of Robert Willig, Mark Israel, Bryan Keating, and Jonathan Orszag, “Measuring Consumer Benefits from Antitrust Immunity for Delta Air Lines and Virgin Blue Carriers,” Docket DOT-OST-2009-1055, October 13, 2010.
- Expert Report of Mark Israel and Michael L. Katz, “Economic Analysis of the Proposed Comcast-NBCU-GE Transaction,” Federal Communications Commission, MB Docket No. 10-56, July 20, 2010.
- Expert Report of Mark Israel and Michael L. Katz, “The Comcast/NBCU Transaction and Online Video Distribution,” Federal Communications Commission, MB Docket No. 10-56, May 4, 2010.
- Expert Report of Mark Israel and Michael L. Katz, “Application of the Commission Staff Model of Vertical Foreclosure to the Proposed Comcast-NBCU Transaction,” Federal Communications Commission, MB Docket No. 10-56, February 26, 2010.
- Expert Report of Robert Willig, Mark Israel, and Bryan Keating, “Competitive Effects of Airline Antitrust Immunity: Response of Robert Willig, Mark Israel, and Bryan Keating” in Docket DOT-OST-2008-0252, January 11, 2010.
- Affidavit of Dr. Mark A. Israel on Class Certification in the Matter of Puerto Rican Cabotage Antitrust Litigation, in the United States District Court for the District of Puerto Rico, MDL Docket No. 3:08-md-1960 (DRD), December 10, 2009.
- Expert Report of Robert Willig, Mark Israel, and Bryan Keating, “Competitive Effects of Airline Antitrust Immunity,” Docket DOT-OST-2008-0252, September 8, 2009.
- Expert Report and Supplemental Expert Report of Dennis W. Carlton and Mark Israel in the Matter of *Toys “R” Us-Delaware, Inc., and Geoffrey Inc. v. Chase Bank USA N.A.*, in American Arbitration Association New York, New York, Commercial Arbitrations No. 13-148-02432-08, Expert Report: February 27, 2009; Supplemental Expert Report: March 20, 2009.
- Expert Reports of James Levinsohn and Mark Israel, In the Matter of *2006 NPM Adjustment Proceeding pursuant to Master Settlement Agreement*, October 6, 2008; January 16, 2009; March 10, 2009.

SELECTED EXPERT WORK IN REVIEW OF MERGERS/TRANSACTIONS

Successful acquisition of Lumen’s mass market fiber business by AT&T, 2025. Served as lead economic expert for the merging parties. Made multiple submissions to the Department of Justice and contributed to white paper demonstrating benefits from the transaction due to complementarity between Lumen’s fiber business and AT&T’s wireless business, as well as lack of any basis to find harm due to de minimis overlap. Deal cleared with no second request.

Successful acquisition of General Mills’ US Yogurt Business by Lactalis, 2025. Served as lead economic expert for General Mills. Made multiple presentations to the Department of Justice showing lack of material substitution between General Mills’ yogurt products and Lactalis’ yogurt products and explaining the deficiencies in the DOJ’s economic modeling approach. Deal cleared with no conditions.

Successful acquisition of Viterra by Bunge Global, 2025. Served as lead economic expert for the merging parties in the United States and Canada. Performed extensive economic analysis and modeling to show lack of horizontal or vertical merger harms and significant efficiencies across a wide variety of agricultural products. Responded to modeling performed by a Canadian economic expert. Deal ultimately cleared with conditions.

Successful acquisition of Ansys by Synopsys, 2025. Served as lead economic expert for the merging parties. Developed economic analysis demonstrating lack of concern over vertical foreclosure issues for presentation to competition agencies in the US, EU, and UK.

Successful acquisition of NWEA by Houghton Mifflin Harcourt, 2023. Served as lead economic expert for Veritas Capital, owner of Houghton Mifflin Harcourt. Provided analyses demonstrating no significant competitive overlaps, no significant vertical concerns, and substantial pro-competitive benefits via integration of curriculum materials and assessment tools. Deal cleared by DOJ without a second request.

Successful merger of NortonLifelock and Avast to form Gen Digital, 2022. Served as lead economic expert for the parties in the United States. Presented economic analyses demonstrating very low levels of customer overlap between the two consumer cybersecurity firms and thus lack of horizontal merger concerns. Deal cleared by DOJ.

Successful acquisition of Sanderson Farms by Joint Venture of Cargill and Continental Grain, 2022. Served as potential testifying expert on behalf of all three parties. Presented economic analyses demonstrating lack of horizontal concerns to the DOJ.

Successful merger of Sony’s Crunchyroll and AT&T’s Funimation anime streaming platforms. 2021. Served as lead economic expert for AT&T. Made multiple presentations to DOJ, extremely limited consumer switching between them, as well as extensive competition with a broader marketplace including Netflix, Amazon, and others. DOJ closed the investigation allowing the merger to proceed with no conditions.

Successful acquisition of Innovative Industries, Inc. by Ex Libris. 2020. Served as lead economist in interactions with FTC. Demonstrated that the acquisition would not harm competition due to the *de minimis* extent of head-to-head competition between Ex Libris and Innovative and the recent decline of Innovative’s business. FTC closed investigation allowing acquisition to proceed with no conditions.

Successful acquisition of TD Ameritrade by Charles Schwab. 2020. Served as lead economist in interactions with DOJ. Presented analyses demonstrating broad market for investor dollars rather than narrow market for RIA Custodian Services. DOJ closed investigation allowing acquisition to proceed with no conditions.

Successful acquisition of Reinhart Foodservice by Performance Food Group Company. 2019. Served as lead economic expert on behalf of the parties in the FTC's investigation of the merger. Presented data analyses showing ample competition and lack of harm to competition in any geographic market. FTC closed the investigation with no conditions.

Successful acquisition of SGA's Food Group of companies by US Foods. 2019. Served as lead economic expert on behalf of the parties in the FTC's investigation of the merger. Presented detailed economics and econometric analyses showing ample competition and lack of harm to competition in any geographic market. FTC cleared the merger subject to divestitures in three geographic markets in the Fall of 2019.

Successful acquisition of Time Warner by AT&T Inc. 2017-2019. Lead economist throughout the DOJ investigation. Then director of all economic work during trial, serving as the central connection point between all experts and counsel and directing development of all aspects of the economic case. Defendants ultimately prevailed in trial and the merger closed in June 2018.

Successful acquisition of Keystone Foods by Tyson Foods, Inc. 2018. Served as lead economic expert for U.S. jurisdiction. Presented economic analyses demonstrating that competition would remain strong post-merger. Ultimately, antitrust agencies in the U.S., China, Japan, and Korea cleared the transaction.

Successful acquisition of NEX Group PLC by CME Group Inc. 2018. Co-lead economic expert with Thomas Stemwedel. Presented several econometric analyses demonstrating that Treasury futures contracts and cash Treasury securities were economic complements rather than substitutes. Based heavily on these Compass Lexecon submissions, the DOJ and CMA closed their investigations without requiring any divestitures.

Successful acquisition of VCA Inc. by Mars, Inc. 2017. Co-lead economic expert with Mary Coleman. Made multiple presentations to FTC demonstrating ample competition in general, emergency, and specialty veterinary services, including econometric analyses showing lack of direct competitive impact of Mars and VCA on one another. Transaction was ultimately cleared subject to a small number of divestitures.

Successful acquisition of Mobileye by Intel. 2017. Served as lead economic expert for Intel. Assisted counsel in preparing FTC presentations and materials demonstrating lack of significant head-to-head competition and lack of valid vertical foreclosure theories. Investigation was closed without Second Request.

FTC litigation against DraftKings, Inc. and FanDuel Inc. (Civil Action No. 17-cv-1195 (KBJ)). 2017. Served as economic expert for FTC and prepared to serve as FTC's testifying expert against the merger, prior to the parties' abandonment of the deal. Developed economic and econometric evidence that the merging parties were closest substitutes and thus likely would have increased prices as a result of their proposed merger.

- Successful merger of ASE Group and SPIL.* 2017. Lead economic expert on behalf of ASE Group. Submitted reports and testified to the Taiwan Fair Trade Commission, which ultimately cleared the transaction, then made multiple presentations to U.S. FTC, which also cleared the transaction. Economic analyses focused on implications of profit margins for market definition and competitive effects, ultimately demonstrating that the transaction was unlikely to cause significant harm to competition.
- Successful acquisition of Alarm.com of two business units (Connect and Piper) from iControl Networks.* 2017. Led team that demonstrated substantial and growing competition in home security and connected home marketplace and thus lack of competitive harm from acquisition. Work focused on importance of downstream market definition as well as empirical evidence of impact of competition on Alarm.com pricing and profitability.
- Successful acquisition of Samsung Electronics, Ltd.'s printer business by HP Inc.* 2016. Led team in evaluating the competitive effects of the acquisition, including assessing shares and competitive effects in overlap areas. Notably, the transaction gained regulatory approval in the U.S. during the initial review period without issuing a Second Request.
- Successful acquisition of Sun Products Corp. by Henkel AG.* 2016. Led team demonstrating lack of competitive impact despite overlaps in laundry detergent and related products.
- Successful acquisition of Starwood Hotels & Resorts by Marriott International.* 2016. Led team that performed detailed analysis of competitive conditions, extensive econometric analysis of pricing, and full review of Marriott's internal pricing models to demonstrate that Starwood and Marriott were not close competitors, combined ownership of the brands would not lead to upward pricing pressure, and competition would remain robust post-merger.
- Successful acquisition of PR Newswire by GTCR.* 2016. Lead economic expert for GTCR. Made presentations to DOJ showing lack of competitive harm from the transaction, based on detailed analysis of win/loss data, including calculations showing no possible upward pricing pressure (UPP) concerns regardless of the level of margins.
- Successful acquisition of Schurz Communications' Broadcast Stations by Gray Television.* 2015. Lead economic expert for Gray. Made presentations to DOJ demonstrating output expanding effects of proposed transaction in light of the scale economies in television production and advertising and the small size of the DMAs affected by the transaction.
- Successful acquisition of the Communications Business of Danaher Corporation by NetScout Systems.* 2015. Lead economic expert for NetScout. Made presentations to DOJ describing proper economic framework for analysis of competition and potential merger harms, and demonstrated that the presence of multiple viable competitors and numerous other credible threats to be used by powerful buyers in a dynamic industry made theories of anti-competitive harm from the merger implausible.
- Successful acquisition of Windmill Distribution Co. by Manhattan Beer Distributors.* 2015. Lead economic expert for Manhattan Beer Distributors. Submitted White Paper to DOJ demonstrating, based on margin data, that the merger would be highly unlikely to lead to anti-competitive effects. Transaction was granted early termination from the Hart Scott Rodino process by the DOJ.

Proposed acquisition of Time Warner Cable by Comcast Corporation. 2014-2015. Served as lead economic expert on broadband issues on behalf of Comcast Corporation. Submitted multiple Declarations and made multiple presentations to DOJ and FCC, explaining lack of horizontal, bargaining, or vertical/foreclosure concerns with regard to broadband competition as a result of the transaction.

Successful acquisition of Leap Wireless by AT&T. 2014. Lead economic expert for AT&T. Submitted multiple Declarations to FCC and made presentation to DOJ, demonstrating the transaction would generate substantial consumer benefits, while generating at most minimal upward pricing pressure in a properly defined mobile wireless services market and no issues related to spectrum concentration or other competitive concerns.

Successful merger of American Airline and US Airways. 2013. Lead consulting expert, managing Compass Lexecon team of over 25 economists supporting multiple experts. Made multiple presentations to DOJ, worked on expert reports in litigation, and assisted counsel with the analysis leading to settlement of litigation, permitting transaction to close.

Successful merger of T-Mobile USA and MetroPCS. 2013. Lead economic expert for T-Mobile USA. Conducted economic analyses of competitive effects and consumer benefits from the transaction, as well as consumer benefits from reduced costs and increased network quality. Presented analyses to both DOJ and FCC.

FTC investigation of acquisition of Dollar Thrifty Automotive Group by Hertz. 2012. Served as a lead economic expert for FTC and prepared to serve as FTC's testifying expert against the merger, prior to case settlement. Conducted empirical analyses based on previous rental car mergers demonstrating likely price increases from the transaction.

Decision by Federal Communications Commission not to extend the ban on exclusive contracts for satellite-delivered, cable-affiliated networks. 2012. Lead economic expert for National Cable and Telecommunications Association. Submitted economic analysis demonstrating that the ban on exclusive distribution of satellite-delivered, cable affiliated networks is no longer warranted given increased marketplace competition. FCC made decision to allow the ban to sunset.

Successful sale of wireless spectrum by SpectrumCo and Cox ("Cable Companies") to Verizon Wireless and successful completion of related commercial agreements. 2012. On behalf of the Cable Companies, performed economic analyses demonstrating lack of competitive harm from the transaction on markets for backhaul and Wi-Fi services. Presented analyses to FCC.

Successful acquisition by LIN Media of broadcast television stations from NVTN. 2012. Lead economic expert for LIN Media. Prepared economic analysis demonstrating lack of competitive concern over potential issues related to SSA and JSA Arrangements.

Proposed acquisition of T-Mobile USA by AT&T. 2011. Served as one of the lead economists, initially for T-Mobile (along with Michael Katz) and ultimately for both parties (along with Michael Katz and Dennis Carlton). Made multiple presentations to DOJ and FCC. Appeared in FCC Workshop, ex parte meeting.

Successful application for antitrust immunity by Delta and Virgin Blue. 2010. Together with Robert Willig, Bryan Keating, and Jon Orszag, prepared economic analyses demonstrating substantial net consumer benefits from antitrust immunity. Submitted results in expert reports to Department of Transportation.

Successful joint venture between Comcast and NBC Universal (and ultimate full acquisition of NBC Universal by Comcast). 2010. Served as one of the lead economists (along with Michael Katz) on behalf of the merging parties. Wrote multiple reports submitted to FCC (with Michael Katz) demonstrating lack of significant competitive concerns from the transaction. Made multiple presentations to DOJ and FCC. Appeared in FCC Workshop of economists, ex parte meeting.

Successful application for antitrust immunity for oneworld alliance and associated joint venture of American Airlines, British Airways, and Iberia Airlines. 2009-2010. Together with Robert Willig and Bryan Keating, prepared economic analyses demonstrating substantial net consumer benefits associated with antitrust immunity for the joint venture. Submitted results in expert reports to Department of Transportation.

Successful acquisition by PepsiCo of bottlers, PBG and PAS. 2009. Performed econometric and simulation analyses demonstrating pro-competitive effect of merger on PepsiCo's own brands, other brands distributed by PBG and PAS, and overall marketplace. Presented results to FTC (together with Dennis Carlton).

Successful merger of Delta Airlines and Northwest Airlines. 2008. In support of Dennis Carlton, developed empirical and theoretical analyses to demonstrate merger's pro-competitive nature. Work focused on (ultimately settled) private litigation opposing the merger.

Successful acquisition of Harcourt Education by Houghton Mifflin. 2007. Along with Daniel Rubinfeld and Frederick Flyer, developed econometric analyses demonstrating lack of competitive harm from proposed merger. Presented results to DOJ.

Successful acquisition of Chicago Board of Trade by Chicago Mercantile Exchange. 2007. Along with Robert Willig and Hal Sider, developed and presented multiple empirical analyses demonstrating lack of competitive harm from merger. Submitted multiple white papers and made multiple presentations to DOJ.

OTHER CONFIDENTIAL CONSULTING WORK IN THE FOLLOWING INDUSTRIES

Automobiles and Components

Consumer Durables

Consumer Services

Financial Services

Energy

Food, Beverage, and Tobacco

Healthcare Equipment and Services

Media

Pharmaceuticals, Biotechnology, and Life Sciences

Retail

Semiconductors and Semiconductor Equipment

Software and Related Services

Technology: Hardware and Equipment

Telecommunication Services

Transportation

Utilities

PUBLICATIONS AND RESEARCH IN PROGRESS

“Retail Price Parity as a Channel-Coordination Mechanism in Dual Distribution,” (with Michele Bisceglia, Salvatore Piccolo, and Paolo Ramezzana), available at <https://ssrn.com/abstract=6422058>, Submitted to *Management Science*, March 2026.

“Competitor Alliances,” (with Daniel O’Brien and Josephine Xu), available at <https://ssrn.com/abstract=6272898>, Submitted to *The Journal of Law and Economics*, February 2026.

“The Horizontal Effects of Competitor Alliances,” (with Daniel O’Brien and Josephine Xu), available at <https://ssrn.com/abstract=6271201>, Submitted to *Concurrences*, February 2026.

“Vertical Mergers with Bilateral Contracting and Upstream and Downstream Investment,” (with Daniel P. O’Brien), available at <https://ssrn.com/abstract=3886048>, Revised and Resubmitted to the *Journal of Economics & Management Strategy*, December 2025.

“Lessons from Foreclosure Parables: The Need to Tether Vertical Merger Analysis,” (with Daniel P. O’Brien), available at <https://ssrn.com/abstract=4726861>; Submitted to *The Review of Industrial Organization*, December 2025.

“RPM and Vertical Integration with Upstream Competition and Noncontractible Efforts,” (with Michele Bisceglia, Salvatore Piccolo, and Paolo Ramezzana), available at <https://ssrn.com/abstract=4913199>; forthcoming in *The Journal of Industrial Economics*, November 2025.

“The Challenges of Cartelization with Many Products and Ongoing Technological Advancements: LCD Crystal Displays Worldwide,” (with Dennis W. Carlton, Ian MacSwain, and Allan Shampine), Chapter 10 in *Cartels Diagnosed: New Insights on Collusion*, Joseph E. Harrington, Jr. and Maarten Pieter Schinkel, eds., December 2024.

“Dynamic Lerner Condition and Horizontal Merger Assessment,” (with Rodrigo Montes, Loren Poulsen, and Jason Wu), available at <https://ssrn.com/abstract=4817343>, May 2024.

- “Evaluating a Theory of Harm in a Vertical Merger: AT&T/Time Warner,” (with Dennis W. Carlton, Georgi V. Giozov, and Allan L. Shampine), Chapter 5 in *Antitrust Economics at a Time of Upheaval: Recent Competition Policy Cases on Two Continents*, John Kwoka, Jr., Tommaso M. Valletti, and Lawrence J. White, eds., August 2023.
- “Cheap Exclusion in Markets with Multiple Complements,” (with Erica Benton and Daniel P. O’Brien), Volume 89 in the *International Journal of Industrial Organization*, July 2023.
- “A Retrospective Analysis of the AT&T/Time Warner Merger” (with Dennis W. Carlton, Georgi V. Giozov, and Allan L. Shampine), Volume 65, Number S2, in the *Journal of Law and Economics*, November 2022.
- “New Merger Guidelines Should Keep the Consumer Welfare Standard” (with Jonathan Orszag and Jeremy Sandford), *CPI Antitrust Chronicle*, November 2022.
- “International Broadband Price Comparisons Tell Us Little about Competition and Do Not Justify Broadband Regulation,” working paper (with Michael Katz and Bryan Keating), commissioned by NCTA – The Internet & Television Association, May 11, 2021.
- “Effects of the 2010 Horizontal Merger Guidelines on Merger Review: Based on Ten Years of Practical Experience,” (with Dennis W. Carlton), Volume 58, Issue 2, in the *Review of Industrial Organization*, November 2020.
- “An Evaluation of the Impact of the 2010 Horizontal Merger Guidelines,” (with Dennis W. Carlton), available at <https://ssrn.com/abstract=3547653>, March 2020.
- “Lessons from AT&T/Time Warner,” (with Dennis W. Carlton and Allan L. Shampine), *Competition Policy International*, July 2019.
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- “Vertical Integration in Multichannel Television Markets: Revisiting Regional Sports Networks Using Updated Data,” (with Georgi Giozov, Nauman Ilias, and Allan Shampine), Volume 4:1 in *The Criterion Journal on Innovation*, 2019.
- “Are Legacy Airline Mergers Pro- or Anti-Competitive? Evidence from Recent U.S. Airline Mergers,” (with Dennis Carlton, Ian MacSwain, and Eugene Orlov), Volume 62, Pages 58-95, in the *International Journal of Industrial Organization*, January 2018.
- “Competitive Effects of International Airline Cooperation,” (with Robert J. Calzaretta and Yair Eilat), Volume 13, Issue 3, Pages 501-548, in the *Journal of Competition Law & Economics*, September 2017.
- “Econometrics and Regression Analysis,” (with Chris Cavanagh, Paul Denis, and Bryan Keating), Chapter 6 in the *American Bar Association’s Proving Antitrust Damages: Legal and Economic Issues, Third Edition*, 2017.
- “Do Premiums Increase After Health Insurance Mergers? – A Reassessment of Guardado et al.’s Findings,” (with Robert C. Bourke, Ben Wagner, and David A. Weiskopf), available at <https://ssrn.com/abstract=2933062>, March 2017.

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- “Antitrust in a Mobile World,” (with Yonatan Even, Jonathan M. Jacobson, Scott Martin, and Dr. Helen Weeds), Chapter 17 in *International Antitrust Law & Policy: Fordham Competition Law 2015*, James Keyte, ed., 2016.
- “Buyer Power in Merger Review,” (with Dennis W. Carlton and Mary Coleman), Chapter 22 in *The Oxford Handbook of International Antitrust Economics*, Volume 1, Roger D. Blair and D. Daniel Sokol, eds., 2015.
- “Airline Network Effects and Consumer Welfare,” (with Bryan Keating, Dan Rubinfeld, and Robert Willig), *Review of Network Economics*, available at <https://ssrn.com/abstract=2473243>, November 2013.
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- “The Delta-Northwest Merger: Consumer Benefits from Airline Network Effects (2008),” (with Bryan Keating, Daniel L. Rubinfeld, and Robert D. Willig), *The Antitrust Revolution*, Sixth Edition, John E. Kwoka, Jr. and Lawrence J. White, eds., July 2013.
- “Proper Treatment of Buyer Power in Merger Review,” (with Dennis W. Carlton), *Review of Industrial Organization*, July 2011.
- “Response to Gopal Das Varma’s Market Definition, Upward Pricing Pressure, and the Role of the Courts: A Response to Carlton and Israel,” (with Dennis W. Carlton), *The Antitrust Source*, December 2010.
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- “Tenure Dependence in Consumer-Firm Relationships: An Empirical Analysis of Consumer Departures from Automobile Insurance Firms,” *The Rand Journal of Economics*, Spring 2005.
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SELECTED PROFESSIONAL PRESENTATIONS

Penn Carey Law Antitrust Association 2026 Annual Symposium, Antitrust at an Inflection Point: Remedies, Regulation, and the New Political Economy, “Legal and Economic Tools for Ecosystem Regulation,” Panelist, April 10, 2026.

LexMundi 2024 Cross-Border Transactions Global Seminar, “U.S. Merger Control Fireside Chat,” Speaker, February 2024.

American Bar Association Section of Antitrust Law, “Nuts & Bolts of Presenting Economic Evidence to the Agencies: Common Pitfalls and Best Practices,” Panelist, October 2019.

Dechert LLP, 2019 Annual Antitrust Spring Seminar, Keynote Speaker, March 2019.

Concurrences Review and The George Washington University Law School, 6th Bill Kovacic Antitrust Salon: Where is Antitrust Policy Going?, “A Judge’s Eye View on Antitrust: Mergers, Cartels, Remedies...,” Panelist, September 2018.

Fordham Competition Law Institute, 45th Annual Conference on International Antitrust Law and Policy, “Merger Remedies,” Panelist, September 2018.

Georgetown Center for Business and Public Policy, “Airline Competition Conference,” Panelist, July 2017.

J.P. Morgan Special Situations Investor Forum, “The Antitrust Merger Review Process,” Panelist, March 2017.

American Bar Association Section of Antitrust Law, “Economic Issues Raised In The Comcast – Time Warner Cable Merger,” Panelist, February 2016.

Fordham Competition Law Institute, 42nd Annual Conference on International Antitrust Law and Policy, “Antitrust in a Mobile World,” Panelist, October 2015.

American Bar Association Section of Antitrust Law, “Merger Practice Workshop,” Faculty Member, October 2015.

Searle Center Conference on Antitrust Economics and Competition Policy, Panel on Recent Transactions in the Telecom Industry, Panelist, September 2015.

National Bureau of Economic Research, Summer Institute 2015, Industrial Organization Meetings, “Panel Discussion of the Comcast-Time Warner Merger,” Panelist, July 2015.

Federal Communications Bar Association, “How the Antitrust Agencies and the FCC are Likely to Analyze Vertical Mergers,” Panelist, November 2014.

The Coca Cola Company Global Antitrust Forum, “Round Table Discussion on Use of Economics and Economists,” Panel Chair, November 2014.

Compass Lexecon Competition Policy Forum, Lake Como Italy, “Consolidation of the Telecoms Industry in the EU and the U.S.,” Panelist, October 2014.

The IATA Legal Symposium 2014, Aviation Law: Upfront and Center, “Merger Analysis – A sudden shift in approach by DOJ in the American Airlines and US Airways merger,” Panelist, February 2014.

Georgetown Law 7th Annual Global Antitrust Enforcement Symposium, “Merger Enforcement and Policy,” Panelist, September 2013.

American Bar Association Section of Antitrust Law, “Airline Mergers: First Class Results or Middle-Seat Misery?” Panelist, May 2013.

American Bar Association Section of Antitrust Law, “Go Low or Go Home! Monopsony a Problem?” Panelist, March 2012.

Federal Communications Bar Association Transactional Committee CLE Seminar, “The FCC’s Approach to Analyzing Vertical Mergers,” Panelist, October 2011.

The Technology Policy Institute Aspen Forum, “Watching the Future: The Economic Implications of Online Video,” Panelist, August 2011.

American Bar Association Forum on Air & Space Law, 2011 Update Conference, “Antitrust Issues: What’s on the Horizon for the Industry,” Panelist, February 2011.

American Bar Association Section of Antitrust Law, “Antitrust in the Airline Industry,” Panelist, September 2010.

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