

**BEFORE THE  
SURFACE TRANSPORTATION BOARD**

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**RECIPROCAL SWITCHING**

**Docket No. EP 711 (Sub-No. 1)**

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**SUPPLEMENTAL COMMENTS OF  
NORFOLK SOUTHERN RAILWAY COMPANY**

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Dated: February 14, 2022

Norfolk Southern Railway Company (“NS”) respectfully submits these supplemental comments in response to the Board’s notice of public hearing served on December 28, 2021, in this proceeding.

## **I. Introduction**

NS has explained its serious concerns with the proposal<sup>1</sup> in this proceeding in its prior comments.<sup>2</sup> As explained in concurrently filed written testimony, NS intends to focus its hearing testimony on the fact that there is no justification for the proposal, the harmful operational impacts that are likely to result from the proposal, if adopted, and explaining why an appropriate access price methodology must be used in the event the Board moves forward with its proposal.

Since issuing the 2016 Proposal, the Board has repeatedly committed itself to evidence-based decision-making.<sup>3</sup> Indeed, there has been a broader emphasis on

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<sup>1</sup> *Reciprocal Switching*, Docket No. EP 711 (Sub-No. 1) (STB served July 27, 2016) (“2016 Proposal” or “Decision”).

<sup>2</sup> NS has actively participated in both this and earlier proceedings related to switching. See Opening Comments of Norfolk Southern Railway Company, *Competition in the Railroad Industry*, Docket No. EP 705 (filed Apr. 12, 2011); Reply Comments of Norfolk Southern Railway, *Competition in the Railroad Industry*, Docket No. EP 705 (filed May 27, 2011); Comments of Norfolk Southern Railway Company, *Petition for Rulemaking to Adopt Revised Competitive Switching Rules*, Docket No. EP 711 (filed March 1, 2013); Reply Comments of Norfolk Southern Railway Company, *Petition for Rulemaking to Adopt Revised Competitive Switching Rules*, Docket No. EP 711 (filed May 30, 2013); Hearing Transcript, at 24-33, STB Docket No. EP 711 (March 26, 2014); Opening Comments of Norfolk Southern Railway Company, *Reciprocal Switching*, Docket No. EP 711 (Sub-No. 1) (filed Oct. 26, 2016) (“NS Comments”); Reply Comments of Norfolk Southern Railway Company, *Reciprocal Switching*, Docket No. EP 711 (Sub-No. 1) (filed Jan. 13, 2017).

<sup>3</sup> See Surface Transportation Board, Budget Requests for Fiscal Year 2020, Fiscal Year 2021, and Fiscal Year 2022.

the importance of improving the use of evidence and data to generate policies at the federal level.<sup>4</sup> The importance of evidence-based policymaking and decision-making, as opposed to regulating by anecdote, cannot be understated. And it stands in stark contrast to the 2016 Proposal's utter lack of analysis and evidence.

Given the long span of time between issuance of the 2016 Proposal and the upcoming hearing, NS will briefly summarize its concerns in these supplemental comments. NS also offers a verified statement from Cynthia M. Sanborn, Executive Vice President and Chief Operating Officer, who will testify at the upcoming hearing. Ms. Sanborn explains the complexity of network operations and her concerns with the Board's proposal. In addition, NS offers a verified statement from Dr. Mark Israel of Compass Lexecon, who will also testify at the upcoming hearing. Dr. Israel states that there is no compelling reason to change the current reciprocal switching regulations and concludes that, as currently articulated, the 2016 Proposal places an extensive amount of traffic at risk of being subject to reciprocal switching requests, which threatens differential pricing and the ability to earn a competitive return on capital in places where it is imposed. Finally, NS incorporates into this proceeding the compelling evidence submitted in Docket No. EP 766, which shows—consistent with evidence submitted in Docket Nos. EP 722 and 761—that there is no justification for the Board tightening its regulatory control over the highly competitive freight rail industry. This includes NS, which,

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<sup>4</sup> See, e.g., Evidence-Based Policymaking Act of 2018, Pub. L. No. 115-435, 132 Stat. 5529; White House Memorandum on Restoring Trust in Government Through Scientific Integrity and Evidence-Based Policymaking (Jan. 27, 2021).

when compared with other companies with which it competes for capital based on the Board's "revenue adequacy" calculation, shows no indication of supra-competitive earnings and thus no indication of anti-competitive activity that would justify the Board's regulatory interference. NS also joins in the supplemental comments of the Association of American Railroads.

## **II. NS Continues to Oppose the 2016 Proposal as Unjustified, Unlawful, and Ill-Advised**

In 2016, the Board proposed to upend decades of precedent regarding the switching remedy at 49 U.S.C. § 11102(c). It did so without analysis or justification. The Decision did not identify the problem it sought to address, it did not justify departing from long-standing precedent, it largely ignored the voluminous prior submissions in Docket No. EP 711<sup>5</sup> establishing the potential adverse impacts on operations and investments, and it failed to offer a viable compensation proposal.

Section 11102(c) was added as part of the Staggers Rail Act of 1980, which dismantled aggressive regulatory policies and directed that railroads be treated more like ordinary businesses rather than like public utilities. With this wise (and stunningly successful) commission from Congress, the Interstate Commerce Commission ("ICC") appropriately concluded that government intervention through forced access should be restricted to situations where a railroad engaged in anticompetitive conduct by using its market power to extract unreasonable terms,

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<sup>5</sup> *Petition for Rulemaking to Adopt Revised Competitive Switching Rules*, Docket No. EP 711.

deprive a shipper of a more efficient route, or disregard the shipper's needs by rendering inadequate service. *Intramodal Rail Competition*, 1 I.C.C.2d 822 (1985), *aff'd sub nom. Balt. Gas & Elec. v. United States*, 817 F.2d 108 (D.C. Cir. 1987); *Midtec Paper Corp. v. Chi. & N. W. Transp. Co.*, 3 I.C.C.2d 171 (1986).<sup>6</sup>

Importantly, the Court of Appeals agreed: "If the Commission were authorized ... to prescribe reciprocal switching ... whenever such an order could enhance competition between rail carriers, it could radically restructure the railroad industry. *We have not found even the slightest indication that Congress intended the Commission in this way to conform the industry more closely to a model of perfect competition.*" *Midtec Paper Corp. v. United States*, 857 F.2d 1487, 1507 (D.C. Cir. 1988) (emphasis added).

The ICC, federal courts, and Congress have all rebuffed numerous attempts by shippers to change forced access from a narrow tool to remedy anticompetitive conduct to one used to supplant market forces. Indeed, Congress has repeatedly rejected requests to transform forced access into a broader remedy.<sup>7</sup>

Yet the Board in 2016 proposed to upend this regulatory regime—one that is appropriately narrow and upon which the industry has relied—with justifications

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<sup>6</sup> The ICC explained that "[t]here is a vast difference between using the [agency's] regulatory power to correct abuses that result from insufficient intramodal competition and using that power to initiate an open-ended restructuring of service to and within terminal areas solely to introduce additional carrier service." *Midtec Paper Corp.*, 3 I.C.C.2d at 174.

<sup>7</sup> See NS Comments, at 43–44 n.34 (listing 18 bills introduced in the House or Senate to relax *Midtec* standard but which did not pass either house of Congress).

that do not withstand scrutiny. The Board's Decision cited a lack of cases brought under § 11102(c) and the improved economic health of the industry,<sup>8</sup> but largely ignored the rail transportation policy's goal of promoting the ability of carriers to earn adequate revenues while minimizing federal regulatory intervention. Likewise, the Decision cited increased consolidation of Class Is,<sup>9</sup> but did not even mention the most comprehensive evidence available on railroad market power—the Christensen Study, commissioned by the Board itself. That study considered changes in the industry, including consolidation and improved financial health, and concluded that there was *no evidence of widespread abuse of market power by railroads*.<sup>10</sup>

As Dr. Israel explains in the attached verified statement at Exhibit A, given the real risks associated with the 2016 Proposal, he considered whether there is evidence of widespread or worsening market failures in the rail industry that might warrant pursuing the proposed changes. Dr. Israel reviewed the Board's recent Rail Rate Study, data on competition from intermodal alternatives to rail, studies regarding the railroads' financial performance, and the Board's own revenue adequacy findings. None of these indicate any clear evidence of widespread or worsening market failures.

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<sup>8</sup> Decision, at 8–9.

<sup>9</sup> Decision, at 9.

<sup>10</sup> Laurits R. Christensen Associates, Inc., *A Study of Competition in the U.S. Freight Railroad Industry and Analysis of Proposals that Might Enhance Competition: Revised Final Report*, ES-5 (2009), *An Update to the Study of Competition in the U.S. Freight Railroad Industry* (2010).

Even if the Board had articulated an adequate justification for abandoning its regulatory regime (which it did not), the 2016 Proposal itself is unlawful for a number of reasons. As NS has previously argued, the proposal is a backdoor attempt to use forced access as a path to potentially lower rates, in direct contravention of court precedent.<sup>11</sup> It is also an unlawful departure from the meaning of “public interest,” which was specifically intended to be the same standard used for terminal facilities and which demands a showing of compelling need due to inadequate service.<sup>12</sup> The 2016 Proposal also impermissibly allows the Board to order switching outside of a terminal area, despite the well-established meaning of reciprocal switching at enactment as an activity that occurs only in a terminal area and the fact that the “reasonable distance outside of a terminal” language exists only in 49 U.S.C. § 11102(a), not § 11102(c).<sup>13</sup> And the Board’s interpretation of “necessary to provide competitive rail service” is illogical, arbitrary, and in conflict with the core framework of the Staggers Act.<sup>14</sup>

Lastly, NS has explained why the 2016 Proposal could result in adverse impacts on the financial health of the industry, rail operations and efficiency, and future investment.<sup>15</sup> In the attached verified statement, Dr. Israel also evaluates the impact of the 2016 Proposal on NS stations and revenues from carload traffic

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<sup>11</sup> NS Comments, at 23.

<sup>12</sup> *Id.* at 28.

<sup>13</sup> *Id.* at 36–39.

<sup>14</sup> *Id.* at 30–36.

<sup>15</sup> *Id.* at 45–58.

originated or terminated by NS that could be subject to the 2016 Proposal, and concludes that exposing that much traffic to potential reciprocal switching requests would lead to less investment and operational challenges. Ms. Sanborn addresses those operational challenges in the attached verified statement at Exhibit B, explaining that additional handlings associated with forced switching slow network velocity, which clogs the network and causes problems for all customers, not just the customer seeking the switch.

Even if all of these harms could be anticipated and controlled (which NS does not believe could be done), the Board proposed vague and inadequate compensation proposals. If the Board were to proceed with the proposal, it must permit the railroad to recover the full opportunity costs of lost traffic or else the compensation would be confiscatory and would impede the industry's efforts to achieve and maintain sound financial health—a goal that Congress has charged the agency to actively support and that ultimately benefits the public.<sup>16</sup>

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<sup>16</sup> See Opening Comments of Union Pacific Railroad Company, *Railroad Revenue Adequacy*, Docket No. EP 722 (filed Sept. 5, 2014), Verified Statement of Kevin M. Murphy (“Murphy EP 722 V.S.”), at 6–7 (“increased [railroad] profitability in recent years ... reflects increased, not reduced, competition and benefits for shippers, contrary to what some shippers may contend”); Opening Comments of Norfolk Southern Railway Company, *Railroad Revenue Adequacy*, Docket No. EP 722 (filed Sept. 5, 2014), Verified Statement of Professor David Sappington (“Sappington EP 722 V.S.”), at 12–13 (“improved earnings have enabled railroads to reinvest more than half a trillion dollars in their operations. This investment has produced important innovations of substantial benefit to shippers and the public generally.”) (footnote omitted); Opening Comments of the Association of American Railroads, *Railroad Revenue Adequacy*, Docket No. EP 722 (filed Sept. 5, 2014), Verified Statement of Joseph P. Kalt (“Kalt EP 722 V.S.”), at 7–8 (“It is tempting for self-interested parties to advocate for operational policies ... that serve their own myopic interests. But if [the Board rewards this] ..., a railroad will not have the ability to

### **III. Objective Data and Expert Testimony Have Repeatedly Established that Tighter Regulation of the Rail Industry Is Not Justified.**

Due to the long span of time between issuance of the Board’s 2016 Proposal and these supplemental comments, NS is updating the record in this proceeding to include the copious and consistent evidence from other proceedings—particularly from Docket No. EP 766—establishing that there is no justification for the Board tightening its regulatory control over the highly competitive freight rail industry. The joint verified statement of Professor Kevin M. Murphy, the George J. Stigler Distinguished Service Professor of Economics in the Booth School of Business and the Department of Economics at The University of Chicago, and Professor Mark E. Zmijewski, Professor Emeritus at The University of Chicago Booth School of Business, submitted in Docket No. EP 766, is attached as Exhibit C.

In Docket No. 766, the railroad petitioners urged the Board to stay true to its commitment to “evidence-based decision-making” and, in turn, to make policy decisions based on objective data rather than on “anecdotal complaints, one-sided testimony, or unproven assumptions.”<sup>17</sup> In particular, the railroad petitioners submitted data and expert testimony that disproved the anecdotal (and unproven) narrative that, because railroads were becoming “revenue adequate” according to the Board’s annual calculations, more regulatory intrusion was needed to ensure

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generate enough revenue to support the fixed and common costs of the network and will have no ability to fund the on-going investment that is required to maintain and/or expand the network over time.”)

<sup>17</sup> Joint Petition for Rulemaking to Modernize Annual Revenue Adequacy Determinations, Docket No. EP 766, at 1 (filed Sept. 1, 2020) (“EP 766 Petition”).

shippers were protected from anticompetitive railroad activity. It turns out that both the objective data and the testimony of some of the most reputable and esteemed economists in our country tell an entirely opposite story. Namely, that railroads are highly competitive and earning normal returns, and there is zero evidence that railroads are operating as monopolies, abusing market power, or charging anticompetitive rates to captive shippers. To the contrary, “the most exhaustive and rigorous studies ..., commissioned by the Board itself, have repeatedly concluded that improvements in carrier financial performance under the Staggers Act have *not* been the result of enhanced exercise of market power. ... This conclusion is supported by independent academic research.”<sup>18</sup>

Likewise, in Docket No. EP 766, the analyses performed by Professors Murphy and Zmijewski established that railroads are earning returns consistent with competitive markets, and consistent with pro-competitive behavior.<sup>19</sup> Due to the significant inaccuracies in the Board’s revenue adequacy calculation, the professors used a “widely used benchmarking methodology” to more accurately study and assess Class I railroad returns.<sup>20</sup> The professors explained: “If the railroads earn a rate of return net of cost of capital no higher than the average or median S&P firm, then there would be no presumption that railroads are earning

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<sup>18</sup> Reply Comments of the Association of American Railroads, *Railroad Revenue Adequacy*, Docket No. EP 722 (filed Nov. 4, 2014), Reply Verified Statement of Professor Joseph P. Kalt, at 6–7 (footnote omitted).

<sup>19</sup> See EP 766 Petition, Verified Statement of Professor Kevin M. Murphy and Professor Mark E. Zmijewski (“Murphy & Zmijewski V.S.”).

<sup>20</sup> *Id.* at 8.

abnormal returns and can set rates without constraint from competition, or that shippers' current protections under the Board's [regulations] are not sufficient."<sup>21</sup> The results were clear: "we conclude that, over the 2006 through 2019 period, the financial performance of the railroad industry and each of the seven Class I railroads fell well below the median and mostly in the bottom quartile of the financial performance of all three benchmarking groups."<sup>22</sup> The professors' findings are not without company. Distinguished economists have definitively explained to the Board that railroads are not "generating above-competitive returns," operating as "monopol[ies],"<sup>23</sup> or enjoying (much less abusing) an increase in market power.<sup>24</sup>

Figures 1 and 2, below, show where NS, in particular, ranks in the professors' benchmarking analysis (which uses the Board's revenue adequacy calculation for all companies). These figures were created from data drawn from the September 1, 2020 (updated February 10, 2021) Murphy & Zmijewski Verified Statement submitted by the railroad petitioners as part of their February 10, 2021, errata in Docket No. EP 766. The figures show that, consistent with the professors' broader

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<sup>21</sup> *Id.* at 18–19.

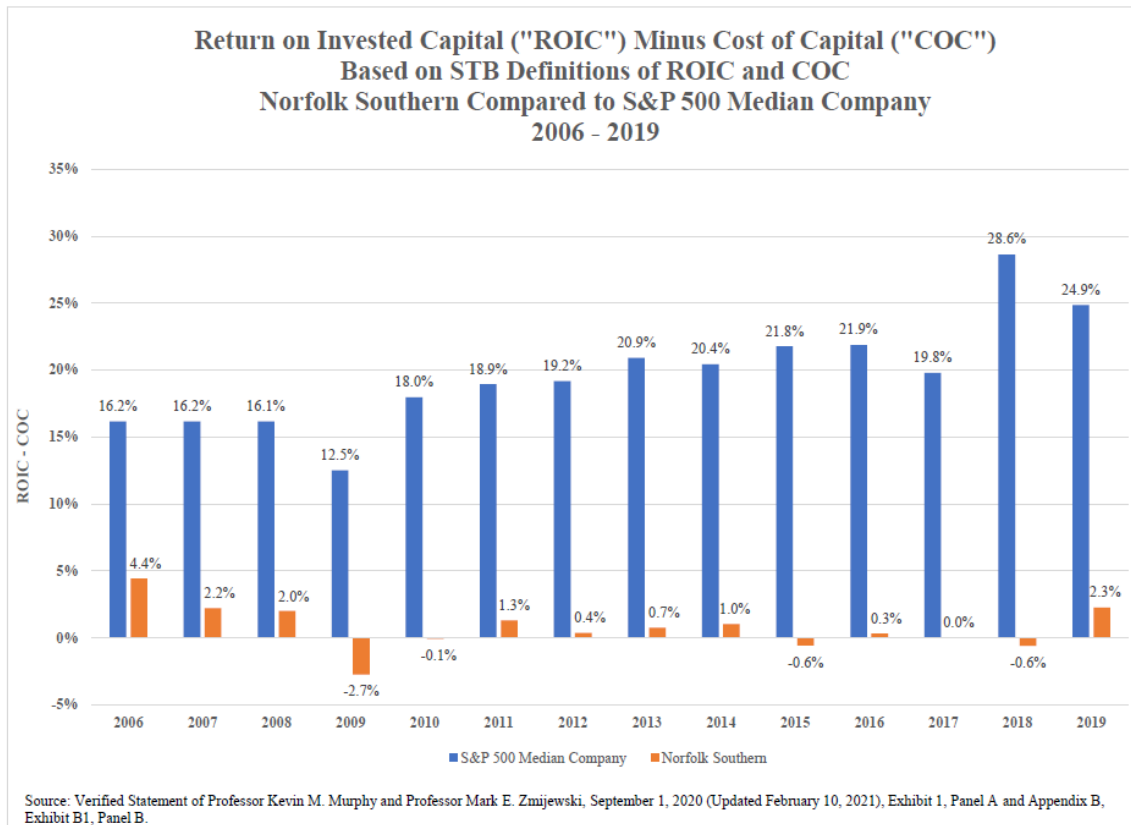
<sup>22</sup> *Id.* at 8.

<sup>23</sup> Kalt EP 722 V.S. at 26.

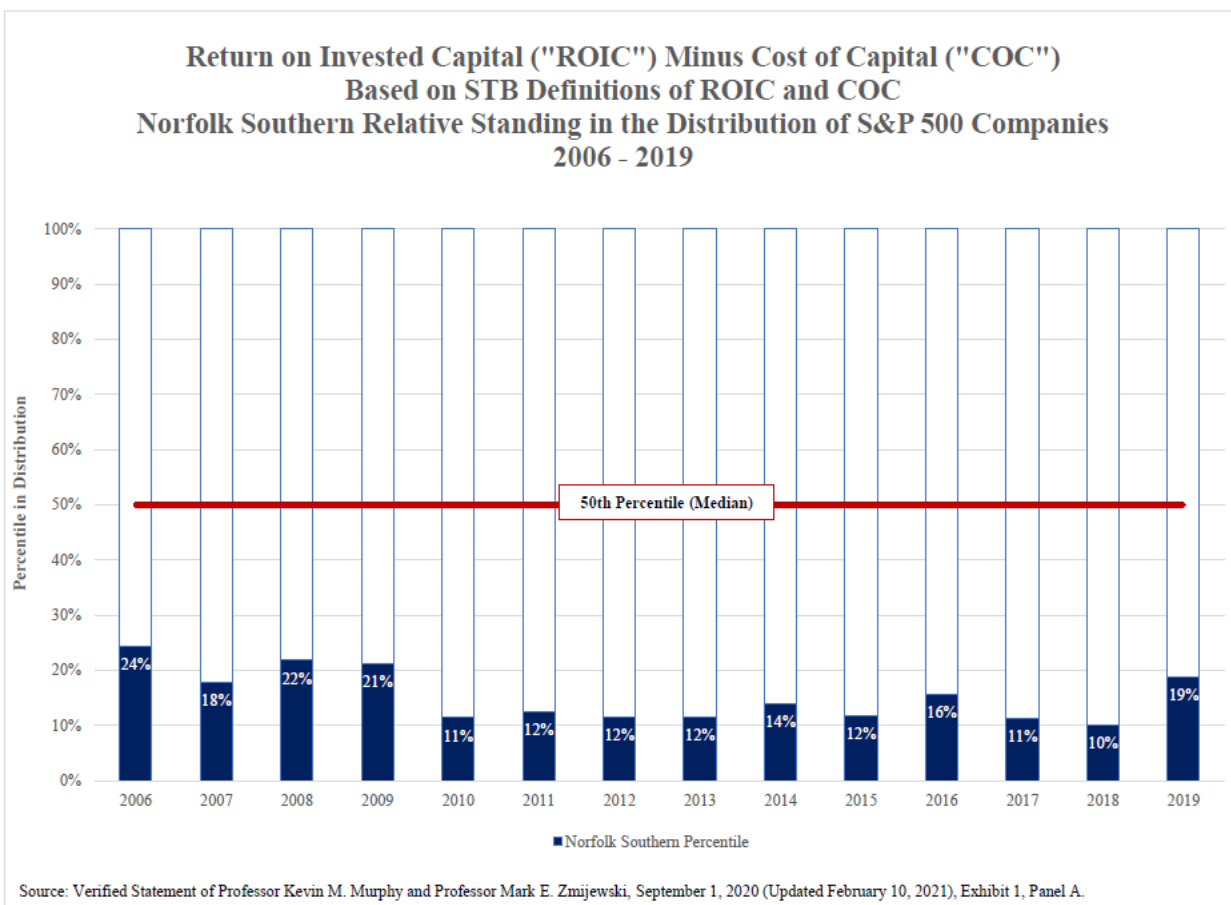
<sup>24</sup> *Id.* at 34 ("Studies of pricing and costs in the U.S. rail freight industry ... provide no evidence that the improved financial health of the industry is the result of an increase in the exercise of market power."); *see also* Reply Comments of the Association of American Railroads, *Railroad Revenue Adequacy*, Docket No. EP 722 (filed Nov. 4, 2014), Reply Verified Statement of Professor Robert Willig, at 3 ("[The idea] that freight firms are permitted to charge near-monopoly prices to captive shippers ... is patently false") (internal quotation marks omitted).

analyses in that docket, NS' returns from 2006 to 2019 fell well below, and were within the bottom quartile, of the returns of its competitive peers with which NS competes for capital.

**Figure 1**



**Figure 2**



If the Board intends to be an agency that bases its policies on “evidence-based decision-making,” the evidence submitted in this proceeding (and in Docket Nos. EP 766, 722, and 761) should compel it to withdraw the 2016 Proposal as wholly lacking justification. The Board’s existing regulatory regime “provides strong protection to shippers that lack effective competition and can reasonably be viewed as replicating the disciplining forces of competition.”<sup>25</sup> Anything more would be

<sup>25</sup> Sappington EP 722 V.S. at 2.

inconsistent with the wisdom of the Staggers Act and would ultimately harm *both* shippers and railroads in the long run.<sup>26</sup>

#### **IV. Conclusion**

For all of the reasons articulated in NS' prior submissions, and as set forth herein, NS urges the Board to withdraw the 2016 Proposal.

Respectfully submitted,

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Dated: February 14, 2022

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<sup>26</sup> Murphy EP 722 V.S. at 29 (explaining that regulating railroads when they are already “constrained by effective competition” would be “inconsistent with Congress’s intent that ... railroads should be able to set the terms of service—rates, conditions, service offerings—without regulatory interference”); Sappington EP 722 V.S. at 2 (“Any additional regulation that considers the earnings railroads achieve in serving shippers that enjoy the protection of effective competition would harm all shippers and seriously undermine recent progress in the U.S. railroad industry.”).

## **Exhibit A**

### **Verified Statement of Dr. Mark Israel**

**BEFORE THE  
SURFACE TRANSPORTATION BOARD**

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**RECIPROCAL SWITCHING**

Docket No. EP 711 (Sub-No. 1)

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**VERIFIED STATEMENT OF**

**MARK A. ISRAEL, Ph.D.**

**February 14, 2022**

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## **I. INTRODUCTION**

### **A. QUALIFICATIONS**

1. My name is Mark A. Israel. I am a Senior Managing Director at Compass Lexecon, an economic consulting firm where I have worked since 2006. I am the head of Compass Lexecon's North American antitrust business. From 2000 to 2006, I served as a full-time member of the faculty at 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—which is 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 Review of Industrial Organization, Information Economics and Policy, and the Journal of Competition Law and Economics, among many others.

3. My work at Compass Lexecon has focused 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 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 curriculum vitae is attached as Exhibit A.

## B. ASSIGNMENT AND PRIMARY CONCLUSIONS

4. I have been asked by Norfolk Southern (“NS”) to participate in the Board’s March 2022 hearing on the reciprocal switching regulations proposed by the Board in the Notice of Proposed Rulemaking issued in July 2016 (hereinafter “2016 NPRM”).<sup>1</sup> I have also been asked to provide these written comments outlining the topics I plan to address at the hearing.

5. Specifically, I have been asked to provide some context for analysis of the proposed regulations based on the relevant economics of the rail industry and to discuss the potential breadth of the impact of the Board’s proposal. In addition to these points, I also stress that establishing an economically reasonable price for access is a complicated—and essential—element of any policy related to mandated switching. I understand Prof. David Sappington has provided prior testimony on this topic in this proceeding and will address this topic at the upcoming hearing.

6. My primary conclusions are as follows:

- In the rail industry, for firms to earn a competitive rate of return, all shipments cannot be priced at marginal cost. Rather, in order to earn a competitive return on capital, at least some prices must be above marginal cost.
- Differential pricing—allowing railroads to charge higher prices to shippers who are more dependent on rail, and who thus get more unique benefit from rail—is essential to provide a competitive return on capital.
- As currently articulated, the Board’s proposals would move prices toward marginal costs where mandated switching is imposed, eliminating—or at least eroding—differential pricing on those routes, and thus creating significant risk that railroads will be unable to generate a competitive return on capital.
- The Board’s proposals for determining the set of stations potentially open to reciprocal switching are very broad, accounting for 54 percent of NS stations that originated or terminated carload traffic in 2019 and 54 percent of NS’s 2019 revenue

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<sup>1</sup> *Reciprocal Switching*, Docket No. EP 711 (Sub-No. 1) (STB served July 27, 2016) (hereinafter, “2016 NPRM”).

from originating or terminating carload traffic. Exposing this volume of traffic to the risk of mandated switching increases railroads' investment risk and thus their cost of capital, and increased switching will also generate increased operating costs that reduce profits, both of which will depress investment.

- Given these risks, and no clear evidence of widespread or worsening competitive problems, the benefit of pursuing the broad changes proposed by the Board is unclear.
- Any policy the Board implements should restrict mandated switching to only the most severe cases—where shippers have no intramodal, intermodal, product, or geographic alternatives—and should include a price that incorporates the full opportunity cost (accounting for a competitive rate of return on capital) of the business no longer carried by the incumbent railroad, so that differential pricing is preserved and the railroad's return on capital is not destroyed.

## **II. ECONOMIC BACKGROUND**

7. The principle that competition should be relied on to set prices whenever possible, and that regulation should seek to mimic competitive outcomes where government intervention is necessary, is the guiding principle of rail regulation.<sup>2</sup>

8. In the rail industry, competition does not always take the form of multiple competing rail options for a given movement.<sup>3</sup> Further, earning a competitive return on capital is not consistent with all prices equaling marginal cost for every move. If all moves had competitive rail options, and this led to all movements being priced at marginal costs—a likely result—railroads would not be able to earn a competitive return on the capital deployed in the rail network, meaning they

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<sup>2</sup> 49 USC § 10101.

<sup>3</sup> See Mayo, John W. and Willig, Robert D., Economic Foundations for 21st Century Freight Rail Rate Regulation (November 15, 2018). Macher, Jeffrey T. and John W. Mayo, Eds., U.S. Freight Rail Economics and Policy: Are we on the Right Track, Routledge, New York and London, 2019, Georgetown McDonough School of Business Research Paper No. 3286211, Available at SSRN: <https://ssrn.com/abstract=3286211> (hereinafter, “Mayo and Willig”) at 3.

would lose the ability to attract capital, which would lead to reduced investment, reduced output, and ultimately harm to shippers.<sup>4</sup>

9. Instead, a competitive outcome is one that ensures railroads are able to earn a competitive return on capital—meaning sufficient profit on enough movements to cover the weighted average cost of the capital deployed in the network—which allows railroads to attract capital and thus invest in and maintain their networks. In order to achieve this goal, it is imperative that railroads be able to charge higher (i.e., above marginal cost) prices to those shippers who are more dependent on, and therefore get more unique benefit from, railroads.<sup>5</sup>

10. In addition to recognizing the need for an adequate return on capital, it is important to recognize that competition for a given rail movement often comes in a form other than a competing railroad serving the same route. In some cases, certain routes may support only one rail carrier. However, even in situations with only one rail carrier, when prices are disciplined by intermodal, product or geographic alternatives, there is generally no need for regulatory intervention. And intervention in markets that are subject to effective competition from one or more of these sources would further threaten railroads' ability to earn a competitive return and, more generally, risk imposing the well-recognized economic costs of regulation where they are unnecessary.

11. Therefore, policies aimed at introducing competitive rail options for shippers should be carefully designed and applied to only the narrowest set of cases where there are no intramodal, intermodal, product, or geographic alternatives for a particular customer. Even then, regulations should provide a clear method for identifying those situations in which mandated access is necessary. And the regulations should also specify an economically coherent method for pricing the access, which ensures incumbent railroads are able to recover the costs of providing the service—including costs arising from operational changes that impact the rest of the rail network—and a competitive return on investment accounting for the opportunity cost of lost shipments.

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<sup>4</sup> See Mayo and Willig at 7.

<sup>5</sup> See, e.g., Coal Rate Guidelines, Nationwide, Interstate Commerce Commission, August 8, 1985, at 4-6. See also, Mayo and Willig at 8-9.

### III. THE BOARD'S RECIPROCAL SWITCHING PROPOSAL

#### A. SUMMARY OF PROPOSAL

12. The Board has proposed “a two-pronged approach, pursuant to which the Board would have the ability to order reciprocal switching either when it is practicable and in the public interest *or* when it is necessary to provide competitive rail service.”<sup>6</sup>

13. The “Practicable and in the Public Interest Prong” would require that shippers demonstrate the following: (1) The shipper and/or receiver requesting switching is served by a Class I railroad; (2) there is (or can be) a working interchange within a reasonable distance; and (3) the potential benefits of the switch outweigh the potential detriments.<sup>7</sup>

14. The “Competitive Rail Service” prong would require that shippers demonstrate the following: (1) The shipper and/or receiver requesting switching is served by only one Class I railroad; (2) inter- and intramodal competition “is not effective” for the movements in question; and (3) there is (or can be) a working interchange within a reasonable distance.<sup>8</sup>

15. The 2016 NPRM does not include a specific proposal for establishing switching fees, but the Board did request comment on two potential approaches. One approach contemplated using a specified set of factors to determine switching costs and one approach involved a variation of the Board’s SSW compensation methodology that compensates incumbent carriers for expenses incurred and a fair and reasonable return on capital employed.<sup>9</sup>

16. As noted above, I understand that Prof. Sappington will provide detailed testimony regarding the economically reasonable method for establishing switching fees. I will note, however, that any economically reasonable policy that establishes mandated switching should include a cost of capital that accounts for the opportunity costs of business lost by the incumbent carrier. Such opportunity costs are completely valid economic costs of providing switching access to another carrier, and thus must be included to cover the relevant cost of doing so. And

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<sup>6</sup> 2016 NPRM at 16.

<sup>7</sup> 2016 NPRM at 18.

<sup>8</sup> 2016 NPRM at 19.

<sup>9</sup> 2016 NPRM at 25-26.

only by including such opportunity costs, which embed a return on the capital deployed in its network, can differential pricing and thus competitive returns on capital be preserved.

17. Notably, the Board's proposal does not identify product or geographic competition as important factors in the determination of "effective" competition. This is not an appropriate basis for determining where regulated access is required, as, when present, product and geographic competition are important sources of competitive discipline.

18. The Board's proposal also would no longer require a showing that railroads have engaged in anticompetitive conduct as a condition of granting a reciprocal switching request, which means that applying some other limiting principle is critical to avoid creating substantial uncertainty and risk regarding where reciprocal switching will apply.

**B. THE BOARD'S PROPOSAL CREATES SUBSTANTIAL RISKS AND COSTS WITH NO CLEAR BENEFIT**

19. As currently proposed—without consideration of product and geographic competition, and with an unclear pricing proposal—introducing this type of direct rail competition would have the effect of pushing prices toward marginal costs where it is imposed, meaning it will erode or eliminate differential pricing in those cases. As noted above, the erosion of differential pricing creates serious risk that the railroad will be unable to generate a competitive return on capital, meaning they would not be able to attract capital, thus leading to reduced investment, reduced service, and ultimately harm to shippers.

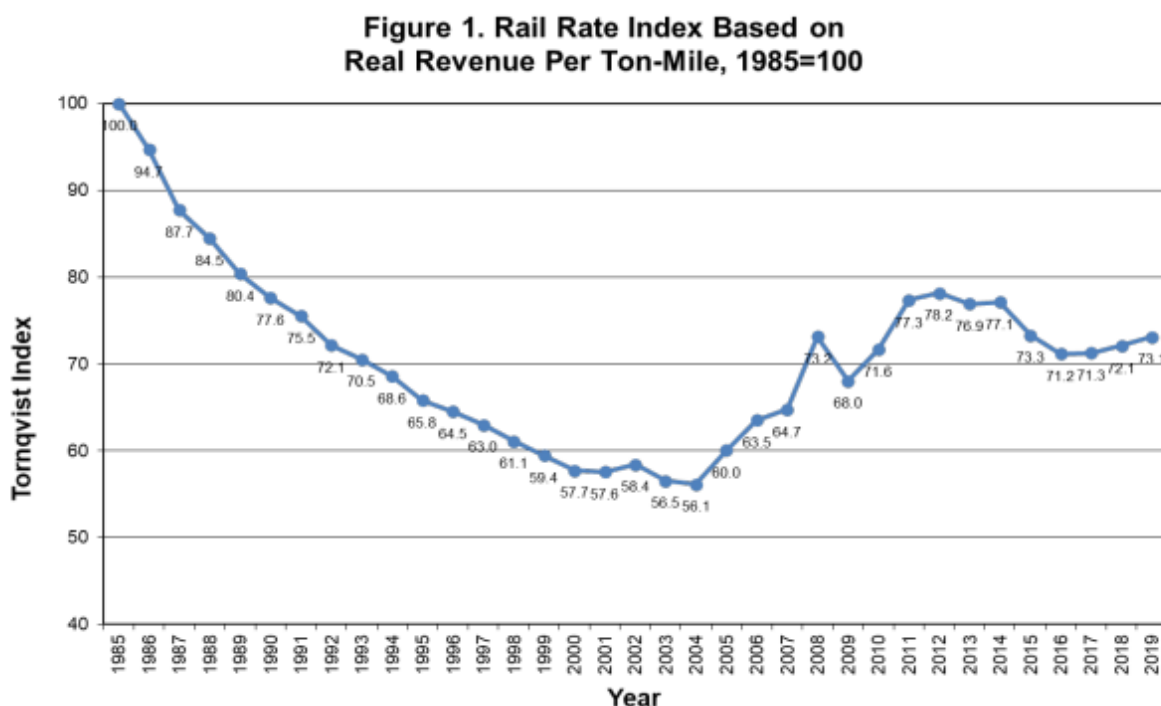
20. Notably, the Board's proposal exposes a substantial amount of traffic to potential reciprocal switching requests. As a matter of economics, the associated risk will create disincentives for future investment because railroads must factor in the possibility that they will be required to provide access to competitors in the future—creating risks that increase their cost of capital—and because the increased operational costs associated with planning for and implementing mandated switching decrease profits, reducing the railroads' ability to generate sufficient profits to cover the heightened cost of capital, thus reducing their ability to attract capital and invest.

21. Given the real risks associated with the proposal, I have considered whether there is evidence of widespread or worsening market failures in the rail industry that might warrant pursuing the proposed changes. As explained below, I have reviewed the STB's recent Rail Rate

Study, data on competition from intermodal alternatives to rail, studies regarding the railroads' financial performance, and the STB's own revenue adequacy findings. None of these establish widespread or worsening market failures of the sort that one should see before considering the use of a new, risky, and costly regulatory approach.

22. **STB Rail Rate Study.** The STB recently released the “Annual Rail Rate Index Study: 1985 – 2021.”<sup>10</sup> The figure below is a copy of “Figure 1. Rail Rate Index Based on Real Revenue Per Ton-Mile, 1985=100” from that study.

**Figure 1: Reproduction of Rail Rate Index**

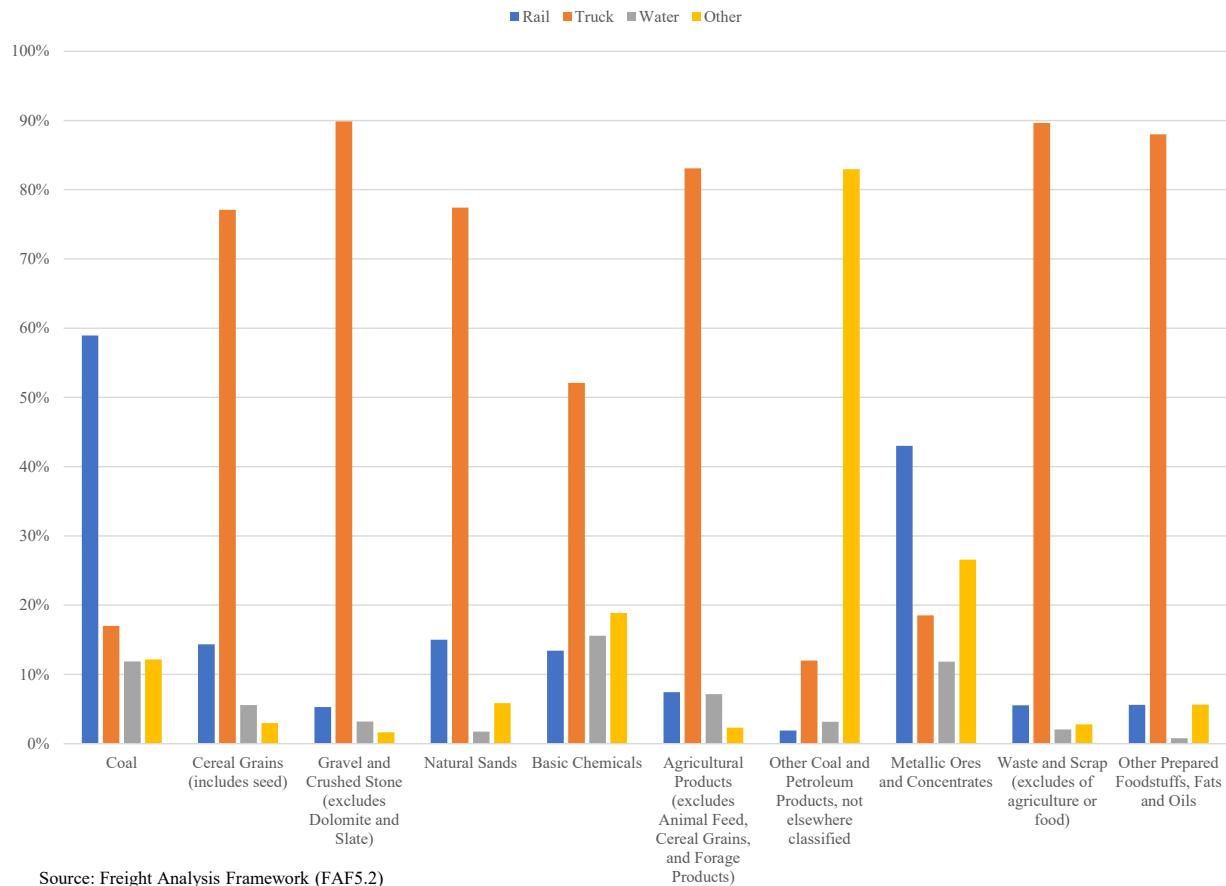


23. As the figure shows, rail rates overall have not risen significantly since the 2016 NPRM and the overall trend in rates does not indicate any broad-based competitive issues that warrants implementing the proposed changes to reciprocal switching regulation. Instead, rates remain below levels seen as recently as 2015.

<sup>10</sup> Surface Transportation Board, Office of Economics, *Annual Rail Rate Index Study: 1985-2019*, December 2, 2021. [https://www.stb.gov/wp-content/uploads/Annual\\_Rail\\_Rate\\_Index\\_Study\\_2019.pdf](https://www.stb.gov/wp-content/uploads/Annual_Rail_Rate_Index_Study_2019.pdf).

24. **Intermodal Competition.** Railroads face significant competition from intermodal alternatives. Based on the federal government’s Freight Analysis Framework database<sup>11</sup>, only 8% of freight tonnages are transported domestically via rail, compared to 64% via truck.<sup>12</sup> Figure 2 reports modal shares for the top ten commodities shipped by rail (by tonnage), demonstrating that railroads face significant competition from trucks and other alternative modes of transportation for these commodities.

**Figure 2: Commodity Freight Tonnages by Domestic Mode of Transportation**



25. As shown in Figure 2, even for the top commodities shipped by rail, trucks move more than 50 percent of seven of the ten commodity groups, and rail moves less than 20 percent of

<sup>11</sup> Freight Analysis Framework materials can be downloaded at <https://faf.ornl.gov/faf5/>. I use the most recent version available (FAF5.2) and the 2017 values, which are the benchmark for future forecasts tied to the 2017 Commodity Flow Survey.

<sup>12</sup> See FAF5.2.csv in my backup for source file / FAF\_Shares.xlsx in my backup.

eight of the ten commodity groups. Of the ten groups, coal is the only commodity for which rail moves more than 50 percent of the volume. Even for the top ten commodities shipped by rail, which make up more than 75 percent of rail's freight tonnages in the FAF data, rail transports only 12 percent of their total tonnages domestically versus 57 percent for trucks.

26. **Rail Performance Benchmarks.** Carefully done studies by top economists find that, applying STB's own methods for determining return on capital (despite their limitations) across industries, railroads are generally in the bottom quartile in terms of return on capital.<sup>13</sup> In particular, a study done by Kevin Murphy and Mark Zmijewski, which was submitted to the Board as part of the Ex Parte 766 proceeding and I understand is being submitted with NS's supplemental comments in this proceeding, compared railroads' financial performance to several benchmark groups of companies operating in "competitive (unregulated) markets."<sup>14</sup> The study concluded that "the financial performance of the railroad industry and each of the seven Class I railroads fell well below the median and mostly in the bottom quartile of the financial performance of all three benchmarking groups."<sup>15</sup>

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<sup>13</sup> Verified Statement of Kevin Murphy and Mark E. Zmijewski, Docket No. Ex Parte 766, "Joint Petition for Rulemaking to Modernize Annual Revenue Adequacy Determinations," September 1, 2020 (hereinafter, "Murphy and Zmijewski VS").

<sup>14</sup> Murphy and Zmijewski VS at ¶ 11.

<sup>15</sup> Murphy and Zmijewski VS at ¶ 11.

27. **Revenue Adequacy.** Figure 3 shows the results of the Board’s revenue adequacy determinations since 2000.<sup>16</sup>

**Figure 3: Reproduction of STB’s Railroad Revenue Adequacy Determinations 2000-2019**

| Docket No. Ex Parte 552 - Railroad Revenue Adequacy                                                                                                                                                      |                          |              |                  |                        |             |            |                        |               |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------|------------------|------------------------|-------------|------------|------------------------|---------------|
| Year                                                                                                                                                                                                     | Industry Cost of Capital | BNSF Railway | CSX Transp. Inc. | Grand Trunk Corp. (CN) | KCS Railway | NS Railway | Soo Line Railroad (CP) | Union Pacific |
| <i>Based on Individual Railroad's Return on Investment</i>                                                                                                                                               |                          |              |                  |                        |             |            |                        |               |
| 2019                                                                                                                                                                                                     | 9.34%                    | 12.04%       | 12.84%           | 7.47%                  | 6.20%       | 11.59%     | 11.34%                 | 15.55%        |
| 2018                                                                                                                                                                                                     | 12.22%                   | 11.89%       | 13.18%           | 7.69%                  | 8.03%       | 11.63%     | 13.49%                 | 15.80%        |
| 2017                                                                                                                                                                                                     | 10.04%                   | 10.70%       | 8.84%            | 7.69%                  | 7.09%       | 10.05%     | 10.71%                 | 14.08%        |
| 2016                                                                                                                                                                                                     | 8.88%                    | 10.11%       | 8.62%            | 8.60%                  | 6.23%       | 9.20%      | 9.58%                  | 13.39%        |
| 2015                                                                                                                                                                                                     | 9.61%                    | 12.82%       | 9.00%            | 10.77%                 | 7.20%       | 9.03%      | 14.50%                 | 15.54%        |
| 2014                                                                                                                                                                                                     | 10.65%                   | 12.88%       | 10.18%           | 11.30%                 | 8.18%       | 11.69%     | † -.42%                | 17.35%        |
| 2013                                                                                                                                                                                                     | 11.32%                   | 14.01%       | 10.00%           | 11.84%                 | 8.67%       | 12.07%     | 12.03%                 | 15.39%        |
| 2012                                                                                                                                                                                                     | 11.12%                   | *13.47%      | 10.81%           | 10.19%                 | 9.54%       | 11.48%     | 5.15%                  | 14.69%        |
| 2011                                                                                                                                                                                                     | 11.57%                   | *12.39%      | 11.54%           | 8.74%                  | 10.76%      | 12.87%     | 7.13%                  | 13.11%        |
| 2010                                                                                                                                                                                                     | 11.03%                   | *10.28%      | 10.85%           | 9.21%                  | 9.77%       | 10.96%     | 8.01%                  | 11.54%        |
| 2009                                                                                                                                                                                                     | 10.43%                   | 8.67%        | 7.30%            | 6.04%                  | 6.51%       | 7.69%      | 6.28%                  | 8.62%         |
| 2008                                                                                                                                                                                                     | 11.75%                   | 10.51%       | 9.34%            | 9.89%                  | 7.72%       | 13.75%     | 9.29%                  | 10.46%        |
| 2007                                                                                                                                                                                                     | 11.33%                   | 9.97%        | 7.61%            | 10.11%                 | 9.37%       | 13.55%     | 15.25%                 | 8.90%         |
| 2006                                                                                                                                                                                                     | 9.94%                    | 11.43%       | 8.15%            | 9.47%                  | 9.31%       | 14.36%     | 11.60%                 | 8.21%         |
| 2005                                                                                                                                                                                                     | 12.19%                   | **9.76%      | 6.23%            | 8.07%                  | 5.89%       | 13.21%     | 8.89%                  | 6.34%         |
| 2004                                                                                                                                                                                                     | 10.11%                   | 5.84%        | 4.43%            | 5.95%                  | 8.30%       | 11.64%     | 3.28%                  | 4.54%         |
| 2003                                                                                                                                                                                                     | 9.40%                    | 6.2%         | 4.0%             | 4.5%                   | 3.7%        | 9.1%       | 0.9%                   | 7.3%          |
| 2002                                                                                                                                                                                                     | 9.75%                    | 6.4%         | 5.2%             | 3.1%                   | 6.5%        | 9.1%       | 5.7%                   | 8.6%          |
| 2001                                                                                                                                                                                                     | 10.19%                   | 7.1%         | 4.6%             | 4.9%                   | 7.0%        | 8.3%       | 5.9%                   | 7.6%          |
| 2000                                                                                                                                                                                                     | 11.03%                   | 8.8%         | 3.6%             | 5.9%                   | 6.3%        | 5.5%       | 5.6%                   | 6.9%          |
| Colored cells indicates year in which railroad was Revenue Adequate                                                                                                                                      |                          |              |                  |                        |             |            |                        |               |
| * Indicates that figure was revised from original calculation, based on decision in FD-35506 (July 25, 2013)                                                                                             |                          |              |                  |                        |             |            |                        |               |
| ** Indicates that figure was corrected from original calculation, based on notice in EP 552 Sub No. 10 (October 26,                                                                                      |                          |              |                  |                        |             |            |                        |               |
| † The negative ROI of the Soo Line Corp. is attributable, in part, to the sale of the Dakota, Minnesota & Eastern lines, to Rapid City, Pierre & Eastern Railroad. The sale resulted in a one-time loss. |                          |              |                  |                        |             |            |                        |               |

28. Despite the limitations of the revenue adequacy calculation (e.g., the use of an accounting return rather than an economic return), the figure shows that Class I railroads’ return on investment is generally close to the industry cost of capital, though an individual railroad’s return on investment may be slightly higher or lower in certain years. Data for NS, in particular, show NS’s return on investment was slightly higher than the industry cost of capital in 2019 (11.59% versus 9.34%), slightly lower in 2018 (11.63% versus 12.22%), and almost the same in 2017

<sup>16</sup> Surface Transportation Board, Economic Data, “Data Issued in Regulatory Proceedings” – “Revenue Adequacy” materials. Available at <https://www.stb.gov/reports-data/economic-data/>.

(10.05% versus 10.04%). Over the last 10 years, NS has been below the industry cost of capital three times and above the industry cost of capital by more than one percent three times. These patterns provide no systematic pattern of ongoing competitive issues to be solved by the proposed regulations.

#### **IV. BREADTH OF POTENTIAL IMPACT OF THE PROPOSED RULES**

29. The two proposals for determining the set of stations potentially open to reciprocal switching are very broad, which will increase the operational costs around network design to accommodate the potential for mandated switching and will exacerbate the risk that railroads will be unable to recover the full costs of investment, and thus will have a disruptive effect on investment incentives, as explained above.

30. Table 1 summarizes the stations and revenues from carload traffic originated or terminated by NS that could be subject to the proposed reciprocal switching requirements.<sup>17</sup> The first line of Table 1 reports all carload traffic originated or terminated by NS in the 2019 Carload Waybill Sample (“CWS”).<sup>18</sup> The second line of Table 1 reports all traffic originating or terminating at stations solely-served by NS,<sup>19</sup> The third and fourth lines of Table 1 report carload traffic and regulated traffic originating or terminating at sole-served stations within a “reasonable distance”<sup>20</sup> of an interchange with another Class I carrier<sup>21</sup> that could be subject to mandated switching under the proposed rules.

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<sup>17</sup> Stations are identified as unique Freight Station Accounting Code (FSAC) where NS originated or terminated traffic. Revenues are the those allocated to NS.

<sup>18</sup> Intermodal traffic is excluded from this analysis.

<sup>19</sup> I identified NS-sole served stations as those where NS was the only originating or termination carrier at the SPLC level based on the 2019 CWS and was designated as an operating location in the Centralized Station Master. This may overstate stations with multiple rail options if customers can only be served by one railroad despite another railroad also operating in that SPLC location. This may understate stations that can be served by another railroad if that other railroad did not provide originating or terminating service within the SPLC in the 2019 CWS.

<sup>20</sup> The Board has invited comment on defining a “reasonable distance.” I have not studied that question, but for the purposes of analyzing the impact of the Board’s proposal, I use the NITL proposal of 30 miles, which was referenced in the 2016 NPRM. See 2016 NPRM at 21. I understand, however, that NS has argued that switching must be within a terminal area.

<sup>21</sup> Interchanges are identified as locations where NS and another Class I railroad have active operating locations and a common junction point according to the Centralized Station Master.

**Table 1: NS Carload Revenues at Operating Stations (\$B)  
2019**

|                                      | <u>Stations</u> |      | <u>Originating</u> |      | <u>Terminating</u> |      | <u>Either</u>   |      |                    |
|--------------------------------------|-----------------|------|--------------------|------|--------------------|------|-----------------|------|--------------------|
|                                      | Total           | %    | Carload Revenue    | %    | Carload Revenue    | %    | Carload Revenue | %    | % Total NS Revenue |
| Norfolk Southern Carload Traffic     | 1728            | 100% | \$7.6              | 100% | \$7.8              | 100% | \$8.4           | 100% | 74%                |
| Sole-Served Stations                 | 1314            | 76%  | \$2.9              | 38%  | \$4.1              | 53%  | \$5.9           | 71%  | 53%                |
| w/in 30 miles of Class I Interchange | 930             | 54%  | \$2.3              | 31%  | \$2.8              | 36%  | \$4.5           | 54%  | 40%                |
| Regulated Commodities                | 750             | 43%  | \$1.3              | 17%  | \$1.9              | 25%  | \$2.9           | 34%  | 26%                |

Notes:

Stations identified originated or terminated NS carload traffic in 2019 and were designated as operating stations in the Centralized Stationmaster

Total NS Revenues of \$11,296M as reported in NS 2019 Annual Report

Sources: 2019 Carload Waybill Sample and Centralized Station Master

31. As shown in Table 1, approximately 54% of the stations at which NS originated or terminated carload traffic in 2019 could potentially be subject to reciprocal switching requests based on the Board's stated criteria. This accounts for approximately 54% of NS's 2019 revenue from either originating or terminating carload traffic and 40% of NS's total railway operating revenue in 2019.<sup>22</sup> When considering the impact of the Board's proposal on regulated commodities only, approximately 34% of NS's 2019 revenue from either originating or terminating carload traffic and 26% of NS's total railway operating revenue in 2019 could potentially be subject to reciprocal switching requests based on the Board's stated criteria.

32. Exposing this much traffic to potential reciprocal switching requests risks substantial reduction in investment incentives. The prospect of being forced to switch will impact NS's decisions on investment in facilities in the future and will lead to less investment and to operational challenges, and thus ultimately harm to shippers.

## V. CONCLUSION

33. There is no compelling reason to change the current reciprocal switching regulations and significant risk that the proposed changes will negatively impact railroads' ability to attract

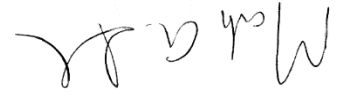
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<sup>22</sup> NS' total railway operating revenue in 2019 was \$11.3 billion according to their 2019 Annual Report Financial Highlights located at <http://www.nscorp.com/content/dam/nscorp/get-to-know-ns/investor-relations/annual-reports/annual-report-2019.pdf>, p 2.

capital and thus their ability to invest in their networks. As currently articulated, the proposed changes place an extensive amount of traffic at risk of being subject to reciprocal switching requests. This threatens differential pricing and railroad's ability to earn a competitive return on capital in places where it is imposed and introduces significant operating costs that will dampen railroad's ability to invest, and thus is disruptive to future investment.

34. If any such regulatory changes are to be made, they should be restricted to only the most severe cases where shippers truly have no other rail, intermodal, product, or geographic alternatives options. Moreover, as discussed in greater detail by Prof. Sappington,<sup>23</sup> any access should be priced in a way that accounts for the full opportunity cost of lost shipments (accounting for a competitive return on capital) so that differential pricing is preserved and the associated return on capital is not destroyed.

I declare the foregoing to be true and correct.



Mark A. Israel  
February 14, 2022

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<sup>23</sup> Opening Comments of Norfolk Southern Railway Company, *Reciprocal Switching*, Docket No. EP 711 (Sub-No. 1) (filed Oct. 26, 2016), Verified Statement of Professor Mark Armstrong and David Sappington.

# EXHIBIT A

**Mark A. Israel**  
**Senior Managing Director, Compass Lexecon**

**February 2022**

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## **PROFESSIONAL EXPERIENCE HIGHLIGHTS**

- Served as an expert for the Federal Government and private parties in cases involving: fixed and mobile telecommunications, cable television, broadband internet service, airlines, social media, other high technology industries, food distribution, coal and other energy markets, railroads, shipping, health insurance, financial markets, credit cards, retail, and many others.
- Testified in Federal Court, in multiple state courts, in front of the United States Copyright Royalty Judges, in front of international competition authorities, and in arbitration proceedings. Appeared in front of government agencies including DOJ, FTC, and FCC, and state agencies on behalf of numerous clients.
- Submitted expert reports in Federal Court, and affidavits, declarations, and papers to U.S. competition agencies, FCC, DOT, international competition authorities, and state regulators.
- Written numerous academic articles on topics including competition economics, merger policy, telecommunications, airlines, insurance markets, and labor markets. Research published in leading scholarly and applied journals including *The American Economic Review*, *The Rand Journal of Economics*, *International Journal of Industrial Organization*, *The Journal of Competition Law and Economics*, and many others, and presented to business, government, and academic audiences worldwide.
- Co-author of the chapter on Econometrics and Regression Analysis in the ABA Treatise, *Proving Economic Damages: Legal and Economic Issues*, 2017.

## **AREAS OF EXPERTISE**

- Antitrust and competition economics; industrial organization 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

## **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, May 1991.

# EXHIBIT A

## **EMPLOYMENT HISTORY**

Compass Lexecon: *Senior Managing Director*, Head of Compass Lexecon North American Antitrust Practice, January 2016 – Present.

(Previously: *Executive Vice President*, April 2013 – January 2016; *Senior Vice President*, January 2009 – March 2013; *Vice President*, January 2008 – December 2008; *Economist*, January 2006 – December 2007.)

Kellogg School of Management, Northwestern University: *Assistant Professor of Management and Strategy*, 2000 – 2006; *Associate Professor of Management and Strategy*, 2007 – 2008.

State Farm Insurance: *Research Administrator*, 1992 – 1995.

## **RECENT PROFESSIONAL RECOGNITIONS**

Global Competition Review Who's Who Legal, Thought Leader in Competition: 2019, 2020.

Global Competition Review Who's Who Legal, Global Leader in Competition – Economists 2020; Experts – Economics – Competition Economists 2020; Experts – Financial Advisory and Valuation – Quantum of Damages 2020.

Global Arbitration Review's International Who's Who of Commercial Arbitration, Leading Expert Witness, 2018.

## **LIVE TESTIMONIAL EXPERIENCE**

Live testimony in front of arbitration panel in confidential arbitration regarding wholesale roaming rate for wireless telecommunications: December 13-14, 2021.

Testimony as Economic Expert on behalf of Nippon Chemi-Con and United Chemi-Con, *In Re Capacitors Antitrust Litigation*, United States District Court for the Northern District of California Division, No. 3:14-CV-03264, Deposition: March 14, 2020; Live Jury Trial Testimony: December 8, 2021.

Testimony as Economic Expert on behalf of Norfolk Southern Railway Company, *In Re Rail Freight Fuel Surcharge Antitrust Litigation*, In the United States District Court for the District of Columbia, MDL No. 1869, Case No. 07-0489 (PLF/GMH), Deposition: November 18, 2021.

Testimony as Economic Expert on behalf of JPMorgan, Goldman Sachs and Glencore, *In Re Aluminum Warehousing Antitrust Litigation*, MDL 2481, In the United States District Court Southern District of New York, No. 16-CV-5955, Deposition: November 5, 2021.

Testimony as Economic Expert on behalf of Cox Automotive, Inc. et al., In the Matter between *Cox Automotive, Inc., Autotrader.com, Inc., Dealer Dot Com, Inc., Dealertrack, Inc.; Homenet, Inc.; Kelley Blue Book Co., Inc.; Vauto, Inc.; Vinsolutions, Inc.; and Xtime, Inc. vs. The Reynolds and Reynolds Company*, American Arbitration Association, Case No. 01-19-0000-4548, Deposition: October 21, 2021.

# EXHIBIT A

- Testimony as Economic Expert on behalf of the Joint Defense Group, 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. 3795-14 CP, Deposition: September 29, 2021.
- Testimony as Economic Expert on behalf of American Express, In the Matter of *B & R Supermarket, Inc., d/b/a Milam's Market, et al., Individually and on Behalf of All Others Similarly Situated v. Visa, Inc., et al.*, In the United States District Court Eastern District of New York, Case No. 117-cv-02738-MKB-VMS, Deposition: August 6, 2021.
- Testimony as Economic Expert on behalf of Bio-Rad Laboratories, Inc., In the Matter of *Bio-Rad Laboratories, Inc. and President and Fellow of Harvard College v. 10X Genomics, Inc., and 10X Genomics, Inc. v. Bio-Rad Labs, Inc. and President and Fellow of Harvard College as Counterclaimants*, In the United States District Court for the District of Massachusetts, Civil Action No. 1:19-cv-12533-wgy, Deposition: June 1, 2021.
- Testimony as Economic Expert on behalf of Joint Applicants, In the Matter of *TracFone Wireless, Inc. (U4321C), América Móvil, S.A.B. de C.V. and Verizon Communications, Inc. for Approval of Transfer of Control over TracFone Wireless, Inc.*, Public Utilities Commission of the State of California, Application 20-11-001, Opening Testimony: March 12, 2021; Rebuttal Testimony: April 9, 2021; Live Trial Testimony: May 5, 2021; Supplemental Testimony: May 28, 2021.
- Testimony as Economic Expert on behalf of Peabody Energy Corporation and Arch Coal, Inc., In the Matter of *Federal Trade Commission v. Peabody Energy Corporation and Arch Coal, Inc.*, In the United States District Court for the Eastern District of Missouri, Civil Action No. 4-20-cv-000317-SEP, Deposition: June 29, 2020; Live Trial Testimony: July 24, 2020.
- Testimony as Economic Expert on behalf of Authenticom, Inc., *In Re Dealer Management Systems Antitrust Litigation*, MDL 2817, United States District Court for the Northern District of Illinois Eastern Division, No. 1:18-CV-864, Deposition: January 16-17, 2020.
- Testimony as Economic Expert on behalf of Trinity, 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, Stage 1 Testimony: May 24, 2017; Stage 2 Deposition: November 14, 2019.
- Testimony as Economic Expert on behalf of Joint Applicants, In the Proposed Merger of T-Mobile US, Inc. and Sprint Communications, Inc., Public Utilities Commission, State of California, San Francisco, California, Docket Nos. A.18-07-011 and A.18-07-012, Direct Rebuttal Testimony: January 29, 2019; Live Testimony: February 7, 2019; Direct Supplemental Testimony: November 7, 2019.
- Testimony as Economic Expert on behalf of Turner Network Sales, Inc., In the Matter of *DISH Network L.L.C. v. Turner Network Sales, Inc.*, JAMS Arbitration No. 1100103066, Deposition: August 9, 2019; Live Trial Testimony: August 29, 2019.

## EXHIBIT A

Testimony of Economic Expert on behalf of Marriott Vacations Worldwide Corporation, et al., In the Matter of *RCHFU, LLC, et al. v. Marriott Vacations Worldwide Corporation, et al.*, In the United States District Court for the Eastern District of Colorado, Civil Action No. 1:16-cv-01301-PAB-GPG, Deposition: July 12, 2019.

Testimony as Economic Expert on behalf of Oscar Insurance Company of Florida, 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, Live Preliminary Injunction Hearing Testimony: January 23, 2019.

Testimony as Economic Expert on behalf of Wilh. Wilhelmsen Holding ASA, 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, Deposition: May 24, 2018; Live Trial Testimony: June 12, June 13, 2018.

Testimony as Economic Expert on behalf of Joint Sports Claimants, In the Matter of *Determination of Cable Royalty Funds*, United States Copyright Royalty Judges in the Library of Congress, Docket No. 14-CRB-0010-CD (2010-2013), Live Testimony: March 12, 2018.

Testimony as Economic Expert on behalf of Comcast Corporation, In the Matter of *Viamedia, Inc. v. Comcast Corporation and Comcast Spotlight, LP*, In the United States District Court Northern District of Illinois Eastern Division, Case No. 16-cv-5486, Deposition: January 5, 2018.

Testimony as Economic Expert on behalf of Energy Solutions, Inc., 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, Deposition: April 17, 2017; Live Trial Testimony: May 2, May 3, 2017.

Testimony as Economic Expert on behalf of Facebook, Inc., In the Matter of *Social Ranger, LLC v. Facebook, Inc.*, In the District Court of Delaware, C.A. No. 14-1525-LPS, Deposition: March 6, 2017.

Testimony as Economic Expert on behalf of Regal Entertainment Group, 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, 234<sup>th</sup> Judicial District, No. 2015-68745, Deposition: January 12, 2016, February 15, 2017; Live Trial Testimony: January 21, 2016.

Testimony as Economic Expert on behalf of Anthem Inc., In the Matter of the *United States of America et al. v. Anthem Inc. and Cigna Corp.*, In the District Court of the District of Columbia, No. 16-cv-01493 (ABJ), Deposition: November 9, 2016; Phase 1 Live Trial Testimony: December 1, December 2, 2016; Phase 2 Live Trial Testimony: December 22, 2016.

# EXHIBIT A

Testimony as Economic Expert on behalf of Defendants, In the Matter of *Darren Ewert v. Nippon Yusen Kabushiki Kaisha et al.*, Supreme Court of British Columbia, No. S-134895, Deposition: September 14, 2016.

Testimony in Commercial Arbitration on Issues Related to Mobile Wireless Competition, New York, NY, April 12, 2016.

Testimony as Economic Expert on behalf of Federal Trade Commission, In the Matter of *Federal Trade Commission et al. v. Sysco Corporation and USF Holding Corp.*, Civil Action No. 15-cv-00256 (APM), Deposition: April 28, 2015; Live Trial Testimony: May 7, May 8, May 14, 2015.

Appearances in Federal Communications Commission, Economists Panels:

- Comcast/Time Warner, January 2015
- AT&T/T-Mobile, July 2011
- Comcast/NBCUniversal, August 2010

Appearance before California Public Utility Commission, Public Hearings on Comcast/Time Warner Merger, Los Angeles, April 2015.

Appearance as Economic Expert in front of Department of Justice, Federal Trade Commission, Federal Communications Commission, and State Regulatory Agencies in many additional transactions, including: Danaher/NetScout, AT&T/Leap Wireless, T-Mobile/MetroPCS, American Airlines/US Airways, SpectrumCo/Cox/Verizon Wireless, oneworld antitrust immunity application, PepsiCo/bottlers, Houghton Mifflin/Harcourt, Chicago Mercantile Exchange/Chicago Board of Trade.

## **EXPERT REPORTS, AFFIDAVITS, AND DECLARATIONS**

Expert Report of Mark A. Israel, In the Matter between *Sean Allott and Panasonic Corporation; Panasonic Corporation of North American; Panasonic Canada Inc.; KOA Corporation; KOA Speer Electronics, Inc., et al.*, In the Ontario Superior Court of Justice, Court File No. 1899-2015 CP, January 17, 2022.

Expert Reports of Mark A. Israel, Ph.D., *In Re Aluminum Warehousing Antitrust Litigation*, In the United States District Court Southern District of New York, MDL No. 2481, Initial Report: September 17, 2021; Supplemental Declaration: January 14, 2022.

Affidavits in confidential arbitration regarding wholesale roaming rate for wireless telecommunications, Initial Affidavit: August 23, 2021; Reply Affidavit: November 15, 2021.

Expert Report of Mark A. Israel, In the Matter of *Bio-Rad Laboratories, Inc. and President and Fellow of Harvard College v. 10X Genomics, Inc., and 10X Genomics, Inc. v. Bio-Rad Labs., Inc. and President and Fellow of Harvard College as Counterclaimants*, In the United States District Court for the District of Massachusetts, Civil Action No. 1:19-cv-12533-wgy, May 14, 2021.

Expert Report of Mark A. Israel, Ph.D., *In Re Rail Freight Fuel Surcharge Antitrust Litigation*, In the United States District Court for the District of Columbia, MDL No. 1869, Case No. 07-489, April 15, 2021.

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Expert Report of Mark A. Israel, In the Matter of *B & R Supermarket, Inc., d/b/a Milam's Market, Grove Liquors LLC, Strouk Group LLC, d/b/a Monsieur Marcel, and Palero Food Corp. and Cagueyes Food Corp., d/b/a Fine Fare Supermarket v. Mastercard International Inc., Visa Inc., Visa U.S.A., Inc., Discover Financial Services, and American Express Company*, In the United States District Court for the Eastern District of New York, Case No. 17-CV-02738 (MKB) (JO), March 22, 2021.

Expert Report of Dr. Mark A. Israel, In the Matter of *Joshua M. Harman Qui Tam v. Trinity Industries, Inc., et al.*, In the Commonwealth of Massachusetts, Superior Court Department, Civil Action No. 2014-02364-D, February 26, 2021.

Verified Statement of Mark Israel, "Review of Commodity, Boxcar, and TOFC/COFC Exemptions," Surface Transportation Board, Docket No. EP 704 (Sub-No. 1), January 29, 2021.

Expert Report of Mark A. Israel, Ph.D., *In Re Comtech/Gilat Merger Litigation*, Court of Chancery of the State of Delaware, Consolidated C.A. No. 2020-0605-JRS, September 24, 2020.

Declaration of Mark Israel and Allan Shampine, In the Matter of *AMC Networks Inc. v. AT&T Inc.*, Before the Federal Communications Commission, MB Docket No. 20-254, File No. CSR-8993, August 20, 2020.

Expert Report of Mark A. Israel, In the Matter between *Ryan Kett and Mitsubishi Materials Corporation, Mitsubishi Cable Industries, Ltd., Mitsubishi Shindoh Co., Ltd., Mitsubishi Aluminum Co., Ltd., Tachibana Metal Mfg. Co., Ltd., and Diamet Corporation*, In the Supreme Court of British Columbia, Case No. VLC-S-S-1813758, July 15, 2020.

Expert Reports of Mark A. Israel, Ph.D., In the Matter of *Federal Trade Commission v. Peabody Energy Corporation and Arch Coal, Inc.*, In the United States District Court for the Eastern District of Missouri, Civil Action No. 4-20-cv-000317-SEP, Initial Report: May 26, 2020; Reply Report: June 19, 2020.

Expert Reports of Mark A. Israel, Ph.D., *In Re Dealer Management Systems Antitrust Litigation*, United States District Court for the Northern District of Illinois Eastern Division, MDL 2817, No. 1:18-CV-864, Initial Report: August 26, 2019; Reply Report: December 19, 2019.

Expert Reports of Mark A. Israel, Ph.D., *In Re Domestic Airline Travel Antitrust Litigation*, United States District Court for the District of Columbia, MDL Docket No. 2656, Misc. No. 15-1404 (CKK), Initial Report: September 30, 2019; Rebuttal Report: November 14, 2019.

Expert Reports of Mark A. Israel, In the Matter of *DISH Network L.L.C. v. Turner Network Sales, Inc.*, JAMS Arbitration No. 1100103066, Initial Report: July 23, 2019; Reply Report: August 2, 2019.

Submission of Mark A. Israel, Maya Meidan, and Robert J. Calzaretta, Jr., "The Atlantic Joint Business Generates Substantial Consumer Benefits," Competition and Markets Authority, United Kingdom, July 1, 2019.

Submission of Philip Haile and Mark Israel, "Alternative Approaches to Airport Slot Allocation: Objectives and Challenges," Department for Transport, United Kingdom, June 20, 2019.

# EXHIBIT A

Submission of Mark A. Israel, Maya Meidan, and Robert J. Calzaretta, Jr., “The Atlantic Joint Business Has Not Harmed Competition on Nonstop Overlap Routes, Including Focus Routes,” Competition and Markets Authority, United Kingdom, June 14, 2019.

Expert Reports of Mark A. Israel, In the Matter of *RCHFU, LLC, et al. v. Marriott Vacations Worldwide Corporation, et al.*, In the United States District Court for the District of Colorado, Civil Action No. 16-01301-PAB-GPG, Initial Report: December 28, 2018; Supplemental Rebuttal Report, June 14, 2019.

Submission of Mark Israel, “The Fidelity/Stewart Merger Does Not Raise Competitive Concerns in the New York Title Insurance Industry,” Revised Section 1506 Application Regarding the Proposed Acquisition of Stewart Title Insurance Company by Fidelity National Financial, Inc., New York State Department of Financial Services, April 12, 2019.

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.

# EXHIBIT A

- 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.
- Reports of Dr. Mark A. Israel, In the Matter of *Viamedia, Inc. v. Comcast Corporation and Comcast Spotlight, LP*, In the United States District Court for the Northern District of Illinois Eastern Division, Case No. 16-cv-5486, Rebuttal Report: November 30, 2017; Errata Sheet for Rebuttal Report: January 4, 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.
- Written Rebuttal Testimony of Dr. Mark A. Israel, In the Matter of *Distribution of Cable Royalty Funds*, Before the Copyright Royalty Judges, Washington, D.C., No. 14-CRB-0010-CD, September 15, 2017; Written Direct Testimony: December 22, 2016.
- 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.

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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 *Liberman 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, 234<sup>th</sup> Judicial District, No. 2015-68745, January 18, 2016.

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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.

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- 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.

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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 OTHER EXPERT WORK IN REVIEW OF MERGERS/TRANSACTIONS**

*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, demonstrating lack of significant competitive interaction between the parties, including 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 economics expert on behalf of the parties in the FTC’s investigation of the merger. Presented detailed data analyses showing ample competition and lack of harm to competition in any geographic market. FTC closed the investigation with no divestitures required in late 2019.

## EXHIBIT A

*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 lead economic expert for FTC and prepared to serve as FTC's testifying expert against the merger, prior to the parties' abandonment of the proposed merger. 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.

## EXHIBIT A

*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.

## EXHIBIT A

*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 of 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 Shared Service and Joint Sale 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.

# EXHIBIT A

*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.

## **SELECTED OTHER EXPERT/CONSULTING WORK**

Led team supporting Dennis Carlton's testimony in Toshiba/Hannstar TFT-LCD Antitrust litigation vs. Plaintiff Best Buy, 2013.

Led team supporting Dennis Carlton's testimony in Toshiba's TFT-LCD Class Action Antitrust litigation. Named Litigation Matter of the Year for 2012 by *Global Competition Review*, 2012.

As economic expert for US Airways, developed econometric analysis of air traffic at major US airports, presented to Philadelphia Airport management team, 2011.

Prepared analysis of the competitive impact of low-cost-carrier competition in Washington, D.C. and New York airports. Filed with DOT, 2011.

On behalf of major pharmaceutical firm, developed econometric model to forecast pharmaceutical expenditures, 2009.

Developed econometric model to measure of the importance of network effects in credit cards in the context of measuring damages incurred by a major credit card issuer, 2007-2008.

# EXHIBIT A

## **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**

- “A Retrospective Analysis of the AT&T/Time Warner Merger” (with Dennis W. Carlton, Georgi V. Giozov, and Allan L. Shampine), Forthcoming in the *Journal of Law and Economics*, available at <https://ssrn.com/abstract=3911492>, October 1, 2021.
- “Vertical Mergers with Bilateral Contracting and Upstream and Downstream Investment,” (with Daniel P. O’Brien), available at <https://ssrn.com/abstract=3886048>, July 15, 2021.
- “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*, March 2021.
- “Lessons from *AT&T/Time Warner*,” (with Dennis W. Carlton and Allan L. Shampine), *Competition Policy International*, July 2019.
- “Are You Pushing Too Hard? Lower Negotiated Input Prices as a Merger Efficiency,” (with Thomas A. Stemwedel and Ka Hei Tse), Volume 82, Issue 2, Pages 623-642, in the *Antitrust Law Journal*, April 2019.

## EXHIBIT A

- “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 2019.
- “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.
- “Complementarity without Superadditivity,” (with Steven Berry, Philip Haile, and Michael Katz), Volume 151, Pages 28-30, in *Economics Letters*, February 2017.
- “Antitrust in a Mobile World,” (with Yonatan Even, Jonathan M. Jacobson, Scott Martin, and Dr. Helen Weeds), Chapter 17 of *International Antitrust Law & Policy: Fordham Competition Law 2015*, Edited by James Keyte, Juris Publishing, Inc., 2016.
- “Buyer Power in Merger Review,” (with Dennis W. Carlton and Mary Coleman), Chapter 22 of *The Oxford Handbook of International Antitrust Economics*, Volume 1, Roger D. Blair and D. Daniel Sokol, eds, Oxford University Press, 2015.
- “The Evolution of Internet Interconnection from Hierarchy to ‘Mesh’: Implications for Government Regulation,” (with Stanley M. Besen), *Information Economics and Policy*, December 2013.
- “Airline Network Effects and Consumer Welfare,” (with Bryan Keating, Dan Rubinfeld, and Robert Willig), *Review of Network Economics*, November 2013.
- “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, Edited by John E. Kwoka, Jr. and Lawrence J. White, Oxford University Press, New York, 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.
- “Will the New Guidelines Clarify or Obscure Antitrust Policy?” (with Dennis W. Carlton), *The Antitrust Source*, October 2010.
- “Should Competition Policy Prohibit Price Discrimination?” (with Dennis W. Carlton), *Global Competition Review*, 2009.

# EXHIBIT A

- “The Empirical Effects of Collegiate Athletics: An Update Based on 2004-2007 Data,” (with Jonathan Orszag), Paper commissioned by National Collegiate Athletic Association, available at [http://www.epi.soe.vt.edu/perspectives/policy\\_news/pdf/NCAASpending.pdf](http://www.epi.soe.vt.edu/perspectives/policy_news/pdf/NCAASpending.pdf), February 2009.
- “Services as Experience Goods: An Empirical Examination of Consumer Learning in Automobile Insurance,” *The American Economic Review*, December 2005.
- “Tenure Dependence in Consumer-Firm Relationships: An Empirical Analysis of Consumer Departures from Automobile Insurance Firms,” *The Rand Journal of Economics*, Spring 2005.
- “The Impact of Youth Characteristics and Experiences on Transitions Out of Poverty,” (with Michael Seeborg), *Journal of Socio-Economics*, 1998.
- “Racial Differences in Adult Labor Force Transition Trends,” (with Michael Seeborg), *Journal of Economics*, 1994.

## **SELECTED RECENT PRESENTATIONS**

- 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, 6<sup>th</sup> 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, 45<sup>th</sup> 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, 42<sup>nd</sup> 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.

## EXHIBIT A

- 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 7<sup>th</sup> 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.

# **EXHIBIT A**

## **GRANTS AND HONORS**

Searle Fund for Policy Research Grant, 2004-2006, for “An Empirical Examination of Asymmetric Information in Insurance Markets.”

Kellogg School of Management Chairs’ Core Course Teaching Award, 2003 & 2005.

Bradley Dissertation Fellowship, Stanford University, 1999-2000.

Stanford University, Outstanding Second Year Paper Prize, 1997.

## **ADVISORY, EDITORIAL, AND TRUSTEE BOARDS**

Global Competition Review, Editorial Board, Member

Holton-Arms School, Board of Trustees, Trustee

Illinois Wesleyan University, Board of Trustees, Trustee

## **REFeree FOR ACADEMIC JOURNALS**

American Economic Review

The Journal of Industrial Economics

The Rand Journal of Economics

Journal of the European Economic Association

The Review of Economic Studies

The Review of Economics and Statistics

Journal of Risk and Insurance

## **Exhibit B**

**Verified Statement of Cynthia M. Sanborn**

**BEFORE THE  
SURFACE TRANSPORTATION BOARD**

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**STB Docket No. EP 711 (Sub-No. 1)**

**RECIPROCAL SWITCHING**

**VERIFIED STATEMENT OF CYNTHIA M. SANBORN**

My name is Cynthia M. Sanborn. I am Executive Vice President and Chief Operating Officer at Norfolk Southern Corporation (“Norfolk Southern”). In my role as Chief Operating Officer, I am responsible for network planning and operations, and ensuring that Norfolk Southern provides safe, efficient, and reliable service over our 19,500 route miles of track. Prior to joining Norfolk Southern in 2020, I held leadership roles at Union Pacific Railroad, including vice president of network planning and operations. I also served for 30 years at CSX Corporation, including as executive vice president and chief operating officer. I hold a Bachelor’s Degree in Computer Science from Emory University and a Master’s in Business Administration from the University of Miami.

While I am here today to testify on behalf of Norfolk Southern, my over thirty years of experience across Class I railroads in the United States offers a breadth of experience not only with the Norfolk Southern network, but with rail networks across the nation, making me especially qualified to testify regarding the challenges and dangers that would be inherent in any forced switching regime imposed by the Board. I testified in this proceeding in 2016 on behalf of CSXT and stand by the concerns I raised at that time. In addition, I support and reiterate the prior

testimony of Jeffrey H. Sliger, formerly Assistant Vice President Transportation Network for Norfolk Southern, who testified in this docket to the efforts that Norfolk Southern has expended to minimize car handling and maximize network efficiency. Mr. Sliger's testimony remains valid to this day and should be considered by the Board as they evaluate this proposal.

While I will not reiterate all the arguments made by Norfolk Southern in prior rounds of testimony, in this testimony I emphasize the complexity of network operations and the ill-advised unintended consequences of a forced switching rule. In Section I, I discuss the operational challenges associated with such a rule, including the rippling effects even minor changes to operations cause across the network system, the harm forced switching would impose on all customers, and the lack of fungibility associated with network resources. In Section II, I emphasize that the Board's proposed case-by-case 'solution' to the operational concerns highlighted by a number of parties will not in fact solve the perceived problem, but instead will result in unintended and unforeseeable consequences. Finally, in Section III, I note that the Board's reciprocal switching proposal will harm all customers; not only those who are eligible for a reciprocal switch, but also those who are ineligible and in turn who will suffer the consequences of a lower velocity network which would be the by-product of a forced switching regime.

In short, I have grave concerns about the Board's proposal, which I strongly believe will have unintended consequences that would result in a degradation of service for all customers and would put significant constraints on the rail network.

## **I. ANY FORM OF FORCED SWITCHING REGULATION WILL CREATE OPERATIONAL CHALLENGES**

### **A. Network Planning is Inherently Complex**

Norfolk Southern's network planning focuses on placing the right resources in the right place based upon predicted traffic flows so as to provide optimum service to all Norfolk Southern customers. Network planning is an inherently complex task that requires the balancing of customer needs and rail resources. To develop a network plan requires analysis of an untold number of factors including consumer demand, current and forecasted customer needs, as well as equipment utilization, track capacity, safety and operational restrictions, and maintenance requirements, among others.

Network planning then requires allocating the necessary resources across the network based on predictions of traffic flows so as to provide safe and reliable service to all of our customers. Each customer's needs are different, from the routing of their traffic, to the type of rail car needed to move the commodity in question. All these factors are considered when developing a network plan, which requires coordinating judgment to maximize the capacity and efficiency of the Norfolk Southern network.

Inherent uncertainty caused by weather or sudden changes in economic conditions put pressure on any network plan. To account for this uncertainty, the overall goal of network planning is to limit volatility and develop the most adaptable plan possible to protect the network from cascading failures.

Adding additional uncertainty through regulatory action such as forced switching will exacerbate the challenges inherent in network planning. In particular, forced switching would have the ill-advised effect of introducing inefficiency into the network by adding touches to individual carloads in the form of additional handlings and new interchange events. This added volatility will create additional complexity and uncertainty into a complex network system.

**B. Forced Switching Will Have a Rippling Effect Across the Norfolk Southern System**

Rail network operations are inherently complex and intertwined. Any shift in traffic patterns in one area of the network can have a rippling effect across the entire Norfolk Southern system. Increased demands on a particular yard or terminal can constrain capacity and slow velocity on one line, which in turn flows across the network, impacting the entire system.

In developing a network plan, the entire route of a shipment is planned and coordinated from railroad receipt to customer delivery. Each customer shipment has its own trip plan down to the car level. In the case of a Norfolk Southern direct shipment, Norfolk Southern's plan will account for each individual car movement, from the local job assigned to pick-up the shipment at a customer facility, to the local yard where the shipment will be placed in a scheduled road train, and thereafter to the destination switching yard and ultimately the local job tasked with final delivery to customer destination. Each car movement is coordinated and,

where possible, each train that the car moves in will be scheduled to maximize the efficiency of the customer's shipment.

Similarly, the network plan for the yards involved will be developed to account for these inbound and outbound shipments. As such, the delivery yard's plan will specify the precise track on which the road train will deliver the cars destined for the customer facility, and the local job plan will specify precisely which cars on which tracks to pick up for final delivery. All these plans are coordinated and interdependent to minimize the amount of time a car remains in a yard and maximize the use of all assets. The local yard job will be scheduled to closely match the arrival time of the road train, to maintain the fluidity of the yard.

Even small changes in operations can have a rippling effect across the network. For example, the late arrival of a train to a yard can result in congestion, because the tracks needed for that late arrival are now occupied by the next work assignment in the yard's operating plan.

In the case of forced switching, unscheduled, unanticipated events will conflict with these planned train movements. Foreign train operations immediately complicate any operating plan because the receiving railroad has no visibility into the foreign operator's plan. A foreign road train—over which Norfolk Southern has no scheduling control—would now need to be accommodated at a local serving yard that has been configured to account for Norfolk Southern operations. By placing cars on tracks otherwise planned for other traffic, that foreign train now interferes

with Norfolk Southern's own operating plan and in turn causes a rippling effect across Norfolk Southern's network by creating capacity constraints at that yard.

### **C. Forced Switching Will Create Inefficiencies**

Maximizing the efficient use of resources is one of the primary goals of network planning. This includes minimizing the number of touches, or handlings, on each car that traverses the network. Norfolk Southern previously testified to the studies it has undertaken to understand the relationships among intermediate handlings—that is, the number of times a car is handled during its journey across the network—shipment velocity, and service. As those studies showed, minimizing the number of intermediate handlings is critical to optimizing shipment velocity. *See* V.S. Sliger, NS Opening Comments, Ex Parte 711 (Sub-No. 1) at 10. Every time a car requires an intermediate handling, that means that the car is stopped in a yard, which in turn reduces that car's velocity and service. *Id.* at 11. Reducing car handlings thus directly impacts the speed at which that particular car reaches its destination.

But that is not the only benefit to reducing car handlings. Norfolk Southern's studies revealed that removing handlings from the network speeds up even those movements that require no handlings themselves. *Id.* at 12. The fewer handlings for any particular car on the network has a direct relationship to the overall velocity of the network. In short, fewer handlings means a more fluid network and better service for all customers.

A forced switching regime would turn that model on its head, by intentionally increasing the number of handlings required to move a car over the network. Adding an interchange to a shipment that previously moved direct via a single carrier adds an additional intermediate handling to that service. Interchange handlings are more complex than other intermediate handlings in that they require coordination between two railroads regarding issues of timing, location, and infrastructure. This in turn will slow down that car, and result in inefficiencies across the network.

**D. The Board's Purported Solution for Forced Switching Assumes Resources are Fungible**

As I have described above, the proper allocation of resources is critical to any network plan. Any changes to system design in turn require the re-allocation or acquisition of resources. In either case—whether acquisition or re-allocation—the placement of resources requires advanced planning as both endeavors are time consuming. The Board's suggestion that it can account for operational disruptions that will occur under a forced switching regime on a case-by-cases basis is illogical. Any change to operations is disruptive. The Board appears to assume that implementing forced switching is a simple task that could be accomplished with the resources currently in use in that terminal area. But that is not the case. Norfolk Southern—like all rail carriers—allocates resources specific to the needs of that location. An assumption that a railroad would have ready access to additional needed resources to accomplish forced switching is also misplaced.

Running a rail network relies on a variety of resources, including our most important resource—our employees—as well as our rail assets which include our fixed network footprint and our rail equipment. Many rail assets are fixed assets—such as track or yard facilities—which, once constructed, cannot be redeployed to other parts of the system. Making decisions regarding the right-sizing of these fixed assets, in particular, requires significant investment and strategic decision making at the highest level.

In the case of network changes that call for the acquisition of new resources, any changes to system design that require equipment acquisitions or personnel hiring can take months. Norfolk Southern has recently made strides to streamline its hiring processes, consistent with FRA regulations, but even with those modifications, it takes on average four months from the time the decision to add conductors is made to the time those personnel are hired, trained, and qualified on the territory. Equipment acquisition similarly takes time from the solicitation of the bid to the delivery of the equipment. For example, acquiring a new locomotive can take as many as 6 months via a lease or 12 months if a new locomotive is purchased.

Even the re-allocation of resources already in place somewhere within the network is time intensive, in particular because not all resources are fungible. Any movement of employees would require certification on a new territory or work assignment. In some cases, such reassignments may be prohibited by existing labor agreements. Similarly, reallocating resources from one area of the network to

another can be complex. Not all equipment is suitable to work on all areas of the network. For example, simply because NS may have an available locomotive of a certain type does not necessarily mean that particular locomotive is suitable for the work demanded from a forced switch. Similarly, one customer's need for gondola cars cannot be satisfied by an excess of boxcars that may be available on another part of the network.

More important than the challenges of matching resources to network needs is the simple fact that re-allocating employees or assets from their current assignment to a new assignment necessarily results in fewer resources available for the original work. If a forced switch required the addition of a yard job to complete the switching activity—because the interchange activities created inefficiencies that now mean the added switch activity cannot be accomplished using one job—the employee utilized for that work would be unavailable to perform her prior assignment. If the work demanded the hiring of a new employee, it would be months before the new hire is available to perform the added work. Even if resources were available somewhere on the network, moving an employee from one yard assignment to another assignment 100 miles away to address a service concern at that location will simply result in congestion at the original yard—thereby simply moving the problem from one location to another.

The lack of fungibility in rail assets means that it is difficult to respond to short-term fluctuations in demand. Sudden traffic shifts can result in an imbalance of resources, creating operating challenges and service failures. As the Board well

knows, recent crew shortages across the entire industry have created significant service challenges for railroads, including Norfolk Southern. Norfolk Southern has implemented many measures in response to the crew contraction, including temporary crew relocations, a significant ramp up in new hiring, amongst others. These measures take time to bring resources back into balance. A forced switching regime will exacerbate these challenges by requiring even more allocation and re-allocation of resources based on the demands of one customer, which may not be in the best interest of the network as a whole.

## **II. CASE BY CASE ANALYSIS DOES NOT ALLEVIATE THE OPERATIONAL CHALLENGES WITH SWITCHING**

The Board has suggested that it could address the operational concerns raised above by employing a case-by-case analysis. But such a proposal will not solve the significant concerns surrounding a forced switching regulation. In particular, the Board's proposed standards for a case-by-case analysis are particularly broad and a case-by-case approach results in an inability to consider the cumulative harms that forced switching orders will impose on the network. This could result in the Board losing sight of the forest through the trees. In particular, one of the avenues of relief under the proposed rule does not appear to allow for consideration of impacts on service quality, other than the incredibly high "unduly hamper" standard. And critically, there is no off-ramp or 'look back' mechanism embedded in the proposal, making it difficult to know how the Board would deal with the cumulative impact to operations as more switching orders are made. All

these concerns mean that the case-by-case approach is not a solution to the operational concerns outlined above.

The case-by-case analysis proposed by the Board would negatively impact Norfolk Southern's ability to efficiently manage its rail network. If Norfolk Southern has to plan for potential forced switching at the hundreds of locations that could be impacted by the Board's forced switching proposal, it will result in the inefficient use of assets. Even the potential for forced switching would have to be incorporated into the operating plan and assets that may be needed for the reciprocal switch would have to be reserved for those locations, even if they may be better utilized in another area of the network. Norfolk Southern would therefore have to reserve sufficient resources in that area to account for the possibility of switching—in effect, it would have to plan to lose a case.

Additionally, the proposed rules rely on the assumption that the Board will be able to foresee traffic flows and predict impacts resulting from a decision to force switching. However, given the ripple effects of a single case and the compounding impacts of multiple cases, this assumption is incorrect. The impacts of a single forced switch would not be limited to that specific area of the network. As described above, a single service change can have far reaching effects on the network, often in unexpected ways.

An effort to address a single customer's perceived lack of competitive service options could ultimately hurt service for many customers. Forced switching can have negative impacts on other customers who are reliant upon the same facilities

as those used by the recipient of the forced switch. Because the switched traffic will absorb more resources—more track capacity and crew time—it will use capacity that would have otherwise been available for other customers. As a result, a case-by-case approach necessarily implicates more than just the customer at issue.

Further, multiple cases could arise at one time or in quick succession, resulting in numerous reciprocal switches across the network that could in turn create conflicting movements that would exacerbate network interference. Cases will compound upon one another and create volatility and uncertainty within the network. This would hurt service for all, rather than improve it for one.

### **III. FORCED SWITCHING HARMS ALL CUSTOMERS**

While certain customers may believe a forced switching regime would be a benefit to them, the negative impact on downstream customers and the overall network would result in harm to all customers. For those customers who may elect to utilize a forced switch, the added handlings to their own traffic will significantly slow the velocity of those shipments resulting in poorer service for them. In turn, the slower movement of that customer's traffic across the network will cascade through the network and degrade service for other customers as well.

A number of rail customers have testified in this proceeding as to the harm forced switching would impose on their rail service. UPS testified that forced switching “imposes an increased regulatory scope imposed on the railroads. UPS's experience in other contexts leads us to conclude that implementation of a new

reciprocal switching scheme will lead to decreased network velocity, diminished capital investments into the freight rail network, and deteriorating rail intermodal service levels.” UPS Letter at 1 (Oct. 26, 2016). I share UPS’s concern that forced switching “would have a net negative effect on the freight rail network and result in unintended consequences detrimental to the efficient move[ment] of freight.” UPS at 2. Hub Group—who “strongly oppose the forced access proposal”—testified that “it is impossible for the Board to know the cumulative effects of forced access and exactly which grant of access will create this spiraling negative effect on rail service.” Hub Group Letter at 1 (Oct. 26, 2016).

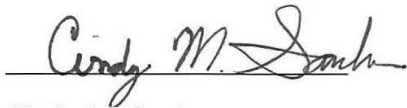
These are precisely the concerns that I have regarding the proposal before the Board. Additional handlings associated with forced switching slow network velocity, which clogs up the network and causes problems for all customers, not just the customer seeking the switch. Thus, customers who may not even be eligible for forced switching will suffer the consequences of the Board’s proposal.

For all of these reasons, I urge the Board not to proceed with the implementation of a forced switching proposal.

### Verification

I, Cynthia M. Sanborn, Executive Vice President and Chief Operating Officer of Norfolk Southern Corporation, verify under penalty of perjury that I have read the foregoing document and know its contents, and that the same is true and correct to the best of my knowledge and belief.

Executed on February 14, 2022

A handwritten signature in cursive script, reading "Cindy M. Sanborn", written over a horizontal line.

Cynthia M. Sanborn

**Exhibit C**

**Professor Kevin M. Murphy & Professor Mark E. Zmijewski  
Verified Statement  
from Docket No. EP 766**

**BEFORE THE  
SURFACE TRANSPORTATION BOARD**

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**JOINT PETITION FOR RULEMAKING  
TO MODERNIZE ANNUAL REVENUE ADEQUACY DETERMINATIONS**

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**VERIFIED STATEMENT OF**

**PROFESSOR KEVIN M. MURPHY**

**PROFESSOR MARK E. ZMIJEWSKI**

**SEPTEMBER 1, 2020  
(UPDATED FEBRUARY 10, 2021)**

|                        |                                                                                                                                                                                                                      |           |
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## **I. INTRODUCTION**

### **A. Credentials of the Witnesses**

#### **1. Professor Kevin M. Murphy**

1. Professor Murphy is the George J. Stigler Distinguished Service Professor of Economics in the Booth School of Business and the Department of Economics at The University of Chicago, where he has taught since 1983. He earned a doctorate degree in economics from The University of Chicago in 1986 and his bachelor's degree, also in economics, from the University of California, Los Angeles, in 1981.

2. At The University of Chicago, Professor Murphy teaches economics in both the Booth School of Business and the Department of Economics. He teaches graduate level courses in microeconomics, price theory, empirical labor economics, and sports analytics. In these courses, he covers a wide range of topics, including the incentives that motivate firms and individuals, the operation of markets, the determinants of market prices, and the impacts of regulation and the legal system. Most of his teaching focuses on two things: how to use the tools of economics to understand the behavior of individuals, firms and markets; and how to apply economic analysis to data. His focus in both research and teaching has been on integrating economic principles and empirical analysis.

3. Professor Murphy has authored or co-authored more than 65 articles in a variety of areas in economics and co-authored a book titled *Chicago Price Theory*. His articles have been published in leading scholarly and professional journals, including the *American Economic Review*, the *Journal of Law and Economics*, and the *Journal of Political Economy*.

4. Professor Murphy is a Fellow of the Econometric Society and a member of the American Academy of Arts and Sciences. In 1997, he was awarded the John Bates Clark Medal, which the American Economic Association awarded once every two years to an outstanding American

economist under the age of forty. In 2005, he was named a MacArthur Fellow, an award that provides a five-year fellowship to individuals who show exceptional merit and promise for continued and enhanced creative work. Also in 2005, he was elected a Fellow of the Society of Labor Economists.

5. In addition to his positions at The University of Chicago, Professor Murphy also is a Senior Consultant to Charles River Associates (“CRA”), a consulting firm that specializes in the application of economics to law and regulatory matters. He has consulted on a variety of antitrust, intellectual property, fraud, and other matters involving economic and legal issues, such as damages, class certification, mergers, labor practices, joint ventures, and allegations of anticompetitive exclusionary access, tying, price fixing, and price discrimination. He has submitted testimony in Federal Court, the U.S. Senate, and to state regulatory bodies, and has submitted expert reports in numerous cases, testified on behalf of the U.S. Federal Trade Commission, and consulted for the U.S. Department of Justice. Professor Murphy has provided expert testimony to the Surface Transportation Board (“Board”) on behalf of both Union Pacific Railroad and CSXT in the past, including in connection with the Board’s previous consideration of revenue adequacy issues. Professor Murphy’s CV is attached to this Statement.

## **2. Professor Mark E. Zmijewski**

6. Professor Mark E. Zmijewski specializes in the areas of accounting, economics, and finance as they relate to valuation, financial analysis, and security analysis, or more generally, financial economics. Professor Zmijewski is Professor Emeritus at The University of Chicago Booth School of Business (“Chicago Booth”), and previously held the Charles T. Horngren Professorship and the Leon Carroll Marshall Professorship in his 30-year career at Chicago Booth. In addition to his faculty duties, Professor Zmijewski also held the positions of Deputy

Dean, PhD Program faculty director, and the Center for Research in Security Prices faculty director, all at Chicago Booth.

7. Professor Zmijewski earned his BS in 1976, MBA in 1981, and PhD (with major in accounting and minors in economics and finance) in 1983, all from the State University of New York at Buffalo. In addition to The University of Chicago, Professor Zmijewski has taught at the State University of New York at Buffalo and at York University in Toronto, Canada. Professor Zmijewski teaches various courses in accounting (financial accounting, managerial accounting, and advanced accounting/mergers and acquisitions), finance (corporate finance, financial strategy and corporate transactions, financial analysis, and valuation of companies and corporate transactions), and entrepreneurship. His research focuses on firm valuation, the pricing of publicly-traded securities, and the ways in which various capital market participants use information to value securities. He has published articles in academic journals in the areas of accounting and financial economics and also co-authored a textbook (with Professor Robert Holthausen of The Wharton School of the University of Pennsylvania) on how to value companies, parts of companies, and the securities issued by companies, titled, *Corporate Valuation: Theory, Evidence and Practice*. Professor Zmijewski has been an Associate Editor of *The Accounting Review*, and has served on the Editorial Boards of both the *Journal of Accounting Research* and *The Accounting Review*.

8. Professor Zmijewski also is a Senior Consultant to Charles River Associates, a consulting firm that provides economic, financial, and management consulting services. He also is a Senior Advisor to, and a member of, the Investment Committee at Patron Capital Partners (Funds IV and V), a private equity investment company with a focus on real estate related investments. Professor Zmijewski was a founding partner of Chicago Partners, LLC, which was acquired by

Navigant Consulting; a former managing director of Navigant Economics (a subsidiary of Navigant Consulting); and a former member of the corporate executive committee of Navigant Consulting.

9. Professor Zmijewski has worked as a consultant or expert in litigation matters in U.S. state and federal courts, in the Supreme Court of Victoria in Australia, and in U.S. and international arbitrations. He has been engaged by the U.S. Department of Justice, the U.S. Federal Trade Commission, and the U.S. Securities and Exchange Commission, as well as by companies, classes of plaintiffs, and individuals. Professor Zmijewski has consulted on business valuation and securities valuation (valuation of corporate transactions, companies, and parts of companies, intangible assets and intellectual property, and securities); securities litigation (Rule 10b-5, Section 11, Section 12, ERISA, Martin Act, effect of disclosures, analysis of how markets work, and insider trading); mergers and acquisitions (appraisals and price disputes, analyzing merger synergies, material adverse changes, corporate transactions, and the process of purchasing and selling companies); antitrust matters (measuring profitability, measuring and analyzing rates of return, and assessing merger efficiencies), and a variety of other valuation, financial analysis, and accounting related issues. Professor Zmijewski's CV is attached to this Statement.

#### **B. Assignment**

10. We have been asked by Canadian National Railway ("CN"), Norfolk Southern Railway ("NS") and Union Pacific Railroad ("UP") to apply economic principles to develop a methodology to modernize how the Surface Transportation Board (the "STB" or "the Board") monitors the financial health of the freight rail industry. Specifically, we propose a refined methodology to assess revenue adequacy that uses the types of accounting-based rates of return

on which the Board historically has relied in its comparison with the railroad industry's cost of capital, but that mitigates some of the limitations and inaccuracies of using accounting-based rates of return in this way. We begin by explaining the economic principles that should guide the assessment of revenue adequacy and use of these principles to minimize the economic harm to both railroads and shippers that could result from misguided rate-of-return regulations based on erroneous and unfounded analyses of the railroads' rates of return. The methodology we then propose is a standard and widely used financial methodology that compares a company's financial performance to that of one or more comparison groups. As applied here, we propose a benchmarking methodology that compares the financial performance of the railroads to the financial performance of companies operating in competitive (unregulated) markets for purposes of assessing revenue adequacy.

### **C. Summary of Conclusions**

11. Based on the analyses that we present in this Statement, we have reached the following conclusions:

- Railroads were deregulated so that they could operate (without financial support from the government) as private firms responsible for purchasing, operating and maintaining the infrastructure and equipment they require. Railroads must compete for the necessary capital with the vast number of other private firms, not just in the United States but worldwide.
- Misguided regulation of railroad rates in response to a conclusion drawn from misleading measurement of railroads' rate of return and misinterpretation of what a measured rate of return implies about a railroad's competitiveness could lead to the classic problems of rate of return regulation and endanger the industry's success. Forces of competition have

motivated railroads to assure a “safe, adequate, economical, efficient, and financially stable rail transportation system.”<sup>1</sup> The potential harm from imposing regulation does not cease once a railroad is profitable.

- Economic efficiency requires that railroads be able to aim for a rate of return greater than their cost of capital. Operational and investment decisions—lowering operating costs, investing in high-return projects, developing new services valued by shippers, changing management—that benefit customers can enable a railroad to earn a rate of return that exceeds its cost of capital for extended periods of time, an outcome that benefits its customers and should be encouraged by the Board.
- Economic research has shown that the limitations and inaccuracies of accounting-based rates of return make it difficult, some say impossible, to infer economic rates of return from accounting rates of return. Fisher and McGowan (1983) expressed one of the strongest conclusions against using accounting rates of return as estimates of economic rates of return: “... there is no way in which one can look at accounting rates of return and infer anything about relative economic profitability ... Economists (and others) who believe that analysis of accounting rates of return will tell them much (if they can only

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<sup>1</sup> Staggers Rail Act of 1980. This point was made long ago by two economists at Princeton University: Professors William Baumol and Robert Willig (see Baumol, William J., and Robert D. Willig, “Verified Statement,” EP 347, Coal Rate Guidelines - Nationwide, May 11, 1981). They explained in their Verified Statement in support of the ICC’s proposal to adopt Ramsey pricing and the stand-alone cost standard in regulating rail rates that “Ramsey pricing and stand-alone costs [are] sufficient pricing restraints,” noting that “it is neither necessary nor desirable to adopt any [] additional pricing constraints. The entire purpose of the Staggers Act and the movement toward (partial) deregulation of rail transportation can be frustrated by adoption of such unnecessary restraints” (pp. 77-78). They concluded further that “those same pricing principles continue to apply with equal validity under adequacy of revenues...the regime of financial solvency will therefore require no modification” in the ICC’s pricing principles (p. 85).

overcome the various definitional problems which separate economists and accountants) are deluding themselves.”<sup>2</sup>

- If it is necessary to compare accounting rates of return to the cost of capital to assess profitability, we propose a widely used benchmarking methodology that compares the railroads’ financial performance to the financial performance of companies operating in competitive (unregulated) markets. This approach provides a more reliable assessment of the financial performance of the railroads relative to their cost of capital.
- Our benchmarking analyses show that the financial performance of the railroad industry and the seven railroads generally was below the financial performance of companies operating in competitive (unregulated) markets. Using two alternative measures of financial performance and three benchmarking groups, we conclude that, over the 2006 through 2019 period, the financial performance of the railroad industry and each of the seven Class I railroads fell well below the median and mostly in the bottom quartile of the financial performance of all three benchmarking groups.

## **II. ECONOMIC PRINCIPLES FOR EVALUATING RAILROADS’ ECONOMIC RATE OF RETURN**

12. Since 1981, the Board or its predecessor agency, the Interstate Commerce Commission (“ICC”), has made an annual determination whether rail carriers are “revenue adequate.” It has done so by comparing each rail carrier’s annual return on the depreciated book value of its assets

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<sup>2</sup> Fisher, Franklin M., and McGowan, John J., “On the Misuse of Accounting Rates of Return to Infer Monopoly Profits,” *American Economic Review*, March 1983, 73, pp. 92 – 93.

(net of “deferred taxes”)<sup>3</sup> with the rail industry’s average cost of capital.<sup>4</sup> Congress mandated an annual evaluation of whether railroads are earning “adequate revenue” when it substantially deregulated the railroad industry in order to “promote a safe and efficient rail transportation system by allowing rail carriers to earn adequate revenues.”<sup>5</sup>

13. We understand some stakeholders are urging the Board to impose additional regulatory constraints on railroads’ pricing and operating flexibility based on a misguided belief that the carriers are earning profits suggestive of noncompetitive pricing. However, fundamental principles of economics counsel caution and careful consideration of how to measure railroad profitability (revenue adequacy), how to interpret a measurement, and whether competition would be enhanced or harmed if the Board mandated additional regulatory action based on inferences drawn from a measure of revenue adequacy.

#### **A. The Goal of the Staggers Act is to Create Conditions for Railroads that Mimic Competitive Markets**

14. The fundamental goal in deregulating the railroads was to provide them with incentives and flexibility to undertake necessary investments and operational changes to become profitable and competitive. Congress recognized that this would benefit shippers and consumers.<sup>6</sup>

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<sup>3</sup> The Board uses historical cost minus accumulated depreciation (net of deferred taxes) as its measure of a railroad’s assets for purposes of calculating revenue adequacy. For ease of exposition, in the rest of our report, we refer to the historical cost minus accumulated depreciation as “book value.”

<sup>4</sup> See STB Decision EP 679, *Association of American Railroads – Petition Regarding Methodology for Determining Railroads Revenue Adequacy*, decided October 23, 2008, pp. 1-2 (“For a railroad, ROI has traditionally been calculated by dividing net income from railroad operations by the depreciated original cost, or book value, of the railroad’s assets. This is done by dividing net railway operating income (an after-tax, before-interest figure) by an investment base that consists of the firm’s net investment in railroad property, plus working capital, less accumulated deferred income tax credits.”).

<sup>5</sup> Staggers Rail Act of 1980, Pub. L. No. 96-448, § 3, 94 Stat. 1897, section 3(a).

<sup>6</sup> The move to deregulate the railroads began with the 1976 Railroad Revitalization and Regulatory Reform Act (“4R Act”), which provided for reduced federal oversight of the railroads. Deregulation was furthered by the 1980 Staggers Rail Act, which gave railroads flexibility to set rates and discontinue unprofitable service.

Railroads had been in extreme financial difficulty for many years. Congress was concerned about their survival as private firms and the risk that taxpayers might have to support the railroads if their financial performance did not improve.<sup>7</sup> Congress appears to have recognized, and the Board and its predecessor agency acted accordingly, that the prospect of earning higher profits not limited by unnecessary rate of return and operational regulation would create incentives for railroads to undertake operational and capital investments to improve service and win customers. And this turned out to be right—deregulation created incentives for private investment in railroads because investors could expect to make profits by investing in railroads. Railroads then invested available capital to become more efficient and profitable.

15. Outcomes since passage of the Staggers Act demonstrate how competition can work to eliminate inefficiencies created by regulation. When the railroads were first deregulated in 1980, many were inefficiently sized and configured.<sup>8</sup> This was especially problematic in a network industry such as this, where freight can travel large distances and move on multiple railroads that must coordinate and perform efficiently to serve shippers well. Railroads responded to

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<sup>7</sup> In contrast to the privately financed freight railroads, Congress passed the Rail Passenger Service Act of 1970, establishing the National Railroad Passenger Corporation to “take over the intercity passenger rail service that had been operated by private railroads. Amtrak began service on May 1, 1971 serving 43 states with a total of 21 routes” (see <http://history.amtrak.com/amtraks-history/1970s>). This federally supported rail service recently requested \$1.7 billion in federal grants for its 2019 fiscal year (see <http://www.amtrak.com/ccurl/412/537/Amtrak-FY2015-Federal-Budget-Request-ATK-14-028,0.pdf>). Freight railroads outside North America also are generally government owned or subsidized.

<sup>8</sup> Committee for a Study of Freight Rail Transportation and Regulation Transportation Research Board, The National Academies of Sciences, Engineering and Medicine, *Modernizing Freight Rail Regulation*, Special Report 318 (2015) at p. 180: “The Staggers Rail Act of 1980 made fundamental changes in the federal railroad regulatory program. When the act was passed, the country’s private freight railroad industry was in financial and physical decline. It had been overregulated and had lost large amounts of traffic to trucks. Some railroads were receiving government subsidies, and the industry’s nationalization was a possibility... The railroads, which had once dominated the transportation of freight and passengers, were left with an asset base that had become oversized and misaligned with demand. They were generating too little revenue to pay for basic upkeep, much less reinvestment. Reducing expansive networks and other legacy capacity that had become uneconomic and making more intensive use of the capacity that remained were critical to the industry’s survival as a private enterprise. The Staggers Rail Act sought to enable such changes, which had been hindered for decades by the federal regulatory regime... The act allowed railroads to shed excess capacity and to concentrate traffic on fewer lines using fewer locomotives and workers.”

deregulation by abandoning many unprofitable operations (that had been sustained only by regulatory requirements or distortions) and integrating many inefficiently sized independent railroads to create strong regional competitors with more efficiently configured networks. The process was not always smooth, but the result has been improved operations on the railroad side (e.g., higher velocity, fewer work events, lower costs, and greater productivity) and better service on the customer side (e.g., faster cycle time, more reliable service, improved car utilization, and single-line service to more markets). The resulting increase in railroads' efficiency and profitability since passage of the Staggers Act is evidence that deregulation enabled railroads to become more financially healthy by improving their service and increasing and diversifying the traffic they carry.

16. The incentive to gain sales and reduce costs in order to increase profitability is the motivation of successful firms in competitive markets free from regulatory restrictions on firms' ability to benefit from their investments and innovation.<sup>9</sup> Competition motivates firms to become more efficient and improve quality, reduce quality-adjusted price, and innovate. For example, when a railroad faces increased competition from trucks, it will be motivated to reduce rates, increase output (through improved quality of rail service—e.g., better schedules, more rapid delivery, etc.) and other actions likely to benefit shippers on those competitive routes.

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<sup>9</sup> See, e.g., Adam Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations* (1776): "Every individual necessarily labors to render the annual revenue of the society as great as he can ... He intends only his own gain, and he is in this, as in many other cases, led by an invisible hand to promote an end which was no part of his intention ... By pursuing his own interests, he frequently promotes that of the society more effectually than when he really intends to promote it. I have never known much good done by those who affected to trade for the public good."; see also Paul I Joskow and Nancy L. Rose, "The Effects of Economic Regulation," *Handbook of Industrial Organization*, Vol. II (R. Schmalensee and R.D. Willig eds.) 1989 at 1449, 1497: "Economic regulation has important direct and indirect effects on the costs of production and the quality of service. Regulatory influences on input choices, X-inefficiency, and technological change tend to increase costs. Regulation also alters the quality and variety of services, although these effects often are difficult to quantify. It tends to increase service quality through non-price competition when regulated prices in structurally competitive industries are above competitive levels. Regulation may lower service quality when its intention is to keep prices below their market-clearing levels."

Because of the network nature of the rail industry, when a railroad improves service for one group of shippers, other customers often benefit as well, even if competition for those other customers did not increase.

17. Competition motivates firms to become more efficient and thus reduces deadweight loss. Deadweight loss occurs when firms allocate resources inefficiently in response to artificial price constraints, such as those imposed through regulation, that do not reflect demand and supply. It represents a loss to society because it reflects wasted resources and is an unnecessary cost to society when competition is sufficient to discipline firms' conduct.

18. Cost-based regulation that forces rail rates toward marginal costs in an attempt to limit railroads' profitability does not produce the same economic welfare benefits as market competition. The reason is simple—with regulated rates and profits, railroads and their investors do not benefit, or benefit fully, from becoming more efficient and innovative, and thus do not have the same incentives to improve their performance. Many products in the broad economy are sold at prices that exceed marginal cost, yet the short-run gain in reduced deadweight loss from forcing down prices would not improve consumer welfare, but instead would cause substantial (and long-lasting) harm to consumers through distorted producer incentives.

19. For example, the price of an iPhone is substantially higher than its marginal cost (and Apple earns large profits from iPhone sales). Yet, few would argue for regulation to force the price of an iPhone down to marginal cost, and wisely so. While sales of iPhones might increase in the short run as more consumers purchase iPhones at the lower, regulated price, in the longer run consumer welfare and output are likely to fall because the price controls would immediately reduce Apple's incentives to innovate and introduce new products with improved features and

quality. Over the longer run, the harm to consumers from forgoing new improved iPhones is likely to far outweigh any short-run benefits consumers receive from lower prices.

20. The danger of price controls is well-established as a matter of both economic theory and empirical fact.<sup>10</sup> For example, the use of rent controls to reduce property rental rates has been studied extensively to understand whether rent controls are an efficient way to increase consumer welfare. Economists find that they are not—instead, they lead to housing shortages and quality declines. Lower rents might benefit those lucky enough to obtain an apartment at a controlled rate, but harm the many who find such apartments unavailable and that those available are not well maintained or modernized because capital does not flow into rental housing but instead into other investments such as commercial real estate where rates of return are not capped.

21. Thus, the well-established economic principles that motivated the Staggers Act and deregulation of railroads teach that, absent strong evidence of market failure, consumers benefit from allowing competition, not regulation, to determine firms' pricing and operational decisions,

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<sup>10</sup> See, e.g., Averch, Harvey, and Leland L. Johnson. "Behavior of the Firm Under Regulatory Constraint," *The American Economic Review* (1962), pp. 1052-69; Baumol, William J., and Alvin K. Klevorick. "Input Choices and Rate-of-Return Regulation: An Overview of the Discussion," *The Bell Journal of Economics and Management Science* (1970), pp. 162-90. There is broad consensus among economists documented in surveys of the literature and of economists' opinions about the inefficiencies created by price controls. For example, a 1992 article reported results of a survey of 1,350 economists (of which 34.4 percent responded) on the question whether "A ceiling on rents reduces the quantity and quality of housing available." About 93.5 percent of respondents agreed – the highest consensus obtained for any of the 40 policy questions asked. See R. M. Alston, J.R. Kearl and M. B. Vaughan, "Is There a Consensus Among Economists in the 1990's?" 82(2) *AEA Papers and Proceedings* 203 (1992), p. 204. A 2012 poll of economists at major U.S. universities (the IGM Economic Experts Panel) found that 95 percent of responses (weighted by each expert's confidence) disagreed with the proposition that "Local ordinances that limit rent increases for some rental housing units... have had a positive impact over the past three decades on the amount and quality of broadly affordable rental housing in cities that have used them." See [http://www.igmchicago.org/igmeconomicexpertspanel/pollresults?SurveyID=SV\\_6upyzeUpI73V5k0](http://www.igmchicago.org/igmeconomicexpertspanel/pollresults?SurveyID=SV_6upyzeUpI73V5k0). As summarized in a survey article reporting on the near unanimity of opinion on the harmful impact of rent controls, "Economists have shown that rent control diverts new investment, which would otherwise have gone to rental housing, toward greener pastures – greener in terms of consumer need. They have demonstrated that it leads to housing deterioration, fewer repairs, and less maintenance." See Walter Block, "Rent Control," *Concise Encyclopedia of Economics* (<http://www.econlib.org/library/Enc/RentControl.html>). According to a well-regarded textbook, rent control "reduces the incentive to build new rental housing, exacerbating the shortage in the long run. Similarly, owners have less of an incentive to maintain rental housing, so it deteriorates faster than otherwise." See D. W. Carlton and J. M. Perloff, *Modern Industrial Organization* 3rd ed. (1999), p. 769.

subject to the discipline of product and capital markets. The original rationale for deregulation was recognition that, overall, the railroads were not potential beneficiaries of market failures that would allow them to earn excessive profits if not constrained, but instead were the victim of regulation that forced them to abandon competitive market principles and deprived them of capital needed to operate efficiently.

**B. Forward-Looking Economic Return on Investment is the Relevant Measure of Railroad Revenue Adequacy**

22. As a matter of economics, the proper way to measure whether a railroad is earning a return on investment sufficient to allow it to meet demands for service in the long run is a return on forward-looking investment costs. The same is true for operating costs—one would not conclude based on wage rates set five years ago in a labor union contract expiring today that the firm could operate profitably in the future if the firm would have to pay much higher wages going forward given changes over the five years in market conditions. Expected future returns determine investors' decisions about where to invest their capital and business executives' decisions how to allocate their scarce resources—they look for opportunities that generate the greatest return on incremental investment, and not to average rate of return on all invested capital.

23. For this reason, the return on the historical net investment base that the Board uses to calculate revenue adequacy can be a misleading indicator of whether railroads can attract the needed capital necessary replace their assets as they depreciate or become economically obsolete, or to invest in order to serve new demands for their services. Accounting measures based on backward looking historical purchase prices and depreciation of the railroad's assets often are uninformative about a firm's ability to attract capital in the future.

24. The relevant economic rate of return for purposes of understanding whether railroads are sufficiently revenue adequate to provide efficient and competitive service to shippers is a forward-looking measure of a company's ability to cover future operating expenses, assure repayment of its debt, and attract and retain the necessary capital to maintain, upgrade and replace its assets. Economic profitability is calculated as the rate at which expected *future* cash flows from making an investment today must be discounted to equal the initial investment.<sup>11</sup> Investors will be willing to lend to a company if the expected future returns on investment will be as high as the investor can expect (after accounting for risk) from alternative investment opportunities. As explained in a popular corporate finance textbook,

The company's book rate of return may not be a good measure of profitability. It is also an *average* across all of the firm's activities. The average profitability of past investments is not usually the right hurdle for new investments.<sup>12</sup>

25. The proper economic rationale for evaluating whether a railroad is revenue adequate is to determine whether it can raise the funds necessary for financial health and growth in the long term. In order for a railroad to be financially healthy in the long term, it must be able to raise capital in markets where investors have numerous potential investment opportunities, whether such investments would be financed out of retained earnings or financed by attracting new capital. For both sources of capital, the return on reinvesting in the railroad's assets must be compared with the return on alternative investments. Investors are not concerned primarily with how successful firms have been with past investments, but how firms will use capital in the future and thus the investor's expected return if it invests in one firm rather than another.

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<sup>11</sup> See J. Berk and P. De Marzo, *Corporate Finance*, 2007 ("Berk and DeMarzo"), pp. 156-158.

<sup>12</sup> R. A. Brealey, S. C. Myers, F. Allen, *Principles of Corporate Finance* 8<sup>th</sup> ed. (2006), p. 89.

26. The methodology used by the Board which relies on book value of assets cannot reveal whether railroads will be able to attract investors in the future. In deciding whether to replace or upgrade track, for example, a railroad does not ask whether the return on book value of existing track exceeds the cost of capital, but whether it can earn an adequate rate of return (above its cost of capital) on the replacement cost of that track. Accounting rates-of-return cannot inform such decision making.

27. Congress and the Board have an interest in monitoring the health of the railroad industry, given the vital importance of the railroad industry in the United States and even world economies for transporting goods to domestic and international markets and avoiding taxpayer subsidization of unprofitable railroads. And because of the importance of having a healthy railroad industry in the United States, it is critical that metrics used and the context in which those metrics are evaluated provide an accurate assessment of the railroads' financial health. If the Board adopts and relies on a metric that systematically under- or overestimates the economic rate of return earned by railroads, then it cannot provide the oversight and monitoring guidance that Congress requires.

28. Congress deregulated the railroads after concluding that the railroad industry could not continue to serve the public well in the long run if the carriers were denied a sufficient economic return on future investments to cover their future cost of capital. But the ICC was unwilling to adopt for its revenue adequacy analysis a measure of a railroad's rate of return based on forward-looking data and evaluations because doing so would be both too costly and too time consuming for such evaluation to be informative and relevant.<sup>13</sup> Historical costs are easier to measure. And

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<sup>13</sup> See *Standards for Railroad Revenue Adequacy* ("Standards II"), 3 I.C.C.2d 261, 277 (1986) (acknowledging that "current cost accounting is theoretically preferable to original cost valuation"); *Standards for Railroad Revenue Adequacy* ("Standards I"), 364 I.C.C. 803, 818 (1981) (explaining that "the replacement cost method is preferable because it comes closer to the competitive result").

at the time of passage of the Staggers Act, the railroads' poor financial health was evident even using returns on book value. Moreover, a fulsome investigation of a railroad's future investment incentives would require investigation of expected supply and demand conditions facing the railroad industry and an understanding of how best to invest to meet demand. For example, it would require understanding whether a railroad would be willing to incur risks associated with building substantial infrastructure to serve demand arising in new geographic areas and for shipment of new commodities when both demand and the return on investment are uncertain.

29. The advantage of using historical costs is that it permits as easy and mechanical calculation of a rate of return using only publicly available data available either from a railroad's financial submissions to the Board or collected from public third-party sources. We discuss the limitation of this approach further below.

### **C. It is Consistent with Competitive Markets for Firms to Earn an Economic Rate of Return Above Their Cost of Capital**

30. Once the Board settles on a methodology for measuring the two necessary components of a revenue adequacy quantification—the rate of return on invested capital (“ROIC”) and the cost of capital—it faces two further determinations: (1) is a railroad or the railroad industry as a whole excessively revenue adequate in a way that indicates that additional regulation would improve competition and (2) if so, what form should such regulation take? Our analysis in this Statement focuses on the first question—how to evaluate whether railroads' rate of return exceeds their cost of capital by an amount that suggests a failure of competition rather than the normal variation of rates of return expected in a competitive marketplace.

31. The goal of the Staggers Act—to rely on competition to the maximum extent possible to discipline rates and services provided by the railroad industry<sup>14</sup>—provides guidance in interpreting a measure of revenue adequacy. The relevant question is what rate of return is consistent with a competitive market and how does the profitability of the railroads compare with competitive market outcomes? Only if that comparison shows that the railroad industry has been unusually profitable *measured against typical, unregulated non-railroad firms* for a sufficiently long period of time is there a reason to investigate whether there might be a market failure that has permitted railroads to charge noncompetitive rates to at least some shippers, and to consider whether the Board’s existing tools to evaluate and constrain unreasonable exercise of a railroad’s market power in the places where it possesses and has exercised such power are not sufficient.

32. In order to understand whether railroads are earning a return on invested capital that is indicative of at least the potential for rates to be unconstrained by competition, it is necessary to benchmark any revenue adequacy measure adopted by the Board against corresponding measures we observe for firms operating under competitive conditions. We propose below in Part IV that the firms included in the S&P 500 stock market index, which are the 500 large companies listed on U.S. stock exchanges designed to represent the U.S. stock market, exclusive of any railroad companies, provide a benchmark for evaluating whether revenue adequacy measures using accounting data indicate that railroads are unusually profitable. The firms whose stock is included in the index are large firms that compete with railroads for capital, including many customers of the railroads. If the railroads earn a rate of return net of cost of capital no higher than the average or median S&P firm, then there would be no presumption that railroads

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<sup>14</sup> See 49 U.S.C. §§ 10101(1), 10701(d)(1).

are earning abnormal returns and can set rates without constraint from competition, or that shippers' current protections under the Board's SAC and related proceedings are not sufficient.

33. In a competitive environment, like that in which railroads operate, CN, NS and UP can obtain a competitive rate of return *on average* only if they have the opportunity to earn above its cost of capital for periods of time. It cannot earn the competitive rate of return necessary to compete for capital if it must endure periods where its rate of return falls below the competitive level, yet it would be denied the prospect of earning a return above its cost of capital at other times. Using regulation to reduce rates that are not above the competitive level creates immediate inefficiencies in investment choices and operational decisions that, over the longer run, would reduce the quantity and quality of railroad service, both for shippers whose rates are adjusted downward and for other shippers using the rail network.

34. There are many reasons why a firm can earn an above average rate of return that do not signal market failure but instead more likely reflect the opposite—increased productivity or the firm benefiting from successful, risky investments in new competitive businesses. A railroad that is especially innovative, risk-taking, efficient in making use of its resources, provides high-level service, or otherwise succeeds relative to its peers in returning profits to its stakeholders should not be penalized for its success, because doing so through regulation unrelated to any anticompetitive pricing will deter the type of procompetitive conduct that should be encouraged. Moreover, measuring the industry's return on investment based on accounting data may give a misleading picture of economic rates of return on current and future investments.

**D. Even if, Contrary to the Evidence, Railroads' ROIC Exceeded Their COC by an Atypically Large Amount, Rate of Return Regulation is Likely to Worsen Competition and Distort Investment and Operational Decisions**

35. A properly calculated measure of economic rate of return could provide information about whether the railroads are earning profits sufficient to achieve and maintain long-run financial solvency. However, there is no economic reason why a finding that a railroad is earning a rate of return at or above its cost of capital or even above that of the average firm in a benchmarking group warrants regulation to force lower rates or cap rate increases across-the-board. Finding that a railroad has achieved or exceeded the profitability of other competitive firms does not tell us that particular rail transportation rates are above or below a competitive level. That determination only can be made after evaluating supply and demand conditions for a particular shipper and shipments (taking into account that a railroad must charge rates above variable cost to some shippers in order to be healthy in the long run). Imposing broad-scale rate regulation when only a fraction of a railroad's services is priced at a level unconstrained by sufficient competition would induce inefficient investment decisions and harm railroads and shippers.

36. A railroad's overall financial condition, even if measured by return on current asset costs, provides no information about whether rates on particular shipments are noncompetitive.

Congress directed that, to the maximum extent possible, railroads should be free to set rates based on competition and the demand for their services, with rates subject to potential regulatory review only if the railroad is "market dominant"—that is, if it faces no effective competition.<sup>15</sup>

The Board implemented this directive by regulating rates for traffic over which railroads are

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<sup>15</sup> See 49 U.S.C. §§ 10101(1), 10701(d)(1).

found to have market dominance only if it determines that those rates exceed a simulated competitive level.<sup>16</sup> Constraints that would restrict railroad pricing or reduce rates below competitive levels irrespective of whether the rates at issue exceed the competitive level would endanger the ability of the railroads to replace and grow their network over the long term.

37. The railroads' improved financial condition since 1980 is evidence of the benefits created when they have flexibility to set rates to shippers freely except when an individualized investigation indicates that a rate exceeds the competitive level. A finding that the railroad as a whole is revenue adequate provides no information about whether an individual rate for a particular shipment is unreasonable—whether the railroad is market dominant for that shipment and whether the challenged rate is noncompetitive.

38. Allocative efficiency requires that individual prices are set competitively, not that prices generate some overall level of return in total. It is efficient to allocate scarce capacity based on willingness to pay, because this allocates capacity to those shippers that value it most. Rate freezes or caps prevent market signals from allocating scarce capacity to where it is most valuable (e.g., to shippers with time critical needs or with more limited competitive options). When rates cannot respond freely to demand, then the critical signal that there is unmet demand for additional capacity is absent.

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<sup>16</sup> Any price that passes the stand-alone cost ('SAC') test is at or below a hypothetical long-run competitive market price in a contestable market where a competing railroad is free to enter (i.e., faces neither entry nor exit costs) by building a railroad network to serve the challenged traffic as well as other traffic that it would be efficient to serve (assuming the other traffic is served at current rates). Rates at or below the SAC level would not induce entry by a competing railroad since such a railroad could not cover its costs even if prices did not fall post entry. Thus, any price consistent with the SAC constraint together with the constraints imposed by alternative modes of shipping (such as truck) is a competitive price.

**E. Revenue Adequacy Determination Will be More Distortionary if Based on Railroad-Specific Evaluation**

39. Regulation will typically disadvantage a regulated firm relative to its unregulated competitors if it is regulated but its competitors are not. The reason is simple: an unregulated profit-maximizing firm will make optimal choices across all the dimensions on which it can compete—price, quality, product features, product selection etc.—but a regulated company is constrained on one or more of these competitive dimensions. These additional constraints will force the firm to make “conditional” profit-maximizing decisions that are less profitable overall.

40. For example, a firm that is compelled to charge prices lower than it would find optimal if it were unregulated will select the optimal combination of quality, features and supply conditional on that price, but its resulting offering will be less attractive than if it could charge a market-determined price. This is what happens with rent control—“price” is below market levels and quality and availability are reduced as a consequence. While regulation may be intended only to prevent the regulated firm from earning “excessive” profits, the result is to induce sub-optimal decisions regarding all the ways in which the firm can compete. Regulations that govern behavior other than price (such as conditions under which a railroad must interchange with its competitors) similarly will distort a wide range of choices made by the regulated firm.

41. Regulating one firm in an industry because it has been relatively profitable while other firms have been less successful would be especially likely to harm competition. It is likely to hobble a firm that has been especially successful because of its efficiency and success with customers. Regulation that restricts a profitable firm’s flexibility to price and to adapt its services to satisfy changing demands of the marketplace will erode its efficiency, which in turn eventually will deprive its customers of high-quality service. This could induce customers to

switch to the regulated firm's competitors, even though the regulated firm could offer a superior option absent regulation.

42. The harmful impact of regulation of some but not all market participants has been illustrated in a different context. In an article that Professor Murphy co-authored, he explained why partial economic reform in some countries, such as occurred in Russia, can create worse outcomes than if all market participants are subject to the same reform or the same regulations. The reason is that resources (inputs) flow into the unregulated sector even if those inputs would create more value if they were available to the regulated firms. The end result can be lower output than with complete regulation, rather than the increased output and efficiency that was the intended result of the partial deregulation.

43. Regulation of some, but not all, competitors also harms the marketplace because it reduces the competitive constraint on unregulated competitors. An unregulated competitor that knows that regulation limits its rival's ability to respond to changes in consumers' demands will feel less competitive pressure to innovate and price competitively. Because of the additional inefficiency that could result if one or some railroads are found to be sufficiently revenue adequate to warrant additional regulation while other railroads are not constrained by those regulations, economics shows that both evaluation of revenue adequacy and imposition of any regulations as a consequence of such a finding should be made on an industry-wide basis, and not as currently performed for each railroad individually.

### **III. IT IS WELL ESTABLISHED THAT ACCOUNTING RATES OF RETURN ARE POOR MEASURES OF ECONOMIC RATES OF RETURN**

44. The measure of financial performance used in the Board's Annual Revenue Adequacy Determinations<sup>17</sup> compares a railroad's accounting-based (or financial statement-based) rate of return on invested capital ("ROIC") to the railroad industry's cost of capital ("COC"), specifically, ROIC minus COC ("ROIC minus COC").<sup>18</sup> However, as we explain in this section, it is well known that accounting-based rates of return do not accurately measure economic rates of return.<sup>19</sup> The magnitude and direction of the inaccuracy when accounting-based rates of return are used as estimates of economic rates of return can be substantial and depend on the specific characteristics of the companies being analyzed. Below, we summarize the peer-reviewed economic literature from the last 50 years that has identified the well-known limitations and inaccuracies of accounting rates of return as measures of financial performance.

45. Early research showed that accounting-based rates of return are poor measures of economic rates of return. These studies, which include Solomon (1961),<sup>20</sup> Harcourt (1965),<sup>21</sup>

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<sup>17</sup> See, for example, Surface Transportation Board, Railroad Adequacy – 2018 Determination, Docket No. EP 552 (Sub-No. 23), September 5, 2019 ("STB 2018 Revenue Adequacy Determination").

<sup>18</sup> STB 2018 Revenue Adequacy Determination, Appendices A and B.

<sup>19</sup> The economic cost of capital (or economic rate of return) is equal to the discount rate that equates the sum of the discounted value of the cash flows generated by an investment to the value of the investment. This economic rate of return concept is often called an internal rate of return ("IRR"), which is discussed in corporate finance textbooks; for example, see BREALEY, R. A., MYERS, S. C., & ALLEN, F. (2006). *Principles of corporate finance*. New York, NY, McGraw-Hill/Irwin, pp.111-118; BERK, J. B., & DEMARZO, P. M. (2011). *Corporate finance*. Boston, MA, Prentice Hall, pp.128-131 and 222-227.

<sup>20</sup> Solomons, D., "Economic and Accounting Concepts of Income," *The Accounting Review*, 1961 36, pp. 374 – 383.

<sup>21</sup> Harcourt, G. C., "The Accountant in a Golden Age," *Oxford Economic Papers*, March 1965, pp. 66-80.

Solomon (1966),<sup>22</sup> Sarnat and Levy (1969),<sup>23</sup> Livingstone and Solomon (1970),<sup>24</sup> Solomon (1970),<sup>25</sup> Stauffer (1971),<sup>26</sup> Weiss (1974),<sup>27</sup> Kay (1976),<sup>28</sup> and Wright (1978),<sup>29</sup> identified numerous factors that affect the relationship between accounting rates of return and economic rates of return. These include accounting capitalization rules; cash flow patterns; accounting depreciation and amortization rules; economic rate of return of the investment; growth rates (current and past); income tax regulations; market value of the investment relative to the book value of the investment (which implicitly includes the degree of conservativeness of accounting rules); price level changes; and project (investment) length. These studies conclude that any specification that includes all of the factors that affect the ability of ROIC to measure a company's economic rate of return is too complex to model; and that the impacts of various factors that determine the magnitude and direction of the difference between measured accounting rates of return and economic rates of return are interrelated. Depending on the

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<sup>22</sup> Solomon, E., "Return on Investment: The Relation of Book Yield to True Yield," in *Research in Accounting Measurement*, ed. R. K. Jaedicke, Y. Ijiri, and O. W. Nielsen, American Accounting Association, 1966; later published in J. Leslie Livingstone and Thomas J. Burns, eds., *Income Theory and Rate of Return*, Columbus: Ohio State University Press, 1971, 105-17.

<sup>23</sup> Sarnat, M. and H. Levy, "The Relationship of Rules of Thumb to the Internal Rate of Return: A Restatement and Generalization," *Journal of finance* June 1969, pp. 470 – 490.

<sup>24</sup> Livingstone, John, and Gerald Solomon, "Relationship Between the Accounting and the Internal Rate of Return Measures: A Synthesis and an Analysis," *Journal of Accounting Research*, Autumn 1970, pp. 199 – 216.

<sup>25</sup> Solomon, Ezra, "Alternative Rate of Return Concepts and Their Implications for Utility Regulation," *Bell Journal of Economics*, Spring 1970, 1, pp. 65 – 81.

<sup>26</sup> Stauffer, Thomas R., "The Measurement of Corporate Rates of Return: A Generalized Formulation," *Bell Journal of Economics* Autumn 1971, 2, pp. 434 – 469.

<sup>27</sup> Weiss (1974) provides a detailed review of this literature; Weiss, Leonard W., "The Concentration-Profits Relationship and Antitrust," in Harvey J. Goldschmid et al., *Industrial Concentration: The New Learning*, Boston, Little, Brown and Co., 1974.

<sup>28</sup> Kay, J. A., "Accountants, Too, Could Be Happy in the Golden Age: The Accountants Rate of Profit and the Internal Rate of Return," 1976, *Oxford Economic Papers* 17 November, pp. 66 – 80.

<sup>29</sup> Wright, F. K., "Accounting Rate of Profit and Internal Rate of Return," *Oxford Economic Papers*, November 1978, pp. 464 – 468.

characteristics of a particular firm, the difference between accounting rates of return and its economic rate of return can be very large and can be either positive or negative.

46. A series of subsequent studies focused on the regulatory implications of the limitations and inaccuracies of using accounting-based rates of return as estimates of economic rates of return. These studies include: Benston (1979),<sup>30</sup> Fisher and McGowan (1983),<sup>31</sup> Fisher (1984),<sup>32</sup> Benston (1985),<sup>33</sup> Salamon (1985),<sup>34</sup> and Salamon (1988).<sup>35</sup> These studies, which expanded on earlier research, analyzed how these factors affect the extent to which accounting-based rates of return reasonably approximate economic rates of return. A common finding, as expressed by Fisher and McGowan (1983), is that the difference between accounting rates of return and economic rates of return can be very large: “the theoretical effects are not so small that they can be neglected in practice. Indeed, they are very large ....”<sup>36</sup> They also concluded that the sign of the difference (error) depends on the characteristics of the company: “the accounting rate of return depends *crucially* on the time shape of benefits [cash flows], and the effect of growth on the accounting rate of return also depends on that time shape. In particular, it is not true that

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<sup>30</sup> Benston, George J., “The FTC’s Line of Business Program: A Benefit-Cost Analysis,” in Harvey Goldschmid, ed., *Business Disclosure. Government’s Need to Know*, New York: McGraw-Hill, 1979, pp. 58 – 118.

Cooper, Joseph D., Proceedings of the Second

<sup>31</sup> Fisher, Franklin M., and McGowan, John J., “On the Misuse of Accounting Rates of Return to Infer Monopoly Profits,” *American Economic Review*, March 1983, 73, pp. 82 – 97.

<sup>32</sup> Fisher, Franklin M., “The Misuse of Accounting Rates of Return: Reply,” *American Economic Review*, June 1984, 74, pp. 509-17.

<sup>33</sup> Benston, George J., “The Validity of Profits- Structure Studies with Particular Reference to the FTC’s Line of Business Data,” *American Economic Review*, March 1985, 75, pp. 37 – 67.

<sup>34</sup> Salamon, Gerald L., “Accounting Rates of Return,” *American Economic Review*, June 1985, 75, pp. 495 – 504.

<sup>35</sup> Salamon, G. (1988), “On the Validity of Accounting Rate of Return in Cross-sectional Analysis: Theory, Evidence and Implications,” *Journal of Accounting and Public Policy*, 7, 1988, pp. 267 – 292.

<sup>36</sup> Fisher and McGowan (1983), p. 83. Fisher (1984) responded to comments on the Fisher and McGowan (1983) paper regarding the magnitude of the difference (error) and did not change their conclusion in Fisher and McGowan (1983) that the difference (error) can be “very large.” See Fisher, Franklin M., “The Misuse of Accounting Rates of Return: Reply,” *American Economic Review*, June 1984, 74, p. 512.

rapidly growing firms tend to understate their profits and slowly growing firms tend to overstate them. The effect can go the other way.”<sup>37, 38</sup>

47. Recent research has developed more generalized models of accounting rates of return. For example, Rajan, Reichelstein, and Soliman (2007) model the complexity of the interrelation among accounting conservatism, growth in new investments, the useful life of assets, and the internal rate of return of projects available to the firm. The authors illustrate the complexity of using accounting rates of return to measure economic rates of return and show that, for example, accounting conservatism and past growth in investments are interrelated and jointly determine how accounting rates of return compare to economic rates of return: “Given conservative accounting, faster growth tends to depress ROI and this decline will be more pronounced for more conservative accounting rules. Conversely, the impact of higher degree of conservatism on ROI will depend on whether past growth rates are above or below a critical level, given by the internal rate of return of the firm’s projects.”<sup>39</sup>

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<sup>37</sup> Fisher and McGowan (1983), p. 84.

<sup>38</sup> Some of these studies, for example, McFarland (1990), analyze how accounting rules for depreciation affect the accuracy of accounting rates of return as estimates of economic rates of return. As noted by Fisher and McGowan (1983) and Fisher (1984), the only way to accurately measure depreciation is to use the depreciation method developed by Hotelling (1925), which measures economic depreciation, and which is similar to using replacement cost to value depreciable assets each year. Fisher (1979), however, shows that accounting rates of return are still inaccurate measures of economic rates of return even when a machine has an infinite life. Regardless, accounting rules for depreciation (and amortization) are only one of the factors that drive the inaccuracy of accounting rates of return as estimates of economic rates of return.

Hotelling, Harold, “A General Mathematical Theory of Depreciation,” *Journal of the American Statistical Association*, September 1925, 20, pp. 340 – 353.

Fisher, Franklin M., “Diagnosing Monopoly,” *Quarterly Review of Economics and Business*, Summer 1979, 19, pp. 7-33.

McFarland, Henry, “Alternative Methods of Depreciation and the Reliability of Accounting Measures of Economic Profits,” *The Review of Economics and Statistics*, Vol. 72, No. 3, August 1990, pp. 521-524.

<sup>39</sup> Rajan, Reichelstein, and Soliman, “Conservatism, Growth, and Return on Investment,” *Review of Accounting Studies*, Vol 12, No. 2-3, 2007, pp. 325-370 at 355-356.

48. In sum, economic research has identified several factors that determine the accuracy and direction of the error of accounting rates of return as estimates of economic rates of return, but no study has derived a closed-form specification for an accounting rate of return based on all of these factors.<sup>40</sup> Economic research shows that the complex relationship among these factors makes it difficult, and some say impossible, to draw any conclusions about economic rates of return based on accounting rates of return. Fisher and McGowan (1983) expressed one of the strongest conclusions against using accounting rates of return as estimates of economic rates of return: "... there is no way in which one can look at accounting rates of return and infer anything about relative economic profitability ... Economists (and others) who believe that analysis of accounting rates of return will tell them much (if they can only overcome the various definitional problems which separate economists and accountants) are deluding themselves."<sup>41</sup>

49. The Fisher and McGowan (1983) results and conclusions do not imply that accounting rates of return are not informative for other purposes, such as by investors to set security prices. Accounting rates of return are widely used in financial analysis,<sup>42</sup> and empirical research shows a statistically significant (although weakening) relation (correlation) between accounting rates of

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<sup>40</sup> Rajan, Reichelstein, and Soliman (2007) have the most comprehensive closed-form specification for a steady-state ROIC based on a subset of these factors.

<sup>41</sup> Fisher and McGowan (1983), pp. 90 – 91.

<sup>42</sup> See Chapters 2 and 4 in Robert W. Holthausen and Mark E. Zmijewski. *Corporate Valuation: Theory, Evidence and Practice*. 2<sup>nd</sup> edition, Cambridge Business Publishers, 2020 ("Holthausen and Zmijewski").

return and stock price movements (for example, Jacobson (1987)).<sup>43</sup> However, that relationship is weak (Lev (1989)<sup>44</sup>) and has weakened over time (Lev and Feng (2016)).<sup>45</sup>

#### **IV. MEASURING FINANCIAL PERFORMANCE OF THE RAILROAD INDUSTRY BASED ON THE BENCHMARKING METHODOLOGY PRODUCES MORE INFORMATIVE RESULTS**

50. In this section, we propose and implement an alternative to the current methodology used by the Board in its Annual Revenue Adequacy Determinations. The methodology we propose is more informative than comparing the railroads' accounting-based rates of return to the industry cost of capital in isolation because it mitigates some of the limitations and inaccuracies identified in the previous section of using accounting-based rates as approximation for economic rates of return as implemented by the STB. More specifically, in this section we analyze two measures of the railroads' financial performance (ROIC minus COC and Adjusted ROIC minus COC) and compared them to the financial performance of three benchmarking groups: (a) S&P 500

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<sup>43</sup> Jacobson, Robert, "The Validity of ROI as a Measure of Business Performance," *American Economic Review*, Vol. 77, No. 3 June 1987, pp. 470-478. Lev, B., "On the Usefulness of Earnings and Earnings Research: Lessons and Directions from Two Decades of Empirical Research," *Journal of Accounting Research* Vol. 27, *Current Studies on The Information Content of Accounting Earnings*, 1989, pp. 153 – 192 and Lev, Baruch and Gu, Feng, *The End of Accounting and the Path Forward for Investors and Managers*, Hoboken, New Jersey: John Wiley & Sons, Inc., 2016. | Series: Wiley finance series; p. xiii ("Based on a comprehensive, large-sample empirical analysis, spanning the past half century, we document a fast and continuous deterioration in the usefulness and relevance of financial information to investors' decisions. Moreover, the pace of this usefulness deterioration has accelerated in the past two decades").

<sup>44</sup> Lev, B., "On the Usefulness of Earnings and Earnings Research: Lessons and Directions from Two Decades of Empirical Research," *Journal of Accounting Research* Vol. 27, *Current Studies on The Information Content of Accounting Earnings*, 1989, pp. 153 – 192.

<sup>45</sup> Lev, Baruch and Gu, Feng, *The End of Accounting and the Path Forward for Investors and Managers*, Hoboken, New Jersey: John Wiley & Sons, Inc., 2016. | Series: Wiley finance series; p. xiii, the authors state: ... "we examine in the first part of this book the usefulness of financial (accounting) information to investors and, regrettably, provide an unsatisfactory report, to put it mildly. Based on a comprehensive, large-sample empirical analysis, spanning the past half century, we document a fast and continuous deterioration in the usefulness and relevance of financial information to investors' decisions. Moreover, the pace of this usefulness deterioration has accelerated in the past two decades."

(excluding railroads, financial institutions, and real estate companies); (b) S&P 500 Industrials Sector; and (c) S&P 500 Railroad Customers.

51. All of the analyses show that the relative financial performance of the railroad industry falls within the bottom quartile of the three benchmarking groups. Furthermore, with a single exception (one railroad for one benchmarking group), all of the analyses show that the relative financial performance of all seven railroads also falls within the bottom quartile of the three benchmarking groups.<sup>46</sup> Thus, the benchmarking analyses we conducted show that financial performance of the railroad industry and the seven railroads was well below the financial performance of companies operating in competitive (unregulated) markets.

#### **A. Benchmarking Methodology**

52. Simply stated, we propose a benchmarking methodology that compares the railroads' financial performance (ROIC minus COC) to the financial performance of companies operating in competitive (unregulated) markets over a sufficiently long period of time to reasonably estimate relative financial performance. Benchmarking methodologies are widely used in many fields and for many purposes. The types of benchmarking that are most useful for evaluating revenue adequacy are benchmarking used to evaluate investment portfolio performance, conduct a financial analysis of a company and its competitive position, and value companies.

53. A financial benchmark is a standard (or reference point) by which to evaluate financial performance. For example, when evaluating an investment portfolio's performance, the process involves comparing "the return of a managed portfolio over some evaluation period to the return

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<sup>46</sup> The one exception is UP for the S&P 500 Railroad Customers sample, which has a median across years equal to the 35<sup>th</sup> percentile for ROIC minus COC and 26<sup>th</sup> percentile for Adjusted ROIC minus COC; however, UP's median percentile for the S&P 500 and S&P 500 Industrials benchmarking groups are all below the 25<sup>th</sup> percentile for both financial performance measures. See Table 7, Panel B.

of a benchmark portfolio. The benchmark portfolio should represent a feasible investment alternative to the managed portfolio being evaluated.”<sup>47</sup> Because accounting-based financial metrics, including accounting rates of return, are inaccurate estimates of the economic concepts of profits, we benchmark a company’s financial metrics against comparable financial metrics of a chosen benchmark group.<sup>48</sup> In forecasting a company’s future financial performance, benchmarking is used both to determine the drivers (financial metrics) generating the output of the forecasting model and to evaluate the reasonableness of the model’s forecasts.<sup>49</sup> Benchmarking also is used in several ways when valuing a company, for example, to measure the company’s cost of capital<sup>50</sup> or to measure the company’s price to earnings, EBITDA to enterprise value, and other market multiples.<sup>51</sup> Establishing the long-run historical performance of a company requires that we analyze time-series of benchmarking results over a sufficiently long period of time to reasonably estimate relative financial performance.

54. Our proposed benchmarking methodology is not innovative or new. It is a standard and well-accepted methodology for analyzing a company’s financial performance. The benchmarking methodology mitigates the erroneous inferences that result from using accounting-based financial rates of return and other financial metrics to estimate the concept of economic profits.

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<sup>47</sup> Argon, G. O. and W. E. Ferson, “Portfolio Performance Evaluation,” *Foundations and Trends in Finance*, Vol. 2, No. 2, 2006, pp. 83–190; see p. 89.

<sup>48</sup> Holthausen and Zmijewski, Chapter 2.

<sup>49</sup> Holthausen and Zmijewski, Chapter 4.

<sup>50</sup> Holthausen and Zmijewski, Chapters 8 and 10.

<sup>51</sup> Holthausen and Zmijewski, Chapters 13 and 14.

## **B. Alternative Specifications of the Return on Invested Capital (ROIC)**

55. In addition to using the Board’s definition of ROIC in our benchmark analysis, we also use an alternative definition of ROIC, Adjusted STB ROIC, which we believe is a more informative measure of financial performance for assessing the financial performance of the railroads. The STB’s Annual Revenue Adequacy Determinations<sup>52</sup> defines ROIC as follows:<sup>53</sup>

$$\text{STB ROIC} = \frac{\text{Adjusted Net Railway Operating Income}}{\text{Tax Adjusted Net Investment Base}}$$

56. The Adjusted STB ROIC makes one adjustment to the Board’s definition of Adjusted Net Railway Operating Income (STB ROIC numerator) and two adjustments to the Board’s definition of Tax Adjusted Net Investment Base (STB ROIC denominator). The adjustment to the Board’s definition of Adjusted Net Railway Operating Income (STB ROIC numerator) eliminates the effect of deferred income taxes in the Provision of Income Taxes. The two adjustments to the Board’s definition of Tax Adjusted Net Investment Base (STB ROIC denominator) are: (a) eliminating the effect of Deferred Tax Liabilities in the calculation of the

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<sup>52</sup> See, for example, STB 2018 Revenue Adequacy Determination, Appendix B. For 2017, the STB adjusted this formula because the decrease in the federal income tax rate (2017 Tax Cut and Jobs Creation Act) resulted in a revaluation of deferred income taxes on the balance sheet (companies, like the railroads, with a net deferred tax liability position on their balance sheet recorded a reduction of that liability, which decreased the provision for income taxes and thus, increased income, in that year). The adjustment had the effect of essentially eliminating this reduction in income tax. “By decision served on July 27, 2018, the Board explained that its revenue adequacy determination, among other calculations for 2017, would be affected by the carriers’ revaluation of their deferred tax liabilities as a result of the Tax Cuts and Jobs Act. R.R. Revenue Adequacy—2017 Determination... The Board adopted this proposal in Railroad Revenue Adequacy—2017 Determination, EP 552 (Sub-No. 22) et al., slip op. at 6-9 (STB served Dec. 6, 2018), and, consistent with that decision, the revenue adequacy determination here reflects the adjustments made in the carriers’ Schedule 250 filings,” STB 2017 Revenue Adequacy Determination, December 21, 2018, footnote 2.

<sup>53</sup> In Appendix A, we provide a detailed description of this formula and the data sources for every input for the railroads and the S&P 500 companies.

Net Investment Base and (b) including the company's investments in non-goodwill intangible assets. The resulting formula for Adjusted STB ROIC is:<sup>54</sup>

$$\text{Adjusted STB ROIC} = \frac{\text{Adjusted Net Railway Operating Income} + \text{Deferred Tax Expense}}{\text{Tax Adjusted Net Investment Base} + \text{Deferred Tax Liabilities} + \text{Non-Goodwill Intangible Assets}}$$

57. The adjustment to the Board's definition of Adjusted Net Railway Operating Income (STB ROIC numerator) to eliminate the effect of deferred income taxes in the Provision of Income Taxes is consistent with basic valuation principles, which measures the value of a company as the discounted value of the cash flows the company is expected to generate for its investors.<sup>55</sup> Eliminating the effect of deferred income taxes in the Provision of Income Taxes is one of the required adjustments to measure a company's cash flows in order to align the company's operating income with the economic concept used in measuring a company's economic profit.

58. The first adjustment to the Board's definition of Tax Adjusted Net Investment Base (STB ROIC denominator) is eliminating the effect of Deferred Tax Liabilities in the calculation of the Net Investment Base. IRS rules for depreciation (and other items resulting in deferred tax liabilities) are not intended for, and do not purport to be, better estimates of economic depreciation and other types of expenses. The basic concept of economic depreciation (Hotelling (1925) or replacement cost as proxy) indicates that accelerated IRS depreciation is not a better estimate of economic depreciation. Thus, this adjustment mitigates—but does not eliminate—the effect of two of the factors that make accounting rates of return inaccurate estimates of the

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<sup>54</sup> Adding Deferred Tax Liabilities to the denominator of the Adjusted STB ROIC has the effect of eliminating the deduction of Deferred Tax Liabilities used in the STB definition of ROIC.

<sup>55</sup> Holthausen and Zmijewski, Chapters 13 and 14.

cost of capital: depreciation in excess of economic depreciation and the book value of the assets relative to the market value of the assets.

59. The second adjustment to the Board's definition of Tax Adjusted Net Investment Base (STB ROIC denominator) is including the company's investments in non-goodwill intangible assets. This adjustment has no meaningful effect on the railroads' ROICs, and thus, no meaningful effect on the ROIC minus COC measure of financial performance used by the Board. However, it can have a meaningful effect on the ROIC of other S&P 500 companies that have substantial investments in non-goodwill intangible assets.<sup>56</sup>

60. As an illustration, consider JM Smucker Company ("Smucker"). In 2016, Smucker's total assets included \$1.6 billion in net property and equipment and \$6.1 billion in non-goodwill intangible assets.<sup>57</sup> Using the STB definition, Smucker's 2016 Tax Adjusted Net Investment Base is \$171.3 million. The value of Smucker's 2016 Tax Adjusted Net Investment Base is substantially less than the book value of its net property and equipment because the STB calculation subtracts Accumulated Deferred Income Tax Credits, which were \$2.4 billion for Smucker in 2016. Using the STB definition, Smucker's Adjusted Operating Income is \$958.8 million and its 2016 ROIC is over 550% ( $5.597 = \$958.8 / \$171.3$ ). Including Smucker's non-goodwill intangible assets in the calculation of its 2016 Tax Adjusted Net Investment Base, increases Smucker's 2016 ROIC denominator to \$6,493.5 million, which reduces its 2016 ROIC to 14.8% ( $0.1477 = \$958.8 / \$6,493.5$ ).

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<sup>56</sup> Examples of non-goodwill intangible assets include assets such as patents, copyrights, trademarks, computer software, licenses, films, and import quotas. Accounting rules generally require companies to expense – as opposed to capitalize – expenditures that result in such assets but require companies to record the value of non-goodwill intangible assets when they acquire another company.

<sup>57</sup> The non-goodwill intangible assets consist of "Customer and contractual relationships, Patents and technology, and Trademarks". See 2016 JM Smucker Annual Report, p. 57.

61. The Smucker's example illustrates the bias of excluding non-goodwill intangible assets in the ROIC calculation, resulting in overstating a company's ROIC. Because none of the railroads have meaningful non-goodwill intangible assets, this adjustment has no effect for assessing their financial performance. However, it has a substantial effect for assessing the railroads' financial performance relative to other companies that may have substantial non-goodwill intangible assets. Generally, excluding non-goodwill intangible assets has the effect of increasing ROIC and thus ROIC minus COC for the benchmark groups.

62. We believe the ROIC measure based on these adjustments are a more useful, albeit still noisy and inaccurate, measure of financial performance to use to compare to a company's COC.

### **C. Data**

63. Our methodology compares the measure of railroads' financial performance used by the Board in its Annual Revenue Adequacy Determinations to the financial performance of three benchmarking groups over the 2006–2019 period:<sup>58</sup> (a) S&P 500 companies excluding railroads, financial institutions, and real estate companies ("S&P 500" benchmarking group);<sup>59</sup> (b) S&P 500 Industrials Sector excluding railroads, the industry sector to which railroads belong ("S&P 500 Industrials Sector" benchmarking group);<sup>60</sup> and (c) customers (shippers) of CN, NS, and/or

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<sup>58</sup> We use this time period as illustration to show the analysis over a sufficiently long period of time to reasonably estimate relative financial performance.

<sup>59</sup> The S&P 500 is "is widely regarded as the best single gauge of large-cap U.S. equities... The index includes 500 leading companies and covers approximately 80% of available market capitalization." See, <http://us.spindices.com/indices/equity/sp-500>. We exclude financial institutions and real estate companies because they have substantially different capital structures and business operations; however, none of the conclusions in our analyses change if we include financial institutions and real estate companies.

<sup>60</sup> Industry Sectors are based on the Global Industry Classification Standard ("GICS").

The GICS methodology aims to enhance the investment research and asset management process for financial professionals worldwide. It is the result of numerous discussions with asset owners, portfolio managers and investment analysts around the world. It was designed in response to the global financial community's need for accurate, complete and standard industry definitions.

UP in the S&P 500 that accounted for at least \$1.0 million of combined revenues to those railroads during 2018 (“S&P 500 Railroad Customers” benchmarking group). All three alternative benchmarking groups include a broad selection of companies that compete with railroads to raise capital. In our analyses, we evaluate each railroad’s relative financial performance by determining the percentile of the distribution of the financial performance of the members of a benchmarking group into which that railroad falls. In addition, we calculate the financial performance of the railroad industry (“Industry Weighted Average”) and benchmark the relative financial performance of the railroad industry as a whole in the same way.<sup>61</sup>

64. Naturally, a company’s ROIC minus COC requires the calculation of that company’s ROIC and industry cost of capital. ROIC does not have a single generally accepted or standard definition. The Board uses a specific definition for ROIC (“STB ROIC”), and we use that definition as one alternative for our analysis. We also use an alternative definition of ROIC (“Adjusted STB ROIC”), which we believe is a more informative measure of accounting-based financial performance for assessing the financial performance of the railroads based on ROIC minus COC. Although we do not agree with the Board’s definition and implementation of the cost of capital, we do not adjust it and instead use the Board’s definition and implementation to measure the cost of capital for the railroads and the companies within the S&P 500 benchmarking groups.

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The GICS structure consists of 11 Sectors, 24 Industry groups, 69 Industries and 158 sub-industries. The railroads are included in the Industrial Sector 20. GICS® Global Industry Classification Standard accessed on August 14, 2020 at [https://www.spglobal.com/marketintelligence/en/documents/112727-gics-mapbook\\_2018\\_v3\\_letter\\_digitalspreads.pdf](https://www.spglobal.com/marketintelligence/en/documents/112727-gics-mapbook_2018_v3_letter_digitalspreads.pdf)

<sup>61</sup> The Industry Weighted Average is equal to the weighted average of the ROICs of the seven railroads minus the industry cost of capital. See Appendix A for detailed description of the Industry Weighted Average calculation.

65. In Appendix A, we provide a detailed description of the formulas used and the data sources for all of the inputs in our analysis.<sup>62</sup> As explained in detail in Appendix A, we use the same data sources and measurement of inputs in calculating railroads' ROIC as those used in the Board's Revenue Adequacy Determinations.<sup>63</sup> Compustat, a publicly available database widely used in peer reviewed academic studies, is our source of data for measuring ROIC for the S&P 500 benchmarking groups. As also explained in detail in Appendix A, the data sources and measurement of the inputs for the railroads cost of capital are the same as those used in the STB's Annual Cost of Capital Decisions.<sup>64</sup> The data sources used to measure the industry cost of capital for the S&P 500 benchmarking groups are Ibbotson<sup>65</sup> and Duff & Phelps,<sup>66</sup> which are publicly available and widely used in peer reviewed academic studies. In Exhibit A1 of Appendix A, we present a list of the S&P 500 benchmarking group for each year in the analysis.<sup>67</sup>

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<sup>62</sup> As explained in detail in Appendix A, for ROIC and the cost of capital for the railroads, we use the same data sources and measurement of the inputs for the calculation of railroads' ROIC as those in the STB Revenue Adequacy Determinations; the data source used to measure ROIC for the S&P 500 companies is Compustat, which is publicly available and widely used in such analyses and in peer reviewed academic studies.

<sup>63</sup> For example, see STB 2018 Revenue Adequacy Determination. See Appendix A for citations to each of these data sources. Appendix B presents the ROIC minus COC for the railroads for each year.

<sup>64</sup> For example, see Surface Transportation Board Decision, Railroad Cost of Capital – 2018, Docket No. EP 558 (Sub-No. 22), August 6, 2019 ("STB 2018 Cost of Capital Decision"). See Appendix A for citations to each of these data sources.

<sup>65</sup> The Ibbotson Cost of Capital Yearbook, originally published by Ibbotson and Associates, had been subsequently published by Morningstar, Inc. through 2014 when it was discontinued. According to Morningstar, the "Cost of Capital Yearbook... includes five separate measures of cost of equity, weighted average cost of capital, detailed statistics for sales and profitability, capitalization, beta, equity valuation multiples,... The publication is considered an invaluable independent resource to a large number of financial professionals." See, Ibbotson Cost of Capital 2012 Yearbook, p. 1.

<sup>66</sup> Duff and Phelps acquired the cost of capital publication business from Morningstar and replaced the discontinued Cost of Capital Yearbook with the Duff & Phelps Valuation Handbook – U.S. Industry Cost of Capital.

<sup>67</sup> As shown in this exhibit, because the S&P 500 has turnover in its membership, the S&P 500 includes 795 companies during 2006 – 2019 period. Only 273 companies (34%) were members of the S&P 500 in every year from 2006 – 2019. 162 companies (21%) were members of the S&P 500 for nine to thirteen years, 135 companies (17%) were members of the S&P 500 for five to eight years, and with 225 companies (28%) members of the S&P 500 for one to four years. The companies marked with an asterisk next right to a company's ticker are financial

#### **D. Railroads' Relative Financial Performance Based on the Board's Definitions of ROIC and Cost of Capital**

66. In this section, we present the results of our comparison of the relative financial performance of seven railroads based on the Board's definitions of ROIC and industry COC: BNSF Railway; CSX Corporation; Grand Trunk Corporation; Kansas City Southern; Norfolk Southern Corporation; Soo Line Corporation; and Union Pacific Corporation. Table 1 below compares the financial performance of the railroads to the S&P 500 excluding railroads, financial institutions, and real estate companies (see Appendix Exhibit A1 for list of companies in the S&P 500 each year).<sup>68</sup> This table has two panels. In the top panel, we present descriptive statistics about the S&P 500 benchmarking group and in the bottom panel, we present the minimum, maximum, median,<sup>69</sup> and average percentile of ROIC minus COC within the distribution of the S&P 500 benchmarking group for the railroad industry and for each of the seven railroads.

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institutions or real estate companies, which we exclude from our analyses because financial institutions and real estate companies have substantially different capital structures, assets, and business models than other companies in the S&P 500. The number of S&P 500 Companies excluding financial institutions and real estate companies is shown at the top of the exhibit and range from 396 to 414 over this period.

<sup>68</sup> See Exhibit 1 for the year-by-year results for the Industry Weighted Average and the seven railroads summarized in Table 1.

<sup>69</sup> We use medians and 25<sup>th</sup> percentiles in our analyses to mitigate the effect of outliers. See Chapter 2 in Holthausen and Zmijewski for a discussion of mitigating the effect of outliers when conducting a financial analysis.

**Table 1**  
**S&P 500 Companies Excluding Railroads, Financial Institutions and Real Estate Companies**

| <b>Number of Observations, Median, 25th Percentile, and % Positive ROIC minus COC Over 2006-2019 Period</b> |                |                |               |                |
|-------------------------------------------------------------------------------------------------------------|----------------|----------------|---------------|----------------|
|                                                                                                             | <b>Minimum</b> | <b>Maximum</b> | <b>Median</b> | <b>Average</b> |
| <b>Number of Observations in Sample</b>                                                                     | 368            | 405            | 395           | 391            |
| <b>Median ROIC minus COC</b>                                                                                | 13%            | 29%            | 19%           | 20%            |
| <b>25th Percentile ROIC minus COC</b>                                                                       | -1%            | 6%             | 5%            | 4%             |
| <b>% with ROIC minus COC &gt; 0.0%</b>                                                                      | 73%            | 91%            | 89%           | 88%            |
| <b><u>Railroad Percentile in the Distribution of ROIC minus COC</u></b>                                     |                |                |               |                |
| <b>Industry Weighted Average ROIC</b>                                                                       | 9              | 22             | 13            | 15             |
| <b>BNSF Railway</b>                                                                                         | 9              | 23             | 15            | 15             |
| <b>CSX Corporation</b>                                                                                      | 6              | 24             | 10            | 12             |
| <b>Grand Trunk Corporation</b>                                                                              | 3              | 16             | 10            | 10             |
| <b>Kansas City Southern</b>                                                                                 | 4              | 18             | 8             | 9              |
| <b>Norfolk Southern Corporation</b>                                                                         | 10             | 24             | 13            | 15             |
| <b>Soo Line Corporation</b>                                                                                 | 2              | 26             | 13            | 13             |
| <b>Union Pacific Corporation</b>                                                                            | 8              | 30             | 22            | 20             |

Sources: Bloomberg; Compustat; Ibbotson Yearbook (2006-2019); STB Revenue Adequacy Determination Report (2006-2018); RevAd 2019 AAR workpaper1.pdf, titled "AAR Duplication of STB Workpapers."

67. As shown in the top panel of Table 1, the number of companies in the S&P 500 benchmarking group varies from 368 to 405 across years (2006 through 2019). The number of observations differs from the possible number of observations because some companies in the S&P 500 benchmarking group have negative denominators based on the Board definition of Tax Adjusted Net Investment Base, so we exclude them from the S&P 500 benchmarking group because their ROIC is not meaningful. The median ROIC minus COC for the S&P 500 benchmarking group ranges from 13% to 29% over the 2006 – 2019 period, and the median of the annual medians is 19% (average 20%). The 25<sup>th</sup> percentile ROIC minus COC for the S&P 500 benchmarking group range from -1% to 6% over the 2006 – 2019 period, and the median of the annual 25<sup>th</sup> percentile is 5% (average 4%). The ROIC minus COC is positive in every year for most companies in the S&P benchmarking group. The percentage of companies in the S&P

500 benchmarking group annually that have a positive ROIC minus COC ranges from 73% to 91% over the 2006 – 2019 period.

68. As shown in the bottom panel of Table 1, the Industry Weighted Average ROIC minus COC percentile for the railroad companies in the S&P as a whole within the S&P 500 benchmarking group over this period ranges from the 9<sup>th</sup> percentile to the 22<sup>nd</sup> percentile. The median of the annual medians of the over this period for the Industry Weighted Average is the 13<sup>th</sup> percentile, and the average of the annual medians over this period is the 15<sup>th</sup> percentile. For the seven railroads, the median of the annual medians over this period range from the 8<sup>th</sup> percentile to the 22<sup>nd</sup> percentile, and the average of the annual medians over this period range from the 9<sup>th</sup> percentile to the 20<sup>th</sup> percentile.

69. Table 2 below presents the same type of analysis as that presented in Table 1 but for the S&P 500 Industrials Sector benchmarking group.<sup>70</sup> As shown in the top panel of Table 2, the number of observations annually in the S&P 500 Industrials Sector benchmarking group varies from 48 to 63. The median ROIC minus COC for the S&P 500 Industrials Sector ranges from 14% to 31% over the 2006 – 2019 period, and the median of the annual medians is 23% (average 23%). The 25<sup>th</sup> percentile ROIC minus COC for the S&P 500 Industrial Sector ranges from 4% to 14% over the 2006 – 2019 period, and the median of the annual 25<sup>th</sup> percentile is 13% (average 12%). The percentage of companies in the S&P 500 Industrial Sector benchmarking group that have a positive ROIC minus COC range from 83% to 100% over the 2006 – 2019 period.

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<sup>70</sup> See Exhibit 1 for the year-by-year results for the Industry Weighted Average and the seven railroads summarized in Table 2.

**Table 2**  
**S&P 500 Companies in the Industrials Sector Excluding Railroads**

| <b>Number of Observations, Median, 25th Percentile, and % Positive ROIC minus COC Over 2006-2019 Period</b> |                |                |               |                |
|-------------------------------------------------------------------------------------------------------------|----------------|----------------|---------------|----------------|
|                                                                                                             | <b>Minimum</b> | <b>Maximum</b> | <b>Median</b> | <b>Average</b> |
| <b>Number of Observations in Sample</b>                                                                     | 48             | 63             | 56            | 57             |
| <b>Median ROIC minus COC</b>                                                                                | 14%            | 31%            | 23%           | 23%            |
| <b>25th Percentile ROIC minus COC</b>                                                                       | 4%             | 14%            | 13%           | 12%            |
| <b>% with ROIC minus COC &gt; 0.0%</b>                                                                      | 83%            | 100%           | 96%           | 95%            |
| <b><u>Railroad Percentile in the Distribution of ROIC minus COC</u></b>                                     |                |                |               |                |
| <b>Industry Weighted Average ROIC</b>                                                                       | 2              | 12             | 7             | 7              |
| <b>BNSF Railway</b>                                                                                         | 2              | 13             | 7             | 7              |
| <b>CSX Corporation</b>                                                                                      | 2              | 11             | 5             | 6              |
| <b>Grand Trunk Corporation</b>                                                                              | 2              | 9              | 5             | 5              |
| <b>Kansas City Southern</b>                                                                                 | 2              | 9              | 4             | 5              |
| <b>Norfolk Southern Corporation</b>                                                                         | 2              | 14             | 8             | 7              |
| <b>Soo Line Corporation</b>                                                                                 | 2              | 15             | 6             | 6              |
| <b>Union Pacific Corporation</b>                                                                            | 4              | 21             | 9             | 10             |

Sources: Bloomberg; Compustat; Ibbotson Yearbook (2006-2019); STB Revenue Adequacy Determination Report (2006-2018); RevAd 2019 AAR workpaper1.pdf, titled "AAR Duplication of STB Workpapers."

70. As shown in the bottom panel of Table 2, the Industry Weighted Average ROIC minus COC percentile within the S&P 500 Industrials Sector benchmarking group over this period ranges from the 2<sup>nd</sup> percentile to the 12<sup>th</sup> percentile. The median of the annual medians over this period for the Industry Weighted Average is the 7<sup>th</sup> percentile, and the average of the annual medians over this period also is the 7<sup>th</sup> percentile. For the seven railroads, the median of the annual medians over this period range from the 4<sup>th</sup> percentile to the 9<sup>th</sup> percentile, and the average of the annual medians over this period range from the 5<sup>th</sup> percentile to the 10<sup>th</sup> percentile.

71. Table 3 below presents the same type of analysis as that presented in Tables 1 and 2 for the S&P 500 Railroad Customers benchmarking group.<sup>71</sup> As shown in the top panel of Table 3,

<sup>71</sup> See Exhibit 1 for the year-by-year results for the Industry Weighted Average and the seven railroads summarized in Table 3.

the number of observations in the S&P 500 Railroad Customers companies varies from 80 to 86. The median ROIC minus COC for the S&P 500 Railroad Customers companies ranges from 3% to 13% over the 2006 – 2019 period, and the median of the annual medians is 8% (average 9%). The 25<sup>th</sup> percentile ROIC minus COC for the S&P 500 companies ranges from -4% to 4% over the 2006 – 2019 period, and the median of the annual 25<sup>th</sup> percentile is 2% (average 2%). The ROIC minus COC is positive for most companies in the S&P companies. The percentage of the S&P 500 companies with a positive ROIC minus COC ranges from 61% to 88% over the 2006 – 2019 period.

**Table 3**  
**Railroad Customer Sample of S&P 500 Companies**

| <b>Number of Observations, Median, 25th Percentile, and % Positive ROIC minus COC Over 2006-2019 Period</b> |                |                |               |                |
|-------------------------------------------------------------------------------------------------------------|----------------|----------------|---------------|----------------|
|                                                                                                             | <b>Minimum</b> | <b>Maximum</b> | <b>Median</b> | <b>Average</b> |
| <b>Number of Observations in Sample</b>                                                                     | 80             | 86             | 84            | 83             |
| <b>Median ROIC minus COC</b>                                                                                | 3%             | 13%            | 8%            | 9%             |
| <b>25th Percentile ROIC minus COC</b>                                                                       | -4%            | 4%             | 2%            | 2%             |
| <b>% with ROIC minus COC &gt; 0.0%</b>                                                                      | 61%            | 88%            | 83%           | 81%            |
| <b>Railroad Percentile in the Distribution of ROIC minus COC:</b>                                           |                |                |               |                |
| <b>Industry Weighted Average ROIC</b>                                                                       | 7              | 36             | 22            | 23             |
| <b>BNSF Railway</b>                                                                                         | 7              | 36             | 24            | 24             |
| <b>CSX Corporation</b>                                                                                      | 5              | 39             | 16            | 18             |
| <b>Grand Trunk Corporation</b>                                                                              | 5              | 29             | 14            | 16             |
| <b>Kansas City Southern</b>                                                                                 | 5              | 28             | 13            | 13             |
| <b>Norfolk Southern Corporation</b>                                                                         | 15             | 33             | 20            | 23             |
| <b>Soo Line Corporation</b>                                                                                 | 6              | 43             | 19            | 20             |
| <b>Union Pacific Corporation</b>                                                                            | 6              | 49             | 35            | 31             |

Sources: Bloomberg; Compustat; Ibbotson Yearbook (2006-2019); STB Revenue Adequacy Determination Report (2006-2018); RevAd 2019 AAR workpaper1.pdf, titled "AAR Duplication of STB Workpapers."

72. As shown in the bottom panel of Table 3, the Industry Weighted Average ROIC minus COC percentile within the sample over this period ranges from the 7<sup>th</sup> percentile to the 36<sup>th</sup> percentile. The median of the annual medians over this period for the Industry Weighted

Average is the 22<sup>nd</sup> percentile, and the average of the annual medians over this period is the 23<sup>rd</sup> percentile. The median of the annual medians over this period for the seven railroads range from the 13<sup>th</sup> percentile to the 35<sup>th</sup> percentile and the average of the annual medians over this period for the seven railroads range from the 13<sup>th</sup> percentile to the 31<sup>st</sup> percentile.

#### **E. Railroads' Relative Financial Performance Based on the Adjusted ROIC and the Board's Definition of the Cost of Capital**

73. In this section, we discuss the relative financial performance of the railroads based on the Adjusted STB ROIC and the industry cost of capital (COC). Recall that the difference between the STB ROIC and the Adjusted STB ROIC is (a) eliminating the effect of deferred income taxes in the Provision of Income Taxes in the Adjusted Net Railway Operating Income (STB ROIC numerator) and (b) eliminating the effect of Deferred Tax Liabilities and including the company's investments in non-goodwill intangible assets in the Tax Adjusted Net Investment Base (STB ROIC denominator). The results in Tables 4 through 6 in this section correspond to the results in Tables 1 through 3 in the preceding section except that the measure of financial performance is Adjusted STB ROIC minus the industry cost of capital (COC), i.e. Adjusted ROIC minus COC.

74. Table 4 below presents the results of this analysis comparing the financial performance of the railroads to the S&P 500 benchmarking group.<sup>72</sup> As shown in the top panel of Table 4, the number of companies in the S&P 500 benchmarking group varies from 393 to 415. The median Adjusted ROIC minus COC for the S&P 500 benchmarking group range from 5% to 12% over the 2006 – 2019 period, and the median of the annual medians is 10% (average 9%). The 25<sup>th</sup> percentile of Adjusted ROIC minus COC for the S&P 500 benchmarking group ranges from -2%

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<sup>72</sup> See Exhibit 2 for the year-by-year results for the Industry Weighted Average and the seven railroads summarized in Table 4.

to 3% over the 2006 – 2019 period, and the median of the annual 25<sup>th</sup> percentile is 2% (average 2%). The percentage of companies in the S&P 500 benchmarking group that have a positive Adjusted ROIC minus COC ranges from 68% to 87% over the 2006 – 2019 period.

**Table 4**  
**S&P 500 Companies Excluding Railroads, Financial Institutions and Real Estate Companies**

| <b>Number of Observations, Median, 25th Percentile, and % Positive ROIC minus COC Over 2006-2019 Period</b> |                |                |               |                |
|-------------------------------------------------------------------------------------------------------------|----------------|----------------|---------------|----------------|
|                                                                                                             | <b>Minimum</b> | <b>Maximum</b> | <b>Median</b> | <b>Average</b> |
| <b>Number of Observations in Sample</b>                                                                     | 393            | 415            | 409           | 406            |
| <b>Median Adjusted ROIC minus COC</b>                                                                       | 5%             | 12%            | 10%           | 9%             |
| <b>25th Percentile Adjusted ROIC minus COC</b>                                                              | -2%            | 3%             | 2%            | 2%             |
| <b>% with ROIC minus COC &gt; 0.0%</b>                                                                      | 68%            | 87%            | 83%           | 83%            |
| <b><u>Railroad Percentile in the Distribution of Adjusted ROIC minus COC</u></b>                            |                |                |               |                |
| <b>Industry Weighted Average ROIC</b>                                                                       | 9              | 25             | 13            | 14             |
| <b>BNSF Railway</b>                                                                                         | 8              | 24             | 14            | 15             |
| <b>CSX Corporation</b>                                                                                      | 6              | 26             | 10            | 12             |
| <b>Grand Trunk Corporation</b>                                                                              | 4              | 15             | 9             | 10             |
| <b>Kansas City Southern</b>                                                                                 | 5              | 20             | 10            | 11             |
| <b>Norfolk Southern Corporation</b>                                                                         | 7              | 21             | 11            | 13             |
| <b>Soo Line Corporation</b>                                                                                 | 1              | 34             | 13            | 14             |
| <b>Union Pacific Corporation</b>                                                                            | 8              | 35             | 17            | 19             |

Sources: Bloomberg; Compustat; Ibbotson Yearbook (2006-2019); STB Revenue Adequacy Determination Report (2006-2018); RevAd 2019 AAR workpaper1.pdf, titled "AAR Duplication of STB Workpapers."

75. As shown in the bottom panel of Table 4, the Industry Weighted Average Adjusted ROIC minus COC percentile within the S&P 500 benchmarking group over this period ranges from the 9<sup>th</sup> percentile to the 25<sup>th</sup> percentile. The median of the annual medians of the over this period for the Industry Weighted Average is the 13<sup>th</sup> percentile, and the average of the annual medians over this period is the 14<sup>th</sup> percentile. For the seven railroads, the median of the annual medians over this period range from the 9<sup>th</sup> percentile to the 17<sup>th</sup> percentile, and the average of the annual medians over this period range from the 10<sup>th</sup> percentile to the 19<sup>th</sup> percentile.

76. Table 5 below presents the same type of analysis as that presented in Table 4 but for the S&P 500 Industrials Sector benchmarking group.<sup>73</sup> As shown in the top panel of Table 5, the number of observations in the S&P 500 Industrials Sector benchmarking group varies from 48 to 66. The median Adjusted ROIC minus COC for the S&P 500 Industrials Sector ranges from 5% to 15% over the 2006 – 2019 period, and the median of the annual medians is 13% (average 12%). The 25<sup>th</sup> percentile Adjusted ROIC minus COC for the S&P 500 Industrial Sector ranges from 1% to 9% over the 2006 – 2019 period, and the median of the annual 25<sup>th</sup> percentile is 7% (average 6%). The percentage of companies in the S&P 500 Industrial Sector benchmarking group that have a positive Adjusted ROIC minus COC ranges from 80% to 97% over the 2006 – 2019 period.

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<sup>73</sup> See Exhibit 2 for the year-by-year results for the Industry Weighted Average and the seven railroads summarized in Table 5.

**Table 5**  
**S&P 500 Companies in the Industrials Sector Excluding Railroads**

| <b>Number of Observations, Median, 25th Percentile, and % Positive ROIC minus COC Over 2006-2019 Period</b> |                |                |               |                |
|-------------------------------------------------------------------------------------------------------------|----------------|----------------|---------------|----------------|
|                                                                                                             | <b>Minimum</b> | <b>Maximum</b> | <b>Median</b> | <b>Average</b> |
| <b>Number of Observations in Sample</b>                                                                     | 48             | 66             | 59            | 59             |
| <b>Median Adjusted ROIC minus COC</b>                                                                       | 5%             | 15%            | 13%           | 12%            |
| <b>25th Percentile Adjusted ROIC minus COC</b>                                                              | 1%             | 9%             | 7%            | 6%             |
| <b>% with ROIC minus COC &gt; 0.0%</b>                                                                      | 80%            | 97%            | 93%           | 92%            |
| <b><u>Railroad Percentile in the Distribution of Adjusted ROIC minus COC</u></b>                            |                |                |               |                |
| <b>Industry Weighted Average ROIC</b>                                                                       | 2              | 13             | 7             | 7              |
| <b>BNSF Railway</b>                                                                                         | 2              | 16             | 6             | 7              |
| <b>CSX Corporation</b>                                                                                      | 2              | 13             | 5             | 6              |
| <b>Grand Trunk Corporation</b>                                                                              | 2              | 11             | 4             | 5              |
| <b>Kansas City Southern</b>                                                                                 | 2              | 11             | 5             | 5              |
| <b>Norfolk Southern Corporation</b>                                                                         | 2              | 13             | 5             | 6              |
| <b>Soo Line Corporation</b>                                                                                 | 2              | 19             | 6             | 7              |
| <b>Union Pacific Corporation</b>                                                                            | 3              | 23             | 7             | 9              |

Sources: Bloomberg; Compustat; Ibbotson Yearbook (2006-2019); STB Revenue Adequacy Determination Report (2006-2018); RevAd 2019 AAR workpaper1.pdf, titled "AAR Duplication of STB Workpapers."

77. As shown in the bottom panel of Table 5, the Industry Weighted Average Adjusted ROIC minus COC percentile within the S&P 500 Industrials Sector benchmarking group over this period ranges from the 2<sup>nd</sup> percentile to the 13<sup>th</sup> percentile. The median of the annual medians of the over this period for the Industry Weighted Average is the 7<sup>th</sup> percentile, and the average of the annual medians over this period is the 7<sup>th</sup> percentile. For the seven railroads, the median of the annual medians over this period range from the 4<sup>th</sup> percentile to the 7<sup>th</sup> percentile, and the average of the annual medians over this period range from the 5<sup>th</sup> percentile to the 9<sup>th</sup> percentile.

78. Finally, Table 6 below presents the same type of analysis as presented in Tables 4 and 5 but for the S&P 500 Railroad Customers benchmarking group.<sup>74</sup> As shown in the top panel of Table 6, the number of observations in the S&P 500 Railroad Customers companies varies from 80 to 87. The median Adjusted ROIC minus COC for the S&P 500 Railroad Customers companies ranges from 0% to 9% over the 2006 – 2019 period, and the median of the annual medians is 5% (average 5%). The 25<sup>th</sup> percentile Adjusted ROIC minus COC for the S&P 500 Railroad Customers companies ranges from -5% to 2% over the 2006 – 2019 period, and the median of the annual 25<sup>th</sup> percentile is 0% (average 0%). The percentage of the S&P 500 Railroad Customers companies that have a positive Adjusted ROIC minus COC ranges from 52% to 84% over the 2006 – 2019 period.

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<sup>74</sup> See Exhibit 2 for the year-by-year results for the Industry Weighted Average and the seven railroads summarized in Table 6.

**Table 6**  
**Railroad Customer Sample of S&P 500 Companies**

| <b>Number of Observations, Median, 25th Percentile, and % Positive ROIC minus COC Over 2006-2019 Period</b> |                |                |               |                |
|-------------------------------------------------------------------------------------------------------------|----------------|----------------|---------------|----------------|
|                                                                                                             | <b>Minimum</b> | <b>Maximum</b> | <b>Median</b> | <b>Average</b> |
| <b>Number of Observations in Sample</b>                                                                     | 80             | 87             | 84            | 83             |
| <b>Median Adjusted ROIC minus COC</b>                                                                       | 0%             | 9%             | 5%            | 5%             |
| <b>25th Percentile Adjusted ROIC minus COC</b>                                                              | -5%            | 2%             | 0%            | 0%             |
| <b>% with ROIC minus COC &gt; 0.0%</b>                                                                      | 52%            | 84%            | 78%           | 76%            |
| <b>Railroad Percentile in the Distribution of Adjusted ROIC minus COC</b>                                   |                |                |               |                |
| <b>Industry Weighted Average ROIC</b>                                                                       | 7              | 40             | 18            | 21             |
| <b>BNSF Railway</b>                                                                                         | 7              | 38             | 20            | 22             |
| <b>CSX Corporation</b>                                                                                      | 6              | 40             | 16            | 18             |
| <b>Grand Trunk Corporation</b>                                                                              | 5              | 29             | 14            | 15             |
| <b>Kansas City Southern</b>                                                                                 | 6              | 31             | 16            | 16             |
| <b>Norfolk Southern Corporation</b>                                                                         | 11             | 36             | 16            | 19             |
| <b>Soo Line Corporation</b>                                                                                 | 6              | 39             | 19            | 21             |
| <b>Union Pacific Corporation</b>                                                                            | 7              | 49             | 26            | 29             |

Sources: Bloomberg; Compustat; Ibbotson Yearbook (2006-2019); STB Revenue Adequacy Determination Report (2006-2018); RevAd 2019 AAR workpaper1.pdf, titled "AAR Duplication of STB Workpapers."

79. As shown in the bottom panel of Table 6, the Industry Weighted Average Adjusted ROIC minus COC percentile within the sample over this period ranges from the 7<sup>th</sup> percentile to the 40<sup>th</sup> percentile. The median of the annual medians over this period for the Industry Weighted Average is the 18<sup>th</sup> percentile, and the average of the annual medians over this period is the 21<sup>st</sup> percentile. The median of the annual medians over this period for the seven railroads range from the 14<sup>th</sup> percentile to the 26<sup>th</sup> percentile and the average of the annual medians over this period for the seven railroads range from the 15<sup>th</sup> percentile to the 29<sup>th</sup> percentile.

## F. Summary and Conclusions

80. In this section, we analyzed the two measures of the railroads' financial performance (ROIC minus COC and Adjusted ROIC minus COC) and compared them to the financial performance of three benchmarking groups. We summarize these results in Table 7.<sup>75</sup>

**Table 7**  
**Summary of the Analysis of the Railroads' Relative Financial Performance**

| <b>Panel A: Benchmarking Groups' Median Statistics Across Years (2006 through 2019)</b> |                                |                                |                              |                                        |                                |                              |
|-----------------------------------------------------------------------------------------|--------------------------------|--------------------------------|------------------------------|----------------------------------------|--------------------------------|------------------------------|
|                                                                                         | <b>STB ROIC minus STB COC</b>  |                                |                              | <b>Adjusted STB ROIC minus STB COC</b> |                                |                              |
|                                                                                         | <b>S&amp;P 500<sup>1</sup></b> | <b>Industrials<sup>2</sup></b> | <b>Customers<sup>3</sup></b> | <b>S&amp;P 500<sup>1</sup></b>         | <b>Industrials<sup>2</sup></b> | <b>Customers<sup>3</sup></b> |
| <b>Number of Observations in Sample</b>                                                 | 395                            | 56                             | 84                           | 409                                    | 59                             | 84                           |
| <b>Median ROIC minus COC</b>                                                            | 19%                            | 23%                            | 8%                           | 10%                                    | 13%                            | 5%                           |
| <b>25th Percentile ROIC minus COC</b>                                                   | 5%                             | 13%                            | 2%                           | 2%                                     | 7%                             | 0%                           |
| <b>% with ROIC minus COC &gt; 0.0%</b>                                                  | 89%                            | 96%                            | 83%                          | 83%                                    | 93%                            | 78%                          |

| <b>Panel B: Railroads' Median of the Annual Percentiles Across Years (2006 through 2019)</b> |                                |                                |                              |                                        |                                |                              |
|----------------------------------------------------------------------------------------------|--------------------------------|--------------------------------|------------------------------|----------------------------------------|--------------------------------|------------------------------|
|                                                                                              | <b>STB ROIC minus STB COC</b>  |                                |                              | <b>Adjusted STB ROIC minus STB COC</b> |                                |                              |
|                                                                                              | <b>S&amp;P 500<sup>1</sup></b> | <b>Industrials<sup>2</sup></b> | <b>Customers<sup>3</sup></b> | <b>S&amp;P 500<sup>1</sup></b>         | <b>Industrials<sup>2</sup></b> | <b>Customers<sup>3</sup></b> |
| <b>Industry Weighted Average ROIC</b>                                                        | 13                             | 7                              | 22                           | 13                                     | 7                              | 18                           |
| <b>BNSF Railway</b>                                                                          | 15                             | 7                              | 24                           | 14                                     | 6                              | 20                           |
| <b>CSX Corporation</b>                                                                       | 10                             | 5                              | 16                           | 10                                     | 5                              | 16                           |
| <b>Grand Trunk Corporation</b>                                                               | 10                             | 5                              | 14                           | 9                                      | 4                              | 14                           |
| <b>Kansas City Southern</b>                                                                  | 8                              | 4                              | 13                           | 10                                     | 5                              | 16                           |
| <b>Norfolk Southern Corporation</b>                                                          | 13                             | 8                              | 20                           | 11                                     | 5                              | 16                           |
| <b>Soo Line Corporation</b>                                                                  | 13                             | 6                              | 19                           | 13                                     | 6                              | 19                           |
| <b>Union Pacific Corporation</b>                                                             | 22                             | 9                              | 35                           | 17                                     | 7                              | 26                           |

Notes:

1 S&P 500 companies excluding Railroads, Financial Institutions and Real Estate Companies

2 S&P 500 companies in the Industrials Sector excluding Railroads

3 Railroad customer sample of S&P 500 companies

Sources: Bloomberg; Compustat; Ibbotson Yearbook (2006-2019); STB Revenue Adequacy Determination Report (2006-2018); RevAd 2019 AAR workpaper1 pdf, titled "AAR Duplication of STB Workpapers "

81. All of the analyses show that the relative financial performance of the railroad industry falls within the bottom quartile of the three benchmarking groups. Thus, the benchmarking analyses we conducted show that financial performance of the railroad industry and the seven

<sup>75</sup> Table 7 summarizes the result shown in Tables 1 through 6 for the median ROIC minus COC and median Adjusted ROIC minus COC.

railroads was well below the financial performance of companies operating in competitive (unregulated) markets.

## **V. SUMMARY AND RECOMMENDATIONS**

82. Economic research has shown that the limitations and inaccuracies of accounting-based rates of return make it difficult, and some say impossible, to draw any inferences about economic rates of return based on accounting rates of return. To the extent it is necessary to use accounting rates of return in comparison to the cost of capital to assess financial performance, using the proposed benchmarking methodology mitigates the limitations and inaccuracies of accounting rates of return as estimates of the cost of capital.

83. Our benchmarking analyses show that the financial performance of the railroad industry as a whole and each of the seven railroads was well below the financial performance of companies operating in competitive (unregulated) markets over the 2006-2019 period. Specifically, using two alternative measures of financial performance and three benchmarking groups, we find that, over this period, the financial performance of the railroad industry and the seven railroads fell well below the median and mostly in the bottom quartile of the financial performance of all three benchmarking groups.

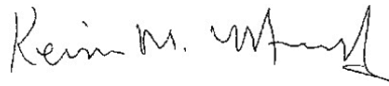
84. If in the future ROIC minus COC exceeds the median for the benchmarking group, then we recommend that the Board should first investigate whether the railroads are above the median for procompetitive reasons – greater efficiency, benefits from risky investments, increases in demand that exceeded expected etc. If, after such investigation, the Board can rule out such procompetitive reasons, and the Board concludes that there is a basis for concern that there is a lack of competition in serving some shippers or some geographic areas, the Board should look to

use its existing tools more effectively and perhaps to make it easier for shippers to challenge specific rates where there may be noncompetitive pricing.

85. In order to avoid penalizing especially efficient railroads and introducing distortions in competition among railroads that would occur if one railroad were subject to additional regulation not imposed on others, the Board should look at the railroad industry as a whole in evaluating whether there is a basis for considering additional regulation in response to potential lack of competition. If the Board determines that such regulation is warranted, it should be imposed on the entire industry, and not just on individual railroads.

**VERIFICATION**

I, Kevin M. Murphy, declare under penalty of perjury that the foregoing is true and correct. Further, I certify that I am qualified and authorized to file this Verified Statement.

A handwritten signature in cursive script that reads "Kevin M. Murphy". The signature is fluid and matches the printed name below it.

Kevin M. Murphy

I, Mark E. Zmijewski, declare under penalty of perjury that the foregoing is true and correct. Further, I certify that I am qualified and authorized to file this Verified Statement.

A handwritten signature in cursive script that reads "Mark E. Zmijewski". The signature is fluid and matches the printed name below it.

Mark E. Zmijewski

## APPENDIX A

### SAMPLES, DEFINITIONS, AND DATA SOURCES

A-1. In this Appendix, we describe the calculation methodology and data sources used in the analysis of railroads' financial performance and the railroads' financial performance relative to the financial performance of three benchmarking samples: (a) S&P 500 companies excluding railroads, financial institutions, and real estate companies;<sup>76</sup> (b) S&P 500 Industrials Sector excluding railroads, the industry sector to which railroads belong;<sup>77</sup> and (c) customers of CN, NS, and/or UP in the S&P 500 that account for at least \$1 million of combined revenue in 2018.<sup>78</sup> We analyze the period from 2006 through 2019. Exhibit A1 presents a list of the S&P 500 companies for each year in the analysis. As shown in this exhibit, because the S&P 500 has turnover in its membership, the S&P 500 includes 795 companies during 2006 through 2019 period.<sup>79</sup> If a company is a member of the S&P 500 on December 31 in a given year, that year is marked with 1 and is 0 otherwise. The companies marked with an asterisk next right to the company's ticker are financial institutions or real estate companies, which we exclude from our

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<sup>76</sup> The S&P 500 stock market index, maintained by S&P Dow Jones Indices, comprises 505 common stocks issued by 500 large-cap companies and traded on American stock exchanges. S&P U.S. Indices Methodology Update, January 21, 2015.

<sup>77</sup> Industry Sectors are based on the Global Industry Classification Standard ("GICS"). GICS "was developed by S&P Dow Jones Indices, ..., and MSCI. ... The GICS structure consists of 11 Sectors, 24 Industry groups, 69 Industries and 158 sub-industries." The railroads are included in the Industrial Sector 20. GICS® Global Industry Classification Standard accessed on November 10, 2019 at [https://www.spglobal.com/marketintelligence/en/documents/112727-gics-mapbook\\_2018\\_v3\\_letter\\_digitalspreads.pdf](https://www.spglobal.com/marketintelligence/en/documents/112727-gics-mapbook_2018_v3_letter_digitalspreads.pdf)

<sup>78</sup> We were provided with a list of S&P 500 customers from CN, NS, and UP. The customer companies with a combined 2018 revenue greater than \$1 million are selected as S&P 500 customers for ranking.

<sup>79</sup> Only 273 companies (34%) were members of the S&P 500 in every year from 2006 through 2019. 162 companies (34%) were members of the S&P 500 for nine to thirteen years, 135 companies (17%) were members of the S&P 500 for five to eight years, and 225 companies (28%) were members of the S&P 500 for one to four years.

analyses because financial institutions and real estate companies have substantially different capital structures, assets, and business models than other companies in the S&P 500.

A-2. The Surface Transportation Board's (STB) measure of financial performance used in the STB's Annual Revenue Adequacy Determinations<sup>80</sup> compares a company's accounting-based (or financial statement-based) rate of return on invested capital (ROIC) to that company's industry economic cost of capital (COC);<sup>81</sup> more specifically, it determines whether ROIC minus COC is negative or positive. In our analyses, we calculate each railroad's financial performance (measured by ROIC minus COC) relative to the financial performance (measured by ROIC minus COC) of the benchmarking samples by calculating each railroad's percentile in the distribution of the benchmarking samples. In addition, we calculate the financial performance of the railroad industry, using weighted average ROIC minus COC (Industry Weighted Average), and calculate the relative financial performance of the railroad industry as a whole in the same manner.

A-3. Naturally, a company's ROIC minus COC requires the calculation of that company's ROIC and industry cost of capital. ROIC does not have a single generally accepted or standard definition. The STB has developed a specific definition for ROIC to calculate the financial performance of the railroads; thus, we adopt the STB definition for ROIC ("STB ROIC"). We also use an alternative definition of ROIC ("Adjusted STB ROIC"), which we believe is a more

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<sup>80</sup> See, for example, Surface Transportation Board, Railroad Adequacy – 2018 Determination, Docket No. EP 552 (Sub-No. 23), September 5, 2019 ("STB 2018 Revenue Adequacy Determination").

<sup>81</sup> "Pursuant to those procedures, which are essentially mechanical, a railroad is considered revenue adequate under 49 U.S.C. § 10704(a) if it achieves a rate of return on net investment (ROI) equal to at least the current cost of capital for the railroad industry." Surface Transportation Board, Railroad Revenue Adequacy – 2018 Determination, September 5, 2019.

useful measure of accounting-based financial performance for assessing the financial performance of the railroads based on ROIC minus COC.

**A. Return on Invested Capital (ROIC) – STB definition**

A-4. The STB’s Annual Revenue Adequacy Determinations<sup>82</sup> define ROIC as follows:<sup>83</sup>

$$\text{STB ROIC} = \frac{\text{Adjusted Net Railway Operating Income}}{\text{Tax Adjusted Net Investment Base}}$$

where adjusted Net Railway Operating Income is defined as:

$$\begin{aligned} & \text{Consolidated Net Railway Operating Income} \\ & + \text{Interest Income from Working Capital Allowance – Cash Portion} \\ & + \text{Income Taxes Associated with Non-Rail Income and Deductions} \\ & + \text{Gain or (Loss) from Transfer/Reclassification to Nonrail-Status (Net of Income Taxes)} \\ & = \text{Adjusted Net Railway Operating Income} \end{aligned}$$

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<sup>82</sup> See, for example, STB 2018 Revenue Adequacy Determination, Appendix B.

<sup>83</sup> For 2017, the STB adjusted this formula because the decrease in the federal income tax rate (2017 Tax Cut and Jobs Creation Act) resulted in a revaluation of deferred income taxes on the balance sheet (companies, like the railroads, with a net deferred tax liability position on their balance sheet recorded a reduction of that liability, which decreased the provision for income taxes and thus, increased income, in that year). The adjustment had the effect of essentially eliminating this reduction in income tax. “By decision served on July 27, 2018, the Board explained that its revenue adequacy determination, among other calculations for 2017, would be affected by the carriers’ revaluation of their deferred tax liabilities as a result of the Tax Cuts and Jobs Act. R.R. Revenue Adequacy—2017 Determination... The Board adopted this proposal in Railroad Revenue Adequacy—2017 Determination, EP 552 (Sub-No. 22) et al., slip op. at 6-9 (STB served Dec. 6, 2018), and, consistent with that decision, the revenue adequacy determination here reflects the adjustments made in the carriers’ Schedule 250 filings,” STB 2017 Revenue Adequacy Determination, December 21, 2018, footnote 2.

and where Tax Adjusted Net Investment Base is defined as:<sup>84</sup>

$$\begin{aligned} & \text{Combined Investment in Railroad Property Used in Transportation Service} \\ & - \text{Interest During Construction} \\ & - \text{Other Elements of Investment} \\ & + \text{Net Rail Assets of Rail Related Affiliates} \\ & + \text{Working Capital Allowance}^{85} \\ & - \text{Accumulated Deferred Income Tax Credits} \\ \hline & = \text{Tax Adjusted Net Investment Base} \end{aligned}$$

A-5. For the railroads, we use the same data sources and measurement of the inputs for the calculation of railroads' ROIC as those in the STB's Revenue Adequacy Determinations; thus, our railroad ROICs are numerically identical to those reported in the STB Revenue Adequacy Determinations for all years in the analysis from 2006 through 2019.<sup>86</sup> The data source used to measure ROIC for the S&P 500 companies is Compustat,<sup>87</sup> which is publicly available and widely used in peer reviewed academic studies. For S&P 500 companies, Adjusted Net Railway Operating Income is equal to operating income ("Earnings Before Interest and Taxes" ("EBIT")) minus income taxes ("Income Tax Provision") plus marginal income tax on non-operating

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<sup>84</sup> The Tax Adjusted Net Investment Base is calculated using the average of the beginning (end of prior year) and ending (end of current year) balances for each year.

<sup>85</sup> The STB defines the Working Capital Allowance as the lesser Cash Working Capital Required and Cash and Temporary Cash Balance. Cash Working Capital Required is defined as Days of Working Capital Required (Days of Operating Revenue in Current Operating Assets + 15 days - Days of Operating Expenses in Current Operating Liabilities) multiplied by Average Daily Expenditures.

<sup>86</sup> STB 2006 Revenue Adequacy Determination, May 6, 2008; STB 2007 Revenue Adequacy Determination, September 26, 2008; STB 2008 Revenue Adequacy Determination, October 26, 2009; STB 2009 Revenue Adequacy Determination, November 10, 2010; STB 2010 Revenue Adequacy Determination, January 2, 2014; STB 2011 Revenue Adequacy Determination, January 2, 2014; STB 2012 Revenue Adequacy Determination, January 2, 2014; STB 2013 Revenue Adequacy Determination, September 2, 2014; STB 2014 Revenue Adequacy Determination, September 8, 2015; STB 2015 Revenue Adequacy Determination, September 8, 2016; STB 2016 Revenue Adequacy Determination, September 6, 2017; STB 2017 Revenue Adequacy Determination, December 21, 2018; STB 2018 Revenue Adequacy Determination, September 5, 2019; 2019 Revenue Adequacy Workpapers, May 1, 2020 (document titled "AAR Duplication of STB Workpapers," RevAd 2019 AAR workpaper1.pdf).

<sup>87</sup> Compustat is a "comprehensive database with standardized, historical and point-in-time data, with flexible delivery options to power your quantitative research and analysis... [with] history back to the 1950s, and extended interim history back to 1962." Source: [https://www.spglobal.com/marketintelligence/en/documents/compustat-brochure\\_digital.pdf](https://www.spglobal.com/marketintelligence/en/documents/compustat-brochure_digital.pdf).

income (expense). Tax Adjusted Net Investment Base for the S&P 500 companies is equal to Net Property, Plant & Equipment (“PPE”) plus Inventory plus Working Capital Allowance<sup>88</sup> minus Accumulated Deferred Income Tax Credits.<sup>89</sup> The formula for measuring ROIC using Compustat data is as follows:<sup>90</sup>

$$ROIC = \frac{ebit - txt + \tau * nopi}{Average(ppent + invt + Min(Max(\frac{rectr}{revt} * 360 + 15) - \frac{ap}{xopr - dp} * 360, 0) * \frac{xopr - dp}{360}, che) - txndbl)}$$

where:

- Compustat mnemonic (ebit) = Earnings Before Interest and Taxes
- Compustat mnemonic (txt) = Income Taxes – Total
- Compustat mnemonic (nopi) = Non-Operating Income (Expense)
- $\tau$  = Marginal Tax Rate; 37.5% (2006-2017) and 24% (2018-2019)
- Compustat mnemonic (ppent) = Property, Plant and Equipment - Total (Net)<sup>91</sup>
- Compustat mnemonic (invt) = Inventories – Total<sup>92</sup>
- Compustat mnemonic (rectr) = Receivables – Trade
- Compustat mnemonic (revt) = Revenue – Total
- Compustat mnemonic (ap) = Accounts Payable – Trade
- Compustat mnemonic (xopr) = Operating Expenses – Total
- Compustat mnemonic (dp) = Depreciation and Amortization, and
- Compustat mnemonic (che) = Cash and Short-Term Investments
- Compustat mnemonic (txndbl) = Net Deferred Tax Liability.<sup>93</sup>

<sup>88</sup> To calculate Working Capital Allowance, we followed the methodology outlined in Schedule 245 to the railroads’ Class I Railroad Annual Report R-1.

<sup>89</sup> We calculated Tax Adjusted Net Investment Base using the average of the beginning (end of prior year) and ending (end of current year) balances for each year.

<sup>90</sup> If the average Tax Adjusted Net Investment Base is non-positive, STB ROIC is set to be empty for that observation. If Earnings Before Interest and Taxes (EBIT) is missing from Compustat’s data pull, STB ROIC is set to be empty. For example, EBITs are missing for Commerce Bancorp (ticker: CBH.1) in 2006 and 2007, so the STB ROICs are set to empty for Commerce Bancorp for both years.

<sup>91</sup> If the data point is missing from Compustat’s data pull, it is set to zero.

<sup>92</sup> If the data point is missing from Compustat’s data pull, it is set to zero.

<sup>93</sup> If the data point is missing from Compustat’s data pull, it is set to zero.

## B. Return on Invested Capital (ROIC) – Adjusted STB ROIC Definition

A-6. Also, we propose and analyze an adjusted STB definition of ROIC, which we believe is a more appropriate ROIC measure to use when comparing a company's accounting-based ROIC to its economic cost of capital. The definition of Adjusted STB ROIC makes one adjustment to the STB definition of Adjusted Net Railway Operating Income (i.e. to the STB ROIC numerator) and two adjustments to the STB definition of Tax Adjusted Net Investment Base (i.e. to the STB ROIC denominator). The adjustment to the STB definition of Adjusted Net Railway Operating Income (STB ROIC numerator) is eliminating the effect of deferred income taxes in the Provision of Income Taxes. The two adjustments to the STB definition of Tax Adjusted Net Investment Base (STB ROIC denominator) are: (a) eliminating the effect of Deferred Tax Liabilities in the calculation of the Net Investment Base; and (b) including the company's investments in non-goodwill intangible assets. The resulting formula for Adjusted STB ROIC is:<sup>94</sup>

$$\text{Adjusted STB ROIC} = \frac{\text{Adjusted Net Railway Operating Income} + \text{Deferred Tax Expense}}{\text{Tax Adjusted Net Investment Base} + \text{Deferred Tax Liabilities} + \text{Non-Goodwill Intangible Assets}}$$

Stated in terms of Compustat data items, the resulting formula for Adjusted STB ROIC is:<sup>95</sup>

$$\text{Adjusted STB ROIC} = \frac{ebit - txt + \tau * nopi + txdi}{\text{Average} \left( ppent + invt + \text{Min} \left( \text{Max} \left( \left( \frac{rectr}{revt} * 360 + 15 \right) - \frac{ap}{xopr - dp} * 360, 0 \right) * \frac{xopr - dp}{360}, che \right) - txndbl + txndbl + intano \right)}$$

where:

<sup>94</sup> Adding Deferred Tax Liabilities to the denominator of the Adjusted STB ROIC has the effect of eliminating the deduction of Deferred Tax Liabilities used in the STB definition of ROIC.

<sup>95</sup> If the average denominator for Adjusted STB ROIC is non-positive, Adjusted STB ROIC is set to be empty for that observation. If Earnings Before Interest and Taxes (EBIT) is missing from Compustat's data pull, Adjusted STB ROIC is set to be empty.

Compustat mnemonic (txdi) = Income Taxes - Deferred<sup>96</sup>

Compustat mnemonic (intano) = Other Intangibles<sup>97</sup>

All other Compustat data items are as defined previously.

A-7. One of these adjustments, i.e. adding the company's investments in non-goodwill intangible assets in the calculation of the STB definition of Tax Adjusted Net Investment Base, has no meaningful effect on the railroads' ROICs, and thus, no meaningful effect on the ROIC minus COC measure of financial performance used by the STB. This adjustment has no meaningful effect on railroads' ROICs because railroads do not have substantial investments in non-goodwill intangible assets. However, this adjustment can have a meaningful effect on the ROIC of other S&P 500 companies who have substantial investments in non-goodwill intangible assets.<sup>98</sup>

A-8. Because none of the railroads have meaningful non-goodwill intangible assets, this adjustment has no effect for assessing the financial performance of the railroads, but it has a substantial effect for assessing the financial performance of the railroads relative to other companies that may have substantial non-goodwill intangible assets.

### **C. Industry Weighted Average Return on Invested Capital (ROIC)**

A-9. In addition to analyzing the ROIC minus COC for each of the railroads, we also analyze ROIC minus COC based on an Industry Weighted Average ROIC. We calculate the Industry

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<sup>96</sup> If Income Taxes – Deferred is missing from Compustat's data pull, Income Taxes – Deferred is calculated as Income Taxes – Total minus Income Taxes – Current. However, if either Income Taxes – Total or Income Taxes – Current is also missing, Income Taxes – Deferred is set to zero.

<sup>97</sup> If the data point is missing from Compustat's data pull, it is set to zero.

<sup>98</sup> Examples of non-goodwill intangible assets include assets such as patents, copyrights, trademarks, computer software, licenses, films, and import quotas. Accounting rules generally require companies to expense – as opposed to capitalize – expenditures that result in such assets but require companies to record the value of non-goodwill intangible assets when they acquire another company.

Weighted Average ROIC as the weighted average ROIC of the seven railroads listed in the STB Revenue Adequacy Determinations.<sup>99</sup>

A-10. We use the STB definition of the cost of capital to measure the cost of capital for the railroads and companies in the S&P 500. The STB outlines its cost of capital methodology in the STB's Railroad Cost of Capital Decisions:<sup>100</sup>

$$\begin{aligned} & \text{Industry Cost of Debt} \quad \quad \quad \times \text{Industry Debt Weight} \\ & + \text{Industry Cost of Preferred Equity} \times \text{Industry Preferred Equity Weight} \\ & + \text{Industry Cost of Common Equity} \times \text{Industry Common Equity Weight} \\ & = \text{Industry Cost of Capital} \end{aligned}$$

where Industry Cost of Debt, Industry Cost of Preferred Equity, and Industry Cost of Common Equity, as well as their respective weights, are determined based on individual railroads' accounting and market data. In the following paragraphs, we provide further details on how STB measures each component of the Industry Cost of Capital.

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<sup>99</sup> In mathematical terms, we define the Industry Weighted Average ROIC in each year equal to the sum of the seven railroads' STB ROIC numerators divided by the sum of the seven railroads' STB ROIC denominators using the reported ROIC components in the STB Revenue Adequacy Determinations. For example, based on the STB 2018 Revenue Adequacy Determination, Appendix B, the 2018 Industry Weighted Average ROIC is 12.70% =  $(5,859,642 + 3,124,995 + 820,915 + 364,179 + 2,774,609 + 472,522 + 6,383,168) / (49,292,436 + 23,714,297 + 10,668,213 + 4,535,569 + 23,850,288 + 3,503,522 + 40,396,642)$ , where \$5,859,642, \$3,124,995, \$820,915, \$364,179, \$2,774,609, \$472,522, and \$6,383,168 refer to the 2018 Adjusted Net Railway Operating Income (in USD thousand) for BNSF Railway, CSX Corporation, Grand Trunk Corporation, Kansas City Southern, Norfolk Southern Corporation, Soo Line Corporation, and Union Pacific Corporation, respectively; and where \$49,292,436, \$23,714,297, \$10,668,213, \$4,535,569, \$23,850,288, \$3,503,522, and \$40,396,642 refer to the 2018 Tax Adjusted Net Investment Base (in USD thousand) for BNSF Railway, CSX Corporation, Grand Trunk Corporation, Kansas City Southern, Norfolk Southern Corporation, Soo Line Corporation, and Union Pacific Corporation, respectively.

<sup>100</sup> See, for example, Surface Transportation Board Decision, Railroad Cost of Capital – 2018, Docket No. EP 558 (Sub-No. 22), August 6, 2019 (“STB 2018 Cost of Capital Decision”). To estimate the railroad cost of capital, STB relies on inputs from the Association of American Railroads (“AAR”) who “calculated the cost of capital for a ‘composite railroad’ based on criteria developed in the Railroad Cost of Capital – 1984, 1 I.C.C.2d 989 (1985),” STB 2008 Cost of Capital Decision, p. 2.

A-11. The STB measures the Industry Cost of Debt based on individual railroads' cost of bonds and cost of equipment trust certificates ("ETCs").<sup>101</sup> The cost of bonds is the market value weighted average yield of the publicly traded bonds of all railroads. The cost of ETCs is the market value weighted average yield of the railroads ETCs.<sup>102</sup> In calculating the cost of bonds and cost of ETCs, the STB also considers the flotation cost<sup>103</sup> associated with the issuance of such securities and adds the flotation costs to the respective estimates of the costs of bonds and ETCs. The market value weighted average of cost of bonds and cost of ETC is the Industry Cost of Debt. The STB measures Debt Weight based on railroads' combined market values of debt, common equity, and preferred equity.

A-12. The STB measures the Cost of Preferred Equity as the market value weighted average of the dividend yields (dividend divided by market price of preferred stock) for the preferred stock of the individual railroads.<sup>104</sup> The STB measures the Preferred Equity Weight based on railroads' combined market values of debt, common equity, and preferred equity.

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<sup>101</sup> ETC is "a debt instrument that allows a company to take possession of and enjoy the use of an asset while paying for it over time. The debt issue is secured by the equipment or physical asset. During this time, the title for the equipment is held in trust for the holders of the issue." See, <https://www.investopedia.com/terms/e/equipmenttrustcertificate.asp>. In addition to the cost of bonds and cost of ETCs, the STB also considers the cost of (i) conditional sales agreements and (ii) capitalized leases and miscellaneous debt, however, these debt instruments either have minimal value or are not publicly traded, so they have insignificant effect on the Industry Cost of Debt calculations.

<sup>102</sup> ETCs are not actively traded on the secondary markets and their yield and market values are estimated by adding a spread to the yield of other securities that are actively traded such as government securities with similar maturity.

<sup>103</sup> "Flotation costs are incurred by a publicly traded company when it issues new securities, and includes expenses such as underwriting fees, legal fees and registration fees." See, <https://www.investopedia.com/terms/f/flotationcost.asp>. The calculation of flotation cost is based on the difference in yields between a new issue with flotation cost and an issues without flotation cost. For more details see, for example, STB 2018 Cost of Capital Decision, p. 6 and Table 7.

<sup>104</sup> See, for example, STB 2018 Cost of Capital Decision, p. 11 and Table 13.

A-13. The STB measures the Cost of Common Equity by equally weighting a Capital Asset Pricing Model-based (“CAPM”) and a Multi-Stage Discounted Cash Flow Model-based (“MSDCF”) equity cost of capital. The STB measures the Common Equity Weight based on railroads’ combined market values of debt, common equity, and preferred equity.

A-14. The CAPM has three inputs: beta, risk-free rate, and market risk premium. The STB measures an industry beta by regressing five years of merger-adjusted weekly returns of the portfolio of all publicly traded railroads over the weekly returns of the S&P 500 Index.<sup>105</sup> The STB measures the risk-free rate based on the average yield to maturity for a 20-year U.S. Treasury Bond.<sup>106</sup> The STB measures the market risk premium based on the Ibbotson/Duff & Phelps Cost of Capital Valuation Handbook.<sup>107</sup> The CAPM equity cost of capital for the railroad industry is calculated as the risk-free rate plus the industry beta times the market risk premium.

A-15. The STB measures the MSDCF equity cost of capital using accounting and market data for the publicly traded railroads and the following methodology. Step one – create a cash flow

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<sup>105</sup> See, for example, STB 2018 Cost of Capital Decision, p.8 and Table 9.

<sup>106</sup> See, for example, STB 2018 Cost of Capital Decision, p.7.

<sup>107</sup> See, for example, STB 2018 Cost of Capital Decision, pp. 7-8, “The Ibbotson SBBI Classic Yearbook, published by Morningstar, which was previously used as the source of the market risk premium for 2013 and 2014, has been discontinued. AAR replaced the former source with the Duff & Phelps’ Valuation Handbook—U.S. Guide to Cost of Capital, as the source of the market risk premium for 2015 and 2016. However, in 2018, Duff & Phelps discontinued the publication of that book in hardcover form and replaced it with an online tool called the Cost of Capital Navigator. According to AAR, the Cost of Capital Navigator uses the same method as Ibbotson and provides the same data reflecting the market-risk premium.”

forecast for each railroad using historical accounting data<sup>108</sup> and expected growth rates.<sup>109</sup> Step two – calculate each railroad’s discount rate by equating that railroad’s observed market value with the present value of its future cash flows from step one. Step three – calculate a market value weighted average of the discount rates determined in step two. The resulting estimate is the MSDCF equity cost of capital for the railroad industry.

A-16. Our data sources and measurement of the inputs for the cost of capital of the railroads are the same as those in the STB’s Cost of Capital Decisions.<sup>110</sup> Thus, our cost of capital estimates

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<sup>108</sup> See, for example, STB 2018 Cost of Capital Decision, pp. 9-10 and Table 11. The cash flow (“CF”) is defined as income before extraordinary items (“IBEI”), minus capital expenditures (“CAPEX”), plus depreciation (“DEP”) and deferred taxes (“DT”). That is,  $CF = IBEI - CAPEX + DEP + DT$ . The MSDCF model assumes three stages. Cash flows are projected using different growth rates in each stage, however, all cash flows are derived starting with a base cash flow (“Base CF”) in the current year. The Base CF is the product of the CF ratio and the revenue for the current year, i.e. year zero. The CF ratio is measured by the ratio of the last five years of historical CF divided by the last five years of historical revenue. The cash flow projections are constructed as follows. In the first stage, years 1 to 5, the cash flows are calculated using Base CF and stage-one growth rate (“g-rate\_1”). The estimated cash flows for years 1 to 5 are  $Base\ CF \cdot (1+g\text{-}rate\_1)$ ,  $Base\ CF \cdot (1+g\text{-}rate\_1)^2$ ,  $Base\ CF \cdot (1+g\text{-}rate\_1)^3$ ,  $Base\ CF \cdot (1+g\text{-}rate\_1)^4$ , and  $Base\ CF \cdot (1+g\text{-}rate\_1)^5$ , respectively. In the second stage, years 6 to 10, the cash flows are assumed to continue to grow at stage-two growth rate (“g-rate\_2”). The estimated cash flows for years 6 to 10 are  $Base\ CF \cdot (1+g\text{-}rate\_1)^5 \cdot (1+g\text{-}rate\_2)$ ,  $Base\ CF \cdot (1+g\text{-}rate\_1)^5 \cdot (1+g\text{-}rate\_2)^2$ ,  $Base\ CF \cdot (1+g\text{-}rate\_1)^5 \cdot (1+g\text{-}rate\_2)^3$ ,  $Base\ CF \cdot (1+g\text{-}rate\_1)^5 \cdot (1+g\text{-}rate\_2)^4$ , and  $Base\ CF \cdot (1+g\text{-}rate\_1)^5 \cdot (1+g\text{-}rate\_2)^5$ , respectively. Finally, in the third stage, years 11 and beyond, the cash flows are assumed to grow indefinitely at a constant rate (“g-rate\_3”). The cash flow for year 11 is  $Base\ CF \cdot (1+g\text{-}rate\_1)^5 \cdot (1+g\text{-}rate\_2)^5 \cdot (1+g\text{-}rate\_3)$ . The cash flow in year 11 is used to calculate the terminal value for each railroad.

<sup>109</sup> See, for example, STB 2018 Cost of Capital Decision, pp. 9-10 and Table 11. The MSDCF model assumes three stages with a different growth rate in each stage. The stage-one growth rate, g-rate\_1, is railroad-specific and is based on earnings per share (“EPS”) forecasts. G-rate\_1 is measured using the median of the long-term (three- to five-year) EPS growth rate forecasts published by the financial analysts following each publicly traded railroad. The source for g-rate\_1 is the Institutional Brokers Estimate System (“I/B/E/S”). The stage-two growth rate, g-rate\_2, is the same for all railroads and is calculated as the average of the individual stage-one growth rates. The stage-three growth rate, g-rate\_3, is estimated based on the sum of the long-run historical growth in real Gross Domestic Product (“GDP”) and the long-run expected inflation.

<sup>110</sup> STB 2006 Cost of Capital Decision, STB 2007 Cost of Capital Decision, STB 2008 Cost of Capital Decision, STB 2009 Cost of Capital Decision, STB 2010 Cost of Capital Decision, STB 2011 Cost of Capital Decision, STB 2012 Cost of Capital Decision, STB 2013 Cost of Capital Decision, STB 2014 Cost of Capital Decision, STB 2015 Cost of Capital Decision, STB 2016 Cost of Capital Decision, STB 2017 Cost of Capital Decision, and STB 2018 Cost of Capital Decision.

for the railroad industry are numerically identical to those reported by STB in all years from 2006 to 2019.<sup>111</sup>

A-17. We measure the industry cost of capital for the S&P 500 companies for each two-digit Standard Industry Classification (“SIC”) code.<sup>112</sup> The data source used to measure the industry cost of capital for the S&P 500 companies is Ibbotson/Duff & Phelps Cost of Capital yearbooks,<sup>113</sup> all of which are publicly available and widely used in such analyses and in peer reviewed academic studies.

A-18. The Industry Cost of Debt for the S&P 500 companies is measured using the cost of debt as reported in the Ibbotson/Duff & Phelps Cost of Capital yearbooks.<sup>114</sup> The Debt Weight is measured by the Debt to Total Capital ratio as reported in the Ibbotson/Duff & Phelps Cost of

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<sup>111</sup> 2019 STB Cost of Capital is used from 2019 Revenue Adequacy Workpapers, May 1, 2020 (document titled “AAR Duplication of STB Workpapers,” RevAd 2019 AAR workpaper1.pdf), which is based on the R1 submissions by the carriers and the AAR cost-of-capital submission.

<sup>112</sup> “The Standard Industrial Classification Codes that appear in a company’s disseminated EDGAR filings indicate the company’s type of business. These codes are also used in the Division of Corporation Finance as a basis for assigning review responsibility for the company’s filings.” U.S. Security and Exchange Commission website, accessed on November 16, 2019 at <https://www.sec.gov/info/edgar/siccodes.htm>.

<sup>113</sup> Ibbotson Cost of Capital 2006 Yearbook, Ibbotson Cost of Capital 2007 Yearbook, Ibbotson Cost of Capital 2008 Yearbook, Ibbotson Cost of Capital 2009 Yearbook, Ibbotson Cost of Capital 2010 Yearbook, Ibbotson Cost of Capital 2011 Yearbook, Ibbotson Cost of Capital 2012 Yearbook, Ibbotson Cost of Capital 2013 Yearbook, Duff & Phelps 2014 Valuation Handbook – U.S. Industry Cost of Capital, Duff & Phelps 2015 Valuation Handbook – U.S. Industry Cost of Capital, Duff & Phelps 2016 Valuation Handbook – U.S. Industry Cost of Capital, Duff & Phelps 2017 Valuation Handbook – U.S. Industry Cost of Capital, and Duff & Phelps 2018 Valuation Handbook – U.S. Industry Cost of Capital, Duff & Phelps Cost of Capital Navigator, U.S. Industry Benchmarking Module, [costofcapital.duffandphelps.com](http://costofcapital.duffandphelps.com), collectively (“Ibbotson/Duff & Phelps Cost of Capital”) yearbooks. The industry data in the cost of capital yearbooks are reported at different levels of aggregation for an industry (one-, two-, three-, and four-digit SIC code levels) and within that industry (median, SIC composite, large composite, and small composite). All inputs from the cost of capital yearbooks we use in our analyses are based on two-digit SIC code industry level and SIC composite data aggregation level.

<sup>114</sup> The Industry Cost of Debt was first published as a standalone reported item in 2011. For years 2006-2010, we calculate the Industry Cost of Debt in a year by adding the 2011 figure to the difference in the spread of a 10-year BBB corporate bond between 2011 and that year. For example, Ibbotson Cost of Capital 2011 Yearbook reports cost of debt of 4.63% for the two-digit SIC code 27. The average spread over the risk-free rate of a 10-year BBB corporate bond, as reported by Bloomberg, was 2.07% in 2011 and 3.27% in 2008. Thus, for 2008, we estimate the cost of debt for SIC code 27 at 5.83% (= 4.63% + 3.27% - 2.07%).

Capital yearbooks. Both the Industry Cost of Debt and Debt Weight are measured at the two-digit SIC code level.<sup>115</sup>

A-19. The Industry Cost of Common Equity for the S&P 500 companies is calculated by equally weighing the common equity cost estimates based on the CAPM and MSDCF methods<sup>116</sup> as reported in the Ibbotson/Duff & Phelps Cost of Capital yearbooks. We calculate the Common Equity Weight as one minus Debt Weight.<sup>117</sup> Both Industry Cost of Common Equity and Common Equity Weight are calculated at the two-digit SIC code level.<sup>118</sup>

A-20. As discussed earlier, the CAPM has three inputs: risk-free rate; market risk premium; and beta. The risk-free rate and the market risk premium are economy-wide estimates. The risk-free rate and the market risk premium for the S&P 500 companies are the annual figures reported in the STB Cost of Capital Decisions. Industry beta for the S&P 500 companies is the levered raw beta reported in the Ibbotson/Duff & Phelps Industry Cost of Capital books at the two-digit SIC code level.<sup>119</sup>

A-21. The MSDCF cost of equity for each company is the 3-Stage Discounted Cash Flow cost of equity reported in Ibbotson/Duff & Phelps Cost of Capital yearbooks at the two-digit SIC

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<sup>115</sup> We used the reported “SIC Composite” definition.

<sup>116</sup> Note that prior to 2008, STB calculated Cost of Common Equity based on CAPM alone. Respectively, for the two years prior to 2008 in my sample, 2006 and 2007, we used only CAPM to estimate the Cost of Common Equity.

<sup>117</sup> This calculation of the Common Equity Weights assumes that the companies in our sample finance their operations with debt and common equity only. In reality, companies use other equity securities, such as preferred equity. Thus, we effectively assume that costs of common and preferred equity are the same. We expect the impact of this assumption on our cost of capital calculations to be *de minimis* due to the usually small proportion of preferred equity to total capital. For example, over the last 13 years, STB determined that the preferred equity accounted for less than 0.005% of the publicly traded railroads’ total capital in 5 of the 13 years and zero % in the other 8 years.

<sup>118</sup> We used the reported “SIC Composite” definition.

<sup>119</sup> We use the reported “SIC Composite” definition.

code level.<sup>120</sup> The methodology of the 3-Stage Discounted Cash Flow Model<sup>121</sup> forms the foundation of STB's MSDCF Model.<sup>122</sup> Thus the 3-Stage Discounted Cash Flow cost of equity and the MSDCF cost of equity are calculated based on the same methodology.

A-22. The Industry Cost of Capital for the S&P 500 companies is equal to the weighted averages of the Industry Cost of Debt and Industry Cost of Equity. The data to measure the industry cost of capital is not available for all years for all two-digit SIC codes because these codes were not available in some of the Ibbotson/Duff & Phelps Cost of Capital yearbooks.<sup>123</sup> When the industry cost of capital was not available for a two-digit SIC code in a year, we estimate the cost of capital for that two-digit SIC code based on the average cost of capital across all two-digit SIC codes in that year.<sup>124</sup>

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<sup>120</sup> We use the reported "SIC Composite" definition.

<sup>121</sup> See, for example, Ibbotson Cost of Capital 2013 Yearbook, p. 13, "The three-stage model identifies three separate growth rates: a growth rate applicable to cash flows during the first five years of future performance, a growth rate applicable to cash flows over the sixth through tenth years, and a growth rate applicable to earnings for all future years following the first ten years... Cash flow is defined as income before extraordinary items plus depreciation less capital expenditures plus deferred taxes. Normal cash flows and income before extraordinary items are used because of the potential for anomalous years. 'Normal' cash flows and income before extraordinary items are estimated by multiplying the last five years average cash flow and earnings rates, both as a percent of sales, by the most recent year's sales... Earnings are used in place of cash flows in the third term, because over extended periods of time it is assumed that capital expenditures and depreciation will be equal... In those instances where companies in the composite do not have a Thomson Reuters earnings growth estimate, the industry average is substituted."

<sup>122</sup> See paragraph A-16 and the footnotes thereto.

<sup>123</sup> The methodology underlying the analyses in the yearbooks require a minimum of 5 companies per industry.

<sup>124</sup> More specifically, if the cost of capital is not available for a given two-digit SIC code in a year, we add the average cost of capital calculated across all two-digit SIC codes ("sample average") in that year to the mean deviation from the sample average across all other years in which there is a cost of capital figure available for the two-digit SIC code with missing cost of capital in the current year. The industry cost of capital was not available for any year for two-digit SIC code 99, Nonclassifiable Establishments. For industries with SIC code 99, we use the sample average cost of capital. The issue of missing industry cost of capital affects less than 3% of our sample.

## **APPENDIX B**

### **RAILROAD'S FINANCIAL PERFORMANCE BASED ON STB DEFINITIONS OF RETURN ON INVESTED CAPITAL (STB ROIC) AND COST OF CAPITAL (STB COC)**

#### **(STB ROIC MINUS STB COC, 2006 – 2019)**

B-1. In Appendix B, we present the STB data for the seven railroads overseen by Board and the Industry Weighted Average over the 2006 - 2019 period; specifically, we present the STB's railroad industry cost of capital, the STB's financial performance metric used in its Annual Revenue Adequacy Determinations (ROIC minus COC), and our alternative measure of financial performance (Adjusted ROIC minus COC).

B-2. In Panel A of Exhibit B1, we present the STB's railroad cost of capital over this period. The range of the STB's railroad cost of capital over this period is from 8.9% to 12.2%. The median cost of capital over this period is 10.8% (average 10.7%).

B-3. In Panel B of Exhibit B1, we present ROIC minus COC for the Industry Weighted Average and for the seven railroads. The range of the ROIC minus COC over this period for the industry is from -2.5% to 3.1%, and the median ROIC minus COC over this period for the industry is 0.7% (average 0.7%). The ROIC minus COC for the seven railroads varies across years and across the railroads in any one year. The median ROIC minus COC over this period across the seven railroads varies from -2.6% to 3.6% and the average varies from -2.5% to 2.4%.

B-4. In Panel C of Exhibit B1, we present Adjusted ROIC minus COC for the Industry Weighted Average and for the seven railroads. The range of the Adjusted ROIC minus COC over this period for the industry is from -3.5% to 1.4%, and the median Adjusted ROIC minus COC over this period for the industry is -1.2% (average -1.3%). The Adjusted ROIC minus COC for the seven railroads also varies across years and across the railroads in any one year.

The median Adjusted ROIC minus COC over this period across the seven railroads varies from -3.0% to 0.3% and the average varies from -3.1% to 0.1%.

## **APPENDIX C**

### **RAILROAD'S (ROIC MINUS COC) PERCENTILES WITHIN S&P 500 SAMPLES**

#### **(RAILROADS' RETURN ON INVESTED CAPITAL AND COST OF CAPITAL MEASURED USING NON-STB PUBLIC DATA)**

C-1. In Appendix C, we present the Industry Weighted Average and each railroad's ROIC minus COC percentile within the distribution of all companies in three benchmarking samples: (a) S&P 500 excluding railroads, financial institutions, and real estate companies ("S&P 500" benchmarking group)); (b) S&P 500 Industrials Sector excluding railroads (industry sector to which railroads belong, "S&P 500 Industrials Sector" benchmarking group); and (c) customers (shippers) of CN, NS, and/or UP in the S&P 500 that accounted for at least \$1.0 million of combined revenues to those railroads during the last year ("S&P 500 Railroad Customers" benchmarking group).

C-2. The analyses we present in Appendix C, Exhibits C1 and C2 are the same as those in Exhibits 1 and 2 except the inputs for the ROIC and cost of capital for the railroads are based on the Compustat data (and not the STB data). That is, we use the same Compustat data for both the railroads and the companies in the S&P 500 benchmarking samples. The percentile numbers of only four (out of seven) railroad companies are presented because only four of the seven railroad companies are publicly traded and, thus, have Compustat financial data.<sup>125</sup> The results for the railroads reported in Exhibits 1 and 2 differ from the results reported in Appendix C, Exhibits C1 and C2 due to differences in data sources. The Compustat data used for the calculation of ROIC are for the consolidated company rather than the U.S. railroad operations

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<sup>125</sup> The four companies are: CSX Corporation, Kansas City Southern, Norfolk Southern Corporation, and Union Pacific Corporation.

only as in the STB filings. The costs of capital also differ because of differences in the STB and the non-STB publicly available databases.<sup>126</sup>

C-3. The results in Exhibit C1 are analogous to the results presented in Exhibit 1. The top section of each panel presents the descriptive statistics about the S&P 500 benchmarking group and the bottom section of each panel presents the railroads' percentile within the distribution of all companies in that benchmarking group; however, as stated above, the inputs for measuring ROIC and the cost of capital for the railroads are based on the Compustat (not STB) data that is also used for the companies in the S&P 500 benchmarking groups.

C-4. Panel A of Exhibit C1 presents the railroads' percentile in the distribution of ROIC minus COC of the S&P 500 benchmarking group. The range of the ROIC minus COC percentile over this period for the industry is from 12<sup>th</sup> to 27<sup>th</sup>, and the median ROIC minus COC percentile over this period for the industry is 19<sup>th</sup> (average 20<sup>th</sup>). The ROIC minus COC percentile for the four publicly traded railroads varies across years and across the railroads in any one year. The median ROIC minus COC percentile over this period across the four railroads varies from 11<sup>th</sup> to 24<sup>th</sup> and the average varies from 11<sup>th</sup> to 21<sup>st</sup>.

C-5. Panel B of Exhibit C1 presents the railroads' percentile in the distribution of ROIC minus COC of the S&P 500 Industrials Sector benchmarking group. The range of the ROIC minus COC percentile over this period for the industry is from 4<sup>th</sup> to 17<sup>th</sup>, and the median ROIC minus COC percentile over this period for the industry is 10<sup>th</sup> (average 10<sup>th</sup>). The ROIC minus COC percentile for the four publicly traded railroads varies across years and across the railroads in any

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<sup>126</sup> One such example is difference in beta, an input for calculating the CAPM equity cost of capital.

one year. The median ROIC minus COC percentile over this period across the four railroads varies from 5<sup>th</sup> to 10<sup>th</sup> and the average varies from 6<sup>th</sup> to 10<sup>th</sup>.

C-6. Panel C of Exhibit C1 presents the railroads' percentile in the distribution of ROIC minus COC of the S&P 500 Railroad Customers benchmarking group. The range of the ROIC minus COC percentile over this period for the industry is from 17<sup>th</sup> to 44<sup>th</sup>, and the median ROIC minus COC percentile over this period for the industry is 31<sup>st</sup> (average 31<sup>st</sup>). The ROIC minus COC percentile for the seven railroads varies across years and across the railroads in any one year. The median ROIC minus COC percentile over this period across the seven railroads varies from 17<sup>th</sup> to 37<sup>th</sup> and the average varies from 18<sup>th</sup> to 32<sup>nd</sup>. In sum, the results shown in Exhibit C1 are qualitatively similar to the results shown in Exhibit 1.

C-7. The results in Exhibit C2 are analogous to the results presented in Exhibit C1, however, the results in Exhibit C2 are for the Adjusted ROIC minus COC whereby the results in Exhibit C1 are for the ROIC minus COC. The top section of each panel in Exhibit C2 presents the descriptive statistics about the S&P 500 benchmarking group and the bottom section of each panel in Exhibit C2 presents the railroads' percentile within the distribution of all companies in that benchmarking group. As stated previously, the inputs for measuring Adjusted ROIC and the cost of capital for the railroads are based on the Compustat (not STB) data that is also used for the companies in the S&P 500 benchmarking groups.

C-8. Panel A of Exhibit C2 presents the railroads' percentile in the distribution of ROIC minus COC of the S&P 500 benchmarking group. The range of the ROIC minus COC percentile over this period for the industry is from 11<sup>th</sup> to 30<sup>th</sup>, and the median ROIC minus COC percentile over this period for the industry is 18<sup>st</sup> (average 19<sup>th</sup>). The ROIC minus COC percentile for the four

publicly traded railroads varies across years and across the railroads in any one year. The median ROIC minus COC percentile over this period across the four railroads varies from 15<sup>th</sup> to 20<sup>th</sup> and the average varies from 15<sup>th</sup> to 22<sup>nd</sup>.

C-9. Panel B of Exhibit C2 presents the railroads' percentile in the distribution of ROIC minus COC of the sample of S&P 500 Industrials Sector companies. The range of the ROIC minus COC percentile over this period for the industry is from 5<sup>th</sup> to 18<sup>th</sup>, and the median ROIC minus COC percentile over this period for the industry is 9<sup>th</sup> (average 9<sup>th</sup>). The ROIC minus COC percentile for the four publicly traded railroads varies across years and across the railroads in any one year. The median ROIC minus COC percentile over this period across the four railroads varies from 7<sup>th</sup> to 11<sup>th</sup> and the average varies from 7<sup>th</sup> to 11<sup>th</sup>.

C-10. Panel C of Exhibit C2 presents the railroads' percentile in the distribution of ROIC minus COC of the sample customers of CN, NS, and UP in the S&P 500. The range of the ROIC minus COC percentile over this period for the industry is from 12<sup>th</sup> to 45<sup>th</sup>, and the median ROIC minus COC percentile over this period for the industry is 26<sup>th</sup> (average 27<sup>th</sup>). The ROIC minus COC percentile for the four publicly traded railroads varies across years and across the railroads in any one year. The median ROIC minus COC percentile over this period across the four railroads varies from 20<sup>th</sup> to 32<sup>nd</sup> and the average varies from 21<sup>st</sup> to 33<sup>rd</sup>. In sum, the results shown in Exhibit C2 are qualitatively similar to the results shown in Exhibit 2.

C-11. Overall, while the results shown in Appendix C, Exhibits C1 and C2 are naturally not identical to the results shown in Exhibits 1 and 2, on the balance, they are qualitatively similar.

Curriculum Vitae  
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# *Curriculum Vitae*

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1988 – 1989: Associate Professor of Business Economics and Industrial Relations, The University of Chicago

1986 – 1988: Assistant Professor of Business Economics and Industrial Relations, The University of Chicago

1983 – 1986: Lecturer, Booth School of Business, The University of Chicago

1982 – 1983: Teaching Associate, Department of Economics, The University of Chicago

1979 – 1981: Research Assistant, Unicon Research Corporation, Santa Monica, California

### **Honors and Awards**

2008: John von Neumann Lecture Award, Rajk College, Corvinus University, Budapest

2007: Kenneth J. Arrow Award (with Robert H. Topel)

October 2005: Garfield Research Prize (with Robert H. Topel)

September 2005: MacArthur Foundation Fellow

1998: Elected to the American Academy of Arts & Sciences

1997: John Bates Clark Medalist

1993: Fellow of The Econometric Society

1989 – 1991: Sloan Foundation Fellowship, The University of Chicago

1983 – 1984: Earhart Foundation Fellowship, The University of Chicago

1981 – 1983: Fellowship, Friedman Fund, The University of Chicago

1980 – 1981: Phi Beta Kappa, University of California, Los Angeles

1980 – 1981: Earhart Foundation Fellowship, University of California, Los Angeles

1979 – 1981: Department Scholar, Department of Economics, University of California, Los Angeles

### **Publications**

#### **Books**

Social Economics: Market Behavior in a Social Environment with Gary S. Becker, Cambridge, MA: Harvard University Press (2000).

Measuring the Gains from Medical Research: An Economic Approach, edited volume with Robert H. Topel, Chicago: The University of Chicago Press (2003).

Chicago Price Theory, by Sonia Jaffe, Robert Minton, Casey B. Mulligan, and Kevin M. Murphy, Princeton University Press (2019).

## Chapters in Books

“Income and Wealth in America,” with Emmanuel Saez, in Inequality and Economic Policy, ed. Tom Church, Christopher Miller, John B. Taylor, Stanford, CA: Hoover Press (2015)

## Articles

“Government Regulation of Cigarette Health Information,” with Benjamin Klein and Lynne Schneider, 24 *Journal of Law and Economics* 575 (1981).

“Estimation and Inference in Two-Step Econometric Models,” with Robert H. Topel, 3 *Journal of Business and Economic Statistics* 370 (1985).

“Unemployment, Risk, and Earnings: Testing for Equalizing Wage Differences in the Labor Market,” with Robert H. Topel, in Unemployment and the Structure of Labor Markets, pp. 103-139, ed. Kevin Lang and Jonathan S. Leonard. London: Basil Blackwell (1987).

“The Evolution of Unemployment in the United States: 1968-1985,” with Robert H. Topel, in NBER Macroeconomics Annual, pp. 11-58, ed. Stanley Fischer. Cambridge, MA: MIT Press (1987).

“Cohort Size and Earnings in the United States,” with Mark Plant and Finis Welch, in Economics of Changing Age Distributions in Developed Countries, pp. 39-58, ed. Ronald D. Lee, W. Brian Arthur, and Gerry Rodgers. Oxford: Clarendon Press (1988).

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“A Theory of Rational Addiction,” with Gary S. Becker, 96 *Journal of Political Economy* 675 (1988).

“Vertical Restraints and Contract Enforcement,” with Benjamin Klein, 31 *Journal of Law and Economics* 265 (1988).

“Income Distribution, Market Size, and Industrialization,” with Andrei Shleifer and Robert W. Vishny, 104 *Quarterly Journal of Economics* 537 (1989).

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“Industrialization and the Big Push,” with Andrei Shleifer and Robert W. Vishny, 97 *Journal of Political Economy* 1003 (1989).

“Building Blocks of Market Clearing Business Cycle Models,” with Andrei Shleifer and Robert W. Vishny, in NBER Macroeconomic Annual, pp. 247-87, ed. Olivier Jean Blanchard and Stanley Fischer. Cambridge, MA: MIT Press (1989).

“Efficiency Wages Reconsidered: Theory and Evidence,” with Robert H. Topel, in Advances in the Theory and Measurement of Unemployment, pp. 204-240. ed. Yoram Weiss and Gideon Fishelson. London: Macmillan (1990).

“Empirical Age-Earnings Profiles,” with Finis Welch, 8 *Journal of Labor Economics* 202 (1990).

“Human Capital, Fertility, and Economic Growth,” with Gary S. Becker and Robert F. Tamura, 98 *Journal of Political Economy*, S12 (1990).

“Accounting for the Slowdown in Black-White Wage Convergence,” with Chinhui Juhn and Brooks Pierce, in Workers and Their Wages: Changing Patterns in the United States, pp. 107-143, ed. Marvin Kesters. Washington, D.C.: American Enterprise Institute (1991).

“The Role of International Trade in Wage Differentials,” with Finis Welch, in Workers and Their Wages: Changing Patterns in the United States, pp. 39- 69, ed. Marvin Kesters. Washington, D.C.: American Enterprise Institute (1991).

“Why Has the Natural Rate of Unemployment Increased over Time?” with Robert H. Topel and Chinhui Juhn, 2 *Brookings Papers on Economic Activity* 75 (1991).

“The Allocation of Talent: Implications for Growth,” with Andrei Shleifer and Robert W. Vishny, 106 *Quarterly Journal of Economics* 503 (1991).

“Rational Addiction and the Effect of Price on Consumption,” with Gary S. Becker and Michael Grossman, 81 *American Economic Review* 237 (1991).

“Wages of College Graduates,” in The Economics of American Higher Education, pp. 121-40, ed. William E. Becker and Darrell R. Lewis. Boston: Kluwer Academic Publishers (1992).

“Changes in Relative Wages, 1963-1987: Supply and Demand Factors,” with Lawrence F. Katz, 107 *Quarterly Journal of Economics* 35 (1992).

“The Structure of Wages,” with Finis Welch, 107 *Quarterly Journal of Economics* 285 (1992).

“The Transition to a Market Economy: Pitfalls of Partial Planning Reform,” with Andrei Shleifer and Robert W. Vishny, 107 *Quarterly Journal of Economics* 889 (1992).

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“Inequality and Relative Wages,” with Finis Welch, 83 *American Economic Review* 104 (1993).

“Why Is Rent-Seeking So Costly to Growth?” with Andrei Shleifer and Robert W. Vishny, 83 *American Economic Review* 409 (1993).

“A Simple Theory of Advertising as a Good or Bad,” with Gary S. Becker, 108 *Quarterly Journal of Economics* 941 (1993).

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“Inequality in Labor Market Outcomes: Contrasting the 1980s and Earlier Decades,” with Chinhui Juhn, 1 *Economic Policy Review* 26 (1995).

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“Wage Inequality and Family Labor Supply,” with Chinhui Juhn, 15 *Journal of Labor Economics* 72 (1997).

“Quality and Trade,” with Andrei Shleifer, 53 *Journal of Development Economics* 1 (1997).

“Vertical Integration as a Self-Enforcing Contractual Arrangement,” with Benjamin Klein, 87 *American Economic Review* 415 (1997).

“Unemployment and Nonemployment,” with Robert H. Topel, 87 *American Economic Review* 295 (1997).

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“Wage Differentials in the 1990s: Is the Glass Half Full or Half Empty?” with Finis Welch, in The Causes and Consequences of Increasing Inequality, pp. 341-64, ed. Finis Welch. Volume II in the Bush School Series in the Economics of Public Policy. Chicago: The University of Chicago Press (2001).

“Economic Perspectives on Software Design: PC Operating Systems and Platforms,” with Steven J. Davis and Jack MacCracken, in Microsoft, Antitrust, and the New Economy: Selected Essays, pp. 361-420, ed. Davis S. Evans. Boston, MA: Kluwer (2001).

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“The Economics of Copyright ‘Fair Use’ in A Networked World,” with Andres Lerner and Benjamin Klein, 92 *American Economic Review* 205 (2002).

“The Economic Value of Medical Research,” with Robert H. Topel, in Measuring the Gains from Medical Research: An Economic Approach, pp. 41-73, ed. Robert H. Topel and Kevin M. Murphy. Chicago: The University of Chicago Press (2003).

“School Performance and the Youth Labor Market,” with Sam Peltzman, 22 *Journal of Labor Economics* 299 (2003).

“Entrepreneurial ability and market selection in an infant industry: evidence from the Japanese cotton spinning industry,” with Atsushi Ohyama and Serguey Braguinsky, 7 *Review of Economic Dynamics* 354 (2004).

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“Diminishing Returns: The Costs and Benefits of Increased Longevity,” with Robert H. Topel, 46 *Perspectives in Biology and Medicine* S108 (2004).

“Persuasion in Politics,” with Andrei Shleifer, 94 *American Economic Review* 435 (May 2004).

“Black-White Differences in the Economic Value of Improving Health,” with Robert H. Topel, 48 *Perspectives in Biology and Medicine* S176 (2005).

“The Equilibrium Distribution of Income and the Market for Status,” with Gary S. Becker and Iván Werning, 113 *Journal of Political Economy* 282 (2005).

“The Market for Illegal Goods: The Case of Drugs,” with Gary S. Becker and Michael Grossman, 114 *Journal of Political Economy* 38 (2006).

“Competition in Two-Sided Markets: The Antitrust Economics of Payment Card Interchange Fees,” with Benjamin Klein, Kevin Green, and Lacey Place, 73 *Antitrust Law Journal* 571 (2006).

“The Value of Health and Longevity,” with Robert H. Topel, 114 *Journal of Political Economy* 871 (2006).

“Social Value and the Speed of Innovation,” with Robert H. Topel, 97 *American Economic Review* 433 (2007).

“Education and Consumption: The Effects of Education in the Household Compared to the Marketplace,” with Gary S. Becker, 1 *The Journal of Human Capital* 9 (Winter 2007).

“Why Does Human Capital Need a Journal?” with Isaac Ehrlich, 1 *The Journal of Human Capital* 1 (Winter 2007).

“Critical Loss Analysis in the Whole Foods Case,” with Robert H. Topel, 3 (2) *GCP Magazine* (March 2008).

“Exclusive Dealing Intensifies Competition for Distribution,” with Benjamin Klein, 75 *Antitrust Law Journal* (October 2008).

“Fertility Decline, the Baby Boom and Economic Growth,” with Curtis Simon and Robert Tamura, 2 *The Journal of Human Capital* 3 (Fall 2008).

“The Market for College Graduates and the Worldwide Boom in Higher Education of Women,” with Gary S. Becker and William H. J. Hubbard, 100 *American Economic Review: Papers & Proceedings* 229 (May 2010).

“Explaining the Worldwide Boom in Higher Education of Women,” with Gary S. Becker and William H. J. Hubbard, 4 *Journal of Human Capital* No. 3 (2010).

“How Exclusivity is Used to Intensify Competition for Distribution-Reply to Zenger,” with Benjamin Klein, 77 *Antitrust Law Journal* No. 2 (2011).

“Achieving Maximum Long-Run Growth,” *Federal Reserve Bank of Kansas City Proceedings of the Annual Jackson Hole Conference 2011*.

“On the Economics of Climate Policy,” with Gary S. Becker and Robert H. Topel, 10 *B.E. Journal of Economic Analysis and Policy* No. 2 (2011).

“Measuring Crack Cocaine and its Impact,” with Roland G. Fryer, Jr., Paul S. Heaton, and Steven D. Levitt, 51 *Economic Inquiry* No. 3 (July 2013).

“Some Basic Economics of National Security,” with Robert H. Topel, 103 *American Economic Review* No. 3 (2013).

“Activating *Actavis*: A More Complete Story,” with Barry C. Harris, Robert D. Willig, and Matthew B. Wright, 28 *Antitrust* No. 2 (Spring 2014).

“Competitive Discounts and Antitrust Policy,” with Edward A. Snyder and Robert H. Topel, Chapter 5 of *The Oxford Handbook of International Antitrust Economics*, Volume 2 (2014).

“Gary Becker as Teacher,” 105 *American Economic Review* No. 5 (2015).

“Black and White Fertility, Differential Baby Booms: The Value of Equal Education Opportunity,” with Robert Tamura and Curtis Simon, 82 *Journal of Demographic Economics*, Issue 1 (2016).

“Human Capital Investment, Inequality, and Economic Growth,” with Robert H. Topel, 34 *Journal of Labor Economics*, No. S2/Part 2 (2016).

“A Theory of Intergenerational Mobility,” with Gary S. Becker, Scott Duke Kominers, and Jörg L. Spenkuch, *Journal of Political Economy* 126, no. S1 (October 2018): S7-S25.

“Gary Becker Remembered,” with James J. Heckman and Edward P. Lazear, *Journal of Political Economy* 126, no. S1 (October 2018): S1-S6.

Sample of “The Power of the Economic Approach: Unpublished Manuscripts of Gary S. Becker,” Edited by Julio J. Elías, Casey B. Mulligan, and Kevin M. Murphy, University of Chicago Press (Forthcoming). *Journal of Human Capital* 2019 13:2, 140-141.

## Selected Working Papers

“Gauging the Economic Impact of September 11<sup>th</sup>,” with Gary S. Becker, Unpublished Working Paper (October 2001).

“War In Iraq Versus Containment: Weighing the Costs,” with Steven J. Davis and Robert H. Topel, NBER Working Paper No.12092 (March 2006).

“The Interaction of Growth in Population and Income,” with Gary S. Becker, Unpublished Working Paper (2006).

“Persuasion and Indoctrination,” with Gary Becker (2007).

“The Value of Life Near Its End and Terminal Care,” with Gary S. Becker and Tomas Philipson (2007).

“On the Economics of Climate Policy,” with Gary S. Becker and Robert H. Topel, Working Paper No. 234 (January 2010, Revised September 2010).

“The Manipulation of Children’s Preferences, Old Age Support, and Investment in Children’s Human Capital,” with Gary S. Becker and Jörg L. Spenkuch, Unpublished Working Paper (February 2012).

“The Collective Licensing of Music Performance Rights: Market Power, Competition and Direct Licensing” (March 2013).

“Activating *Actavis* with A More Complete Model,” with Michael G. Baumann, John P. Bigelow, Barry C. Harris, Janusz A. Ordoover, Robert D. Willig, and Matthew B. Wright, (January 2014).

“A Theory of Bundling Advertisements in Media Markets,” with Ignacio Palacios-Huerta, NBER Working Paper No. 229994 (December 2016).

## Selected Comments

Comment on “Causes of Changing Earnings Equality” by Robert Z. Lawrence. Federal Reserve Bank of Kansas City (1998).

“Comment: Asking the Right Questions in the Medicare Reform Debate,” Medicare Reform: Issues and Answers, pp. 175-81, ed. Andrew J. Rettenmaier and Thomas R. Saving. Chicago: The University of Chicago Press (2000).

Comment on “Social Security and Demographic Uncertainty” by Henning Bohn, in Risk Aspects of Investment-Based Social Security Reform, ed. John Y. Campbell and Martin Feldstein. Chicago: The University of Chicago Press (2001).

Comment on “High Technology Industries and Market Structure” by Hal R. Varian.  
Federal Reserve Bank of Kansas City (2001).

### Popular Press Articles

“The Education Gap Rap,” *The American Enterprise* (March-April 1990), pp. 62.

“Rethinking Antitrust,” with Gary S. Becker, *Wall Street Journal* (February 26, 2001), A22.

“Prosperity Will Rise Out of the Ashes,” with Gary S. Becker, *Wall Street Journal* (October 29, 2001), A22.

“The Economics of NFL Team Ownership,” with Robert H. Topel, report prepared at the request of the National Football League Players’ Association (January 2009).

### Articles About Murphy

“Higher Learning Clearly Means Higher Earning,” by Carol Kleiman. *Chicago Tribune*, March 12, 1989, Jobs Section pp. 1. Long article about “The Structure of Wages” with picture of Murphy.

“Why the Middle Class Is Anxious,” by Louis S. Richman. *Fortune*, May 21, 1990, pp. 106. Extensive reference to Murphy's work on returns to education.

“Unequal Pay Widespread in U.S.,” by Louis Uchitelle, *New York Times*, August 14, 1990, Business Day section pp. 1. Long piece on income inequality.

“One Study’s Rags to Riches Is Another’s Rut of Poverty,” by Sylvia Nasar, *New York Times*, June 17, 1992, Business Section pp. 1. Long piece on the income inequality research.

“Nobels Pile Up for Chicago, but Is the Glory Gone?” by Sylvia Nasar, *New York Times* November 4, 1993, Business Section pp. 1. Long piece on Chicago School of economics. Featured a photo of five of the “brightest stars on the economics faculty” (including Murphy) and a paragraph about Murphy’s research.

“This Sin Tax is Win-Win,” by Christopher Farrell. *Business Week*, April 11, 1994, pp. 30. Commentary section refers to Murphy, Becker, and Grossman’s work on rational addiction.

“Growing inequality and the economics of fragmentation,” by David Warsh, *Boston Sunday Globe*, August 21, 1994, pp. A1. Two-page article with picture and biographical details about Murphy and his research; part of a series about “how the new generation replaced the old in economics.”

“A Pay Raise’s Impact,” by Louis Uchitelle. *New York Times*, January 12, 1995, Business Section pp. 1. Article about consequences of proposed increase in the minimum wage. Articles featuring Murphy's comments on the minimum wage appeared in numerous

other publications, including the *Chicago Tribune*; in addition, Murphy was interviewed on CNN (January 26, 1995).

“The Undereducated American,” *Wall Street Journal*, August 19, 1996, A12. Changes in the rate of returns to education.

“In Honor of Kevin M. Murphy: Winner of the John Bates Clark Medal,” by Finis Welch, 14 *Journal of Economic Perspectives* 193 (2000).

### **Testimony, Reports, and Depositions (Last 4 Years)**

Deposition of Kevin M. Murphy, January 5, 2016, in the Matter of ABS Global, Inc. v. Inguran, LLC d/b/a Sexing Technologies and XY, LLC v Genus PLC, The United States District Court for the Western District of Wisconsin. Case No. 14-cv-503.

Supplemental Expert Report of Kevin M. Murphy, January 13, 2016, in the Matter of The Dial Corporation, Henkel Consumer Goods, Inc., H.J. Heinz Company, H.J. Heinz Company, L.P., Foster Poultry Farms, Smithfield Foods, Inc., HP Hood LLC, BEF Foods, Inc. and Spectrum Brands, Inc. v. News Corporation, News America Inc., News America Marketing FSI L.L.C., News America Marketing In-Store Services L.L.C., The United States District Court for the Southern District of New York. Case No. 13-cv-06802 (WHP).

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Expert Report of Kevin M. Murphy, February 5, 2016, in the Matter of Moldex Metric, Inc. v. 3M Company and 3M Innovative Properties Company, The United States District Court for the District of Minnesota. Case No. 2014-cv-01821 (JNE/FLN).

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Verified Statement of Kevin M. Murphy, March 7, 2016, Exhibit II-B-2 to CSXT Reply Evidence, In Re: STB Docket No. NOR 42142.

Expert Report of Kevin M. Murphy, March 8, 2016, in the Matter of ABS Global, Inc. v. Inguran, LLC d/b/a Sexing Technologies and XY, LLC v Genus PLC, The United States District Court for the Western District of Wisconsin. Case No. 14-cv-503.

Expert Report of Kevin M. Murphy, March 9, 2016, in the Matter of Lisa Watson, Wayne Miner, and James Easley, Individually and on Behalf of All Others Similarly Situated v. Philip Morris Companies, Inc. a corporation, and Philip Morris Incorporated, a corporation, in the Circuit Court of Pulaski County, Arkansas. Case No. CV03-4661.

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Verified Statement of Kevin M. Murphy, July 26, 2016, In Re: STB Docket No. 704 (Sub-No. 1), Review of Commodity, Boxcar, and TOFC/COFC Exemptions.

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Expert Report of Kevin M. Murphy, September 23, 2016, in the Matter of First Impressions Salon, Inc., Roy Mattson, Belle Foods Trust, Bankruptcy Estate of Yarnell's Ice Cream Company, Inc., Piggly Wiggly Midwest LLC and KPH Healthcare Services, Inc., aka Kinney Drugs, Inc. et.al. v. National Milk Producers Federation, Cooperatives Working Together, Dairy Farmers of America, Inc., Land O'Lakes, Inc., Dairy Lea Cooperative Inc., Agri-Mark, Inc. d/b/a Cabot Creamery Cooperative, Inc., The United States District Court for the Southern District of Illinois. Case No. 3:13-cv-00454-NJR-SCW.

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Expert Report of Kevin M. Murphy, November 21, 2016, in the Matter of Valassis Communications, Inc. v. News America Inc., a/k/a News America Marketing Group, News America Marketing FSI, Inc., a/k/a News America Marketing FSI LLC, and News America Marketing In-Store Services, Inc. a/k/a News America Marketing In-Store Services, LLC, The United States District Court for the Eastern District of Michigan, Southern Division. Case No. 2-06-cv-10240-AJT-MJH.

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Expert Report of Kevin M. Murphy, April 3, 2017, in the Matter of Optical Disc Drive Products Litigation (Hewlett-Packard Company v. Toshiba Corporation, et al.), The United States District Court for the Northern District of California, San Francisco Division. MDL No. 2143, No. 3:13-cv-05370 RS.

Expert Report of Kevin M. Murphy, April 3, 2017, in the Matter of Optical Disc Drive Products Litigation (Ingram Micro Inc., et al. v. LG Electronics, Inc., et al.), The United States District Court for the Northern District of California, San Francisco Division. No. 3:10-md-2143 RS.

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Expert Report of Kevin M. Murphy, August 25, 2017, in the Matter of Gene R. Romero, et al. v. Allstate Insurance, et al., The United States District Court for the Eastern District of Pennsylvania. Case No. 01-3894 (consolidated with other matters) (E.D. Pa.).

Expert Rebuttal Report of Kevin M. Murphy, September 18, 2017, in the Matter of Gene R. Romero, et al. v. Allstate Insurance, et al., The United States District Court for the Eastern District of Pennsylvania. Case No. 01-3894 (consolidated with other matters) (E.D. Pa.).

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Marketing In-Store Services L.L.C., a/k/a News America Marketing In-Store Services, Inc., The United States District Court for the Southern District of New York. Case No. 1:17-cv-07378-PKC.

Deposition of Kevin M. Murphy, January 17, 2018, in the Matter of Valassis Communications, Inc. v. News Corporation, News America Marketing, a/k/a News America Incorporated, a/k/a News America Marketing Group, a/k/a News America Marketing FSI L.L.C., a/k/a News America Marketing FSI, Inc.; and News America Marketing In-Store Services L.L.C., a/k/a News America Marketing In-Store Services, Inc., The United States District Court for the Southern District of New York. Case No. 1:17-cv-07378-PKC.

Verified Statement of Kevin M. Murphy, January 19, 2018, In Re Biogen '755 Patent Litigation, The United States District Court for the District of New Jersey. Civil Action No. 10-2734 (CCC/JAD).

Trial Testimony of Kevin M. Murphy, February 1, 2018, In Re Biogen '755 Patent Litigation, The United States District Court for the District of New Jersey. Civil Action No. 10-cv-2734 (CCC/JBC).

Expert Report and Testimony of Kevin M. Murphy, February 28, 2018 in the Matter of Washington Metropolitan Area Transit Authority and Amalgamated Transit Union Local 689, Interest Arbitration Under Sections 66(C) Of the WMATA Compact, The United States District Court for the District of Columbia.

Expert Report of Kevin M. Murphy, June 29, 2018, in the Matter of Gene R. Romero, et al. v. Allstate Insurance, et al., The United States District Court for the Eastern District of Pennsylvania. Case No. 01-3894 (consolidated with other matters) (E.D. Pa.).

Expert Report of Kevin M. Murphy, July 30, 2018, in the Matter of Daniel Gordon, et al. v. Amadeus IT Group, S.A. et al. The United States District Court for the Southern District of New York. Civ. A. No. 1:15-cv-05457-KPF.

Declaration of Kevin M. Murphy, August 16, 2018, in the Matter of Genentech, Inc., Biogen, Inc., Hoffmann-La Roche Inc., and City of Hope v. Celltrion, Inc., Celltrion Healthcare Co., Ltd., Teva Pharmaceuticals USA, Inc., and Teva Pharmaceuticals International GmbH, The United States District Court for the District of New Jersey. Civ. A. No. 18-cv-00574 (RMB) (KMW).

Expert Report of Kevin M. Murphy, September 21, 2018, in the Matter of Certain Memory Modules and Components Thereof, International Trade Commission, Washington, DC 20436. No. 337-TA-1089.

Reply Declaration of Kevin M. Murphy, September 26, 2018, in the Matter of Genentech, Inc., Biogen, Inc., Hoffmann-La Roche Inc., and City of Hope v. Celltrion, Inc., Celltrion Healthcare Co., Ltd., Teva Pharmaceuticals USA, Inc., and Teva Pharmaceuticals International GmbH, The United States District Court for the District of New Jersey. Civ. A. No. 18-cv-00574 (RMB) (KMW).

Expert Rebuttal Report of Kevin M. Murphy, October 9, 2018, in the Matter of Certain Memory Modules and Components Thereof, International Trade Commission, Washington, DC 20436. No. 337-TA-1089.

Deposition of Kevin M. Murphy, October 29, 2018, in the Matter of Certain Memory Modules and Components Thereof, International Trade Commission, Washington, DC 20436. No. 337-TA-1089.

Confidential Submission to the U.S. Department of Justice, Economic Considerations for Modification and Termination of the ASCAP Consent Decree, October 30, 2018.

Expert Report of Kevin M. Murphy, March 1, 2019, in the Matter of First Impressions Salon, Inc., Roy Mattson, KPH Healthcare Services, Inc., d/b/a Kinney Drugs, Inc. and Piggly Wiggly Midwest, LLC. v. National Milk Producers Federation, Cooperatives Working Together, Dairy Farmers of America, Inc., Land O'Lakes, Inc., Dairy Lea Cooperative Inc., Agri-Mark, Inc. d/b/a Cabot Creamery Cooperative, Inc., The United States District Court for the Southern District of Illinois. Case No. 3:13-cv-00454-SCW.

Expert Report of Kevin M. Murphy, March 15, 2019, in the Matter of Robert Binz V, Michael Binz, Leslie Clemenson, William Clynes, Andrew Margolick, Gregory Melita, and Nili Sinai-Nathan v. Amadeus IT Group, S.A., Amadeus North America, Inc., Amadeus Americas, Inc., Sabre Corporation f/k/a Holdings Corporation, Sabre Holdings Corporation, Sabre GLBL Inc., Sabre Travel International Limited, Travelport Worldwide Limited, and Travelport LP d/b/a Travelport, The United States District Court for the Southern District of New York. Civ A. No. 1:15-cv-05457-KPF.

Verified Statement of Kevin M. Murphy, April 25, 2019, On Behalf of Union Pacific Railroad Company in NAFCA vs. Union Pacific Railroad Company, Before the Surface Transportation Board. STB Docket No. NOR 42144.

Deposition of Kevin M. Murphy, May 9, 2019, in the Matter of Robert Binz V, Michael Binz, Leslie Clemenson, William Clynes, Andrew Margolick, Gregory Melita, and Nili Sinai-Nathan v. Amadeus IT Group, S.A., Amadeus North America, Inc., Amadeus Americas, Inc., Sabre Corporation f/k/a Holdings Corporation, Sabre Holdings Corporation, Sabre GLBL Inc., Sabre Travel International Limited, Travelport Worldwide Limited, and Travelport LP d/b/a Travelport, The United States District Court for the Southern District of New York. Civ A. No. 1:15-cv-05457-KPF.

Expert Report of Kevin M. Murphy, May 10, 2019, in the Matter of National Prescription Opiate Litigation (MDL No. 2804), The United States District Court for the Northern District of Ohio Eastern Division. Case No. 17-op-5004 and Case No. 18-op-45090. (Corrected and Restated Expert Report filed June 21, 2019).

Expert Report of Kevin M. Murphy, May 10, 2019, In Re Packaged Seafood Products Antitrust Litigation (Associated Wholesale Grocers, Inc. v. Bumble Bee Foods, LLC et al.), In the United States District Court of the Southern District of California. No. 15-md-2670.

Expert Report of Kevin M. Murphy, May 10, 2019, In Re Packaged Seafood Products Antitrust Litigation (W. Lee Flowers & Co., Inc. v. Bumble Bee Foods LLC, et al.), In the United States District Court of the Southern District of California. No. 15-md-2670.

Expert Report of Kevin M. Murphy, May 10, 2019, In Re Packaged Seafood Products Antitrust Litigation (Winn-Dixie Stores, Inc. and Bi-Lo Holding, LLC. v. Bumble Bee Foods, LLC et al.), In the United States District Court of the Southern District of California. No. 15-md-2670.

Expert Addendum Report of Kevin M. Murphy, May 24, 2019, In Re Packaged Seafood Products Antitrust Litigation (Affiliated Foods Midwest Cooperative, Inc. v. Bumble Bee Foods LLC, et al.), In the United States District Court of the Southern District of California. No. 15-md-2670.

Deposition of Kevin M. Murphy, June 6, 2019, in the Matter of National Prescription Opiate Litigation (MDL No. 2804), The United States District Court for the Northern District of Ohio Eastern Division. Case No. 17-op-5004 and Case No. 18-op-45090.

Expert Report of Kevin M. Murphy, June 10, 2019, In Re Payment Card Interchange Fee and Merchant Discount Antitrust Litigation, In the United States District Court for the Eastern District of New York. No. 05-md-1720 (MKB) (JO).

Deposition of Kevin M. Murphy, June 25, 2019, In Re Packaged Seafood Products Antitrust Litigation, In the United States District Court of the Southern District of California. No. 15-md-2670.

Expert Report of Kevin M. Murphy, July 15, 2019, in the Matter of Blue Cross Blue Shield Antitrust Litigation (MDL No.: 2406), The United States District Court for the Northern District of Alabama Southern Division. Master File No. 2:13-CV-20000-RDP.

Submission to the U.S. Department of Justice, Economic Considerations for Modification and Termination of the ASCAP Consent Decree, August 9, 2019.

Expert Report of Kevin M. Murphy, November 15, 2019, In Re Dealer Management Systems Antitrust Litigation, MDL 2817, The United States District Court for the Northern District of Illinois Eastern Division. No. 1:18-CV-00864. (Corrected and Restated Expert Report filed January 15, 2020).

Expert Report of Kevin M. Murphy, December 6, 2019, in the Matter of North American Soccer League, LLC v. United States Soccer Federation, Inc., and Major League Soccer, LLC, In the United States District Court for The Eastern District of New York. No. 1:17-cv-05495-MKB-ST.

Expert Report of Kevin M. Murphy, December 20, 2019, in the Matter of The United States of America v. Sabre Corporation, Sabre GLBL Inc., Farelogix, Inc., and Sandler Capital Partners V, L.P., In the United States District Court for The District of Delaware. No: 1:19-cv-01548-LPS.

Expert Rebuttal Report of Kevin M. Murphy, January 3, 2020, in the Matter of The United States of America v. Sabre Corporation, Sabre GBL Inc., Farelogix, Inc., and Sandler Capital Partners V, L.P., In the United States District Court for The District of Delaware. No: 1:19-cv-01548-LPS.

Expert Rebuttal Report of Kevin M. Murphy, January 10, 2020, in the Matter of The United States of America v. Novelis Inc. and Aleris Corporation, In the United States District Court for the Northern District of Ohio. No.: 1:19-cv-02033-CAB.

Expert Reply Report of Kevin M. Murphy, January 15, 2020, in the Matter of The United States of America v. Sabre Corporation, Sabre GBL Inc., Farelogix, Inc., and Sandler Capital Partners V, L.P., In the United States District Court for The District of Delaware. No: 1:19-cv-01548-LPS.

Deposition of Kevin M. Murphy, January 18, 2020, in the Matter of The United States of America v. Sabre Corporation, Sabre GBL Inc., Farelogix, Inc., and Sandler Capital Partners V, L.P., In the United States District Court for The District of Delaware. No: 1:19-cv-01548-LPS.

Deposition of Kevin M. Murphy, January 21, 2020, and January 22, 2020, In Re Payment Card Interchange Fee and Merchant Discount Antitrust Litigation, In the United States District Court for the Eastern District of New York. No. 05-md-1720 (MKB) (JO).

Deposition of Kevin M. Murphy, January 24, 2020, In Re Dealer Management Systems Antitrust Litigation, MDL 2817, The United States District Court for the Northern District of Illinois Eastern Division. No. 1:18-CV-00864.

Deposition of Kevin M. Murphy, January 27, 2020, in the Matter of The United States of America v. Novelis Inc. and Aleris Corporation, In the United States District Court for the Northern District of Ohio. No.: 1:19-cv-02033-CAB.

Expert Report of Kevin M. Murphy, February 3, 2020, In Re Opioid Litigation, In the Supreme Court of the State of New York County of Suffolk. Index No.:400001/2017, Index No.: 400008/2017, and Index No.: 400016/2018.

Trial Testimony of Kevin M. Murphy, February 3, 2020, in the Matter of The United States of America v. Sabre Corporation, Sabre GBL Inc., Farelogix, Inc., and Sandler Capital Partners V, L.P., In the United States District Court for The District of Delaware. No: 1:19-cv-01548-LPS.

Deposition of Kevin M. Murphy, February 13, 2020, in the Matter of North American Soccer League, LLC v. United States Soccer Federation, Inc., and Major League Soccer, LLC, In the United States District Court for The Eastern District of New York. No. 1:17-cv-05495-MKB-ST.

Deposition of Kevin M. Murphy, February 19, 2020, In Re Opioid Litigation, In the Supreme Court of the State of New York County of Suffolk. Index No.:400001/2017, Index No.: 400008/2017, and Index No.: 400016/2018.

Arbitration Testimony of Kevin M. Murphy, February 25, 2020, in the Matter of The United States of America v. Novelis Inc. and Aleris Corporation, In the United States District Court for the Northern District of Ohio. No.: 1:19-cv-02033-CAB.

Expert Report of Kevin M. Murphy, May 30, 2020, in the Matter of an Independent Review Process, Afiliis Domains No. 3 Limited v. Internet Corporation for Assigned Names and Numbers, before The International Centre for Dispute Resolution.

Expert Report of Kevin M. Murphy, July 24, 2020, in the Matter of The State of Ohio v. McKesson Corporation, Cardinal Health, Inc., AmerisourceBergen Drug Corporation, and Miami-Luken, Inc., In the Court of Common Pleas for Madison County, Ohio. Case No. CVH20180055.

Expert Report of Kevin M. Murphy, August 27, 2020, in the Matters of The City of Huntington v. AmerisourceBergen Drug Corporation, et al., and Cabell County Commission v. AmerisourceBergen Drug Corporation, et al., In the United States District Court for the Southern District of West Virginia. Civil Action Nos. 3:17-01362 and 3:17-01665.

Curriculum Vitae  
of  
Professor Mark E. Zmijewski

## Mark E. Zmijewski (Zme – yev’ -ski) Bio

Professor Zmijewski specializes in the areas of accounting, economics, and finance as they relate to valuation, financial analysis, and security analysis, or more generally, financial economics. He is Professor Emeritus at The University of Chicago Booth School of Business, and previously held the Charles T. Horngren Professorship and the Leon Carroll Marshall Professorship in his 30-year career at the Booth. In addition to his research and teaching activities, Professor Zmijewski also held the positions of Deputy Dean, Associate Dean for PhD Studies, and the Faculty Director of the Center for Research in Security Prices (CRSP), all at the Booth School of Business. Professor Zmijewski is a Senior Consultant to Charles River Associates, a consulting firm that provides economic, financial, and management consulting services. He is also a Senior Advisor to, and a member of, the Investment Committee at Patron Capital Partners (Funds IV and V), a private equity investment company with a focus on real estate related investments. Professor Zmijewski was a Founding Partner of Chicago Partners, LLC, which was acquired by Navigant Consulting. He is the former Managing Director of Navigant Economics (a subsidiary of Navigant Consulting) and a former member of the Corporate Executive Committee of Navigant Consulting.

Professor Zmijewski earned his BS in 1976, MBA in 1981, and PhD with a major in accounting and minors in economics and finance in 1983, all from the State University of New York at Buffalo. In addition to The University of Chicago, he has taught at the State University of New York at Buffalo and at York University in Toronto, Canada. He has taught various courses in accounting (financial accounting, managerial accounting, and advanced accounting/mergers and acquisitions), finance (corporate finance, financial strategy and corporate transactions, financial analysis, and valuation of companies and corporate transactions), and entrepreneurship. Professor Zmijewski’s research has focused on firm valuation and the ways in which various capital market participants use information to value securities. He has published articles in academic journals in the areas of accounting and financial economics and has co-authored a textbook (with Professor Robert Holthausen of The Wharton School of the University of Pennsylvania) on how to value companies, parts of companies, and the securities issued by companies, titled “Corporate Valuation: Theory, Evidence and Practice.” He has been an Associate Editor of *The Accounting Review*, and has been on the Editorial Boards of both the *Journal of Accounting Research* and *The Accounting Review*.

Professor Zmijewski has worked as a consultant or expert in litigation matters in US state and federal courts, in the Supreme Court of Victoria in Australia, and in US and international arbitrations. The issues on which he has consulted include: business valuation and securities valuation (valuation of corporate transactions, companies, and parts of companies, intangible assets and intellectual property, and securities); securities litigation (10b-5, section 11, section 12, ERISA, Martin Act, and insider trading); mergers and acquisitions (appraisals and price disputes, analyzing merger synergies, material adverse changes, corporate transactions, and the process of purchasing and selling companies); solvency and ability to pay (fraudulent conveyance, solvency assessment, and ability to pay government fines); antitrust litigation (analysis of merger efficiencies, failing firm defense, and financial analyses of alleged anticompetitive behavior); commercial and stockholder disputes (measurement of damages, accounting analyses, and economic assessment of transactions); accounting issues (measuring and analyzing revenue, cost structures, profitability, rates of return, interest rates, and other financial metrics and concepts); and creating and evaluating business plans.

The frameworks and tools used in his work are generally applicable to all industries, and he has applied his expertise in a broad range of sectors, including the airline, auto, chemical, computer hardware and software, credit card, energy, entertainment, financial services, for-profit education, health care, insurance, heavy and light manufacturing, pharmaceutical, retail, real estate investment fund, technology, telecommunications, and transportation industries, among others.

**Mark E. Zmijewski**  
**(Zme-yev'-ski)**  
Senior Consultant

PhD, Accounting  
State University of New York  
at Buffalo

MBA, Accounting  
State University of New York  
at Buffalo

BA, Accounting  
State University of New York  
at Buffalo

## Academic employment

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1984–Present | The University of Chicago Booth School of Business<br><i>Professor Emeritus</i> (2018–Present)<br><i>Charles T. Horngren Professor of Accounting</i> (2015–2018)<br><i>Leon Carroll Marshall Professor of Accounting</i> (1999–2015)<br><i>Deputy Dean</i> (1996–2011)<br><i>Professor of Accounting</i> (1992–1999)<br><i>Associate Dean for PhD Studies</i> (1995–1996)<br><i>Executive Director, Center for Research in Securities Prices (CRSP)</i><br>(1992–1998)<br><i>Associate Professor of Accounting</i> (1988–1992)<br><i>Assistant Professor of Accounting</i> (1984–1988) |
| 1980–1984    | <i>Assistant Professor of Accounting</i> , State University of New York at Buffalo                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 1979–1982    | <i>Course Director</i> , York University, Toronto Canada                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 1977–1980    | <i>Teaching Assistant</i> , State University of New York at Buffalo                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

## Honors and awards

Business Information Professional of the Year—Education, Beta Alpha Psi, 2007.

Hillel J. Einhorn Excellence in Teaching Award, The Executive MBA Program, The University of Chicago Graduate School of Business, 1999.

Emory Williams Award for Excellence in Teaching, The University of Chicago, 1988

Competitive Manuscript Award, American Accounting Association, 1984.

Beta Alpha Psi, Honorary Accounting Society, 1981.

Beta Gamma Sigma, Honorary Business Society, 1980.

## Grants

Research Grant, SEC and Financial Reporting Institute, 1985.

University Fellowship, State University of New York at Buffalo, 1979.

Graduate Fellowship, State University of New York at Buffalo, 1976–1978.

## Publications

*Corporate Valuation: Theory, Evidence and Practice (textbook)*. With Robert W. Holthausen, Cambridge Business Publishers, LLC, 1<sup>st</sup> Edition, 2014; 2nd edition, 2020.

“Valuation with Market Multiples: How to Avoid Pitfalls When Identifying and Using Comparable Companies.” With R. Holthausen. *Journal of Applied Corporate Finance*, Summer 2012.

“Pitfalls in Levering and Unlevering Beta and Cost of Capital Estimates in DCF Valuations.” With R. Holthausen. *Journal of Applied Corporate Finance*, Summer 2012.

“Accounting and Disclosure Issues in Structured Finance.” With Keith Bockus and W. Dana Northcut. In *Corporate Aftershock: The Public Policy Lessons from the Collapse of Enron and Other Major Corporations*, C.L. Culp and W.A. Niskanen, eds., Wiley, 2003.

“Discovery and the Financial Analyst.” With Roger Hickey. *Litigation Services Handbook*, January 1995.

“How Useful Are Wall Street Week Stock Recommendations?” With P. Griffin and J. Jones. *Journal of Financial Statement Analysis*, Fall 1995.

“Contemporaneous Announcements of Dividends and Earnings.” With R. Leftwich. *Journal of Accounting, Auditing, and Finance*, Autumn 1994.

“The Relative Informativeness of Accounting Disclosures in Different Countries.” With A. Alford, J. Jones, and R. Leftwich. *Journal of Accounting Research*, Supplement, 1993.

“Extensions and Violations of the Statutory SEC Form 10-K Filing Requirements.” With A. Alford and J. Jones. *Journal of Accounting and Economics*, 1993.

“SEC Form 10-K/10-Q Reports and Annual Reports to Shareholders: Reporting Lags and Squared Market Model Prediction Errors.” With P. Easton. *Journal of Accounting Research*, Winter 1993.

*The Phish Corporation: A Practice Case in Managerial Accounting*, With R. Derstine, R. Huefner, and S. Gunn. McGraw-Hill, 1991.

“Cross-Sectional Variation in the Stock Market Response to the Announcement of Accounting Earnings.” With P. Easton. *Journal of Accounting and Economics*, 1989.

“An Evaluation of Alternative Proxies for the Market’s Expectation of Earnings.” With L. Brown, P. Griffin, and R.L. Hagerman. *Journal of Accounting and Economics*, 1987.

"Predictive Value of Accounting Information." With P. Griffin. In *Usefulness to Investors and Creditors of Information Provided by Financial Reporting*, 2<sup>nd</sup> Edition, P. Griffin, ed. Financial Accounting Standards Board, 1987.

"Security Analyst Superiority Relative to Univariate Time-Series Models in Forecasting Quarterly Earnings." With L. Brown, P. Griffin, and R. Hagerman. *Journal of Accounting and Economics*, 1987.

"The Effect of Labor Strikes on Security Analysts' Forecast Superiority and on the Association between Risk-Adjusted Stock Returns and Unexpected Earnings." With L. Brown. *Contemporary Accounting Research*, 1987.

"Estimating Models with Binary Dependent Variables: Some Theoretical and Empirical Observations." With G. Gessner, W. Kamakura, and N. Malhotra. *Journal of Business Research*, 1987.

"Methodological Issues Related to the Estimation of Financial Distress Prediction Models." *Journal of Accounting Research*, 1984.

"The Association Between the Magnitude of Quarterly Earnings Forecast Errors and Risk-Adjusted Stock Returns." With R.L. Hagerman and P. Shah. *Journal of Accounting Research*, 1984.

"An Income Strategy Approach to the Positive Theory of Accounting Policy Setting/Choice." With R.L. Hagerman. *Journal of Accounting and Economics*, 1981. Reprinted in *The Economics of Accounting Policy Choice*, Ray Ball and Clifford Smith, Jr., eds. McGraw-Hill, 1992.

"A Test of Accounting Bias and Market Structure: Some Additional Evidence." With R.L. Hagerman. *Review of Business and Economic Research*, 1981.

"Some Economic Determinants of Accounting Policy Choice." With R.L. Hagerman. *Journal of Accounting and Economics*, 1979.

Comments on "Earnings Forecasting Research: Its Implications for Capital Markets Research." *International Journal of Forecasting*.

## Dissertation committees

Sandip Madan, The University of Chicago, 1999, Member

Keith Bockus, The University of Chicago, 1998, Co-Chairperson

Beverly Walther, The University of Chicago, 1995, Member

Howard Bunsis, The University of Chicago, 1993, Co-Chairperson

Phillip Berger, The University of Chicago, 1992, Member

Stuart Essig, The University of Chicago, 1991, Member

Sherri Jarrell, The University of Chicago, 1991, Member

Andrew Alford, The University of Chicago, 1990, Chairperson

Mark Lang, The University of Chicago, 1990, Member

Laureen Maines, The University of Chicago, 1990, Member

Walter Teets, The University of Chicago, 1988, Member

Siew Teoh, The University of Chicago, 1988, Member

Kirsten Ely, The University of Chicago, 1988, Member

M. Daniel Beneish, The University of Chicago, 1987, Member

Pat O'Brien, The University of Chicago, 1986, Member

W. Forbes Cavanagh, State University of New York at Buffalo, 1985, Member

## University activities

Accounting Advisory Counsel, State University of New York at Buffalo, 1993–1995.

Faculty Facilitator, Leadership, Education, and Development (LEAD) Program, The University of Chicago, Graduate School of Business, 1989, 1991.

Dean's Advisory Committee on MBA Students and Curriculum, The University of Chicago, 1988.

Executive Director, Management Development Council, State University of New York at Buffalo, 1981–1984.

Advisor, Center for Management Development, State University of New York at Buffalo, 1979–1980.

## Editorial service and boards

Associate Editor, *The Accounting Review*, 1993–1997.

Editorial Board, *Journal of Accounting Research*, 1988–1993.

Editorial Board, *The Accounting Review*, 1985–1987.

## Ad hoc referee

*Journal of Accounting, Auditing, and Finance*

*The Accounting Review*

*Contemporary Accounting Research*

*The Financial Review*

*Journal of Accounting and Economics*

*Journal of Accounting Research*

*Journal of Banking and Finance*

*Journal of Business*

*Journal of Forecasting*

*International Journal of Forecasting*

*Management Science*

## Professional organizations

American Accounting Association

The American Finance Association

## Testimony, declarations, and other court filings and submissions in the past five years

*Federal Trade Commission v. Peabody Energy Corporation and Arch Coal, Inc.* In the United States District Court for the Eastern District of Missouri, C.A. No 4:20-cv-00317-SEP. Deposition testimony June 26, 2020. Trial testimony July 24, 2020.

*Zantran Pty Limited, Applicant vs. Crown Resorts Limited, Respondent.* In the Federal Court of Australia Victoria Registry, Case No. VID 1317/2017. Expert Reports April 18, 2019 and March 27, 2020.

*Alison Court, et al., Applicants vs. Spotless Group Holdings Limited, Respondent.* In the Federal Court of Australia Victoria Registry, Case No. VID 561/2017. Expert Reports December 22, 2019 and March 25, 2020.

*In Re American Realty Capital Properties, Inc. Litigation.* In the United States District Court for the Southern District of New York, C.A. No. 1:15-mc-00040-AKH. Deposition testimony July 26, 2019.

*In Re Appraisal of Jarden Corporation.* In the Court of Chancery of the State of Delaware, Consol. C.A. No. 12456-VCS. Deposition testimony May 2, 2018. Trial testimony June 26, 2018 and June 28, 2018. Affidavit July 26, 2019.

*In Re Bracket Holding Corp. Litigation.* In the Superior Court of the State of Delaware, Consol. C.A. No. N15C-02-233 WCC CCLD. Deposition testimony September 20, 2018. Affidavit July 25, 2019.

*Nathan F. Brand et al. v. William A. Linton and Promega Corporation.* State of Wisconsin Dane County Circuit Court, Case No. 2016CV001978. Deposition testimony November 14, 2018. Trial testimony July 22, 2019.

*Precision Castparts Corp. and PCC Germany Holdings GMBH v. Schulz Holding GMBH & Co. KG, et al.* International Centre For Dispute Resolution, American Arbitration Association, Case No. 01-18-0001-0115. First witness statement November 16, 2018. Second witness statement May 17, 2019. Arbitration testimony July 1, 2019.

*Reynolds American Inc. v. Third Motion Equities Master Fund Ltd, et al.* State of North Carolina Forsythe County. In the General Court of Justice, Superior Court Division, Case No. 17 CVS 7086. Deposition testimony April 17, 2019. Trial testimony June 17, 2019.

*In Re Appraisal of Stillwater Mining Company.* In the Court of Chancery of the State of Delaware. Consol. C.A. No. 2017-0385-JTL. Deposition testimony November 27, 2018. Trial testimony December 13, 2018.

*In Re Appraisal of Columbia Pipeline Group, Inc.* In the Court of Chancery of the State of Delaware, Consol. C.A. No. 12736-VCL. Deposition testimony August 14, 2018. Trial testimony November 2, 2018.

*Federal Trade Commission v. Tronox Limited, et al.* In the United States District Court for the District of Columbia, Docket No. D09377. Deposition testimony May 15, 2018. Trial testimony May 31, 2018.

*Brian Jones, Applicant vs. Treasury Wine Estates Limited, Respondent.* In the Federal Court of Australia District of New South Wales, Case No. NSD 660 of 2014. Expert Report February 4, 2017, Expert Rebuttal Report July 10, 2017, Supplemental Expert Rebuttal Report August 17, 2017.

*Money Max Int Pty Limited (ACN 152 073 580), as a trustee for the Goldie Superannuation Fund, Applicant vs. QBE Insurance Group Limited (ACN 008 485 014), Respondent.* In the Federal Court of Australia, Case No. VID 513 of 2015. Expert Report August 10, 2017.

*United States of America v. Bumble Bee Foods, LLC.* In the United States District Court, Northern District of California, San Francisco Division, Case No. 17-CR-00249 CRB. Presentations before the U.S. Department of Justice, Antitrust Division September 20, 2016 and January 9, 2017. Declaration filed July 18, 2017.

*Authenticom, Inc. v. CDK Global, LLC and The Reynolds and Reynolds Company.* In the United States District Court for the Western District of Wisconsin, Case No. 17-CV-318. Declaration filed June 16, 2017. Trial testimony June 28, 2017.

*United States Securities and Exchange Commission v. ITT Educational Services, Inc. et al.* In the United States District Court, Southern District of Indiana, Indianapolis Division, Case No. 15-CV-00758. Deposition testimony May 10, 2017.

*In the matter of Determination of Rates and Terms for Making and Distributing Phonorecords (Phonorecords III).* Before the Copyright Royalty Board Library of Congress, Washington, D.C., Docket No. 16-CRB-0003-PR (2018-2022). Trial testimony April 12, 2017.

*PharMerica Corporation et al. v. AmerisourceBergen Drug Corporation v. BGS Pharmacy Holding Company et al.* In the Jefferson Circuit Court Division Ten (10), Case No. 14-CI-004682. Deposition testimony April 4, 2017.

*In Re Caesars Entertainment Operating Company, Inc., et al. Chapter 11 Bankruptcy Case.* In the United States Bankruptcy Court for the Northern District of Illinois Eastern Division, Case No. 15-01145 (ABG). Declaration filed December 2, 2016.

*Beef Products, Inc., BPI Technology, Inc. and Freezing Machines, Inc. v. American Broadcasting Companies, Inc., ABC News, Inc., Diane Sawyer, Jim Avila, David Kerley, Gerald Zirnstein, Carl Custer, and Kit Foshee.* In the State of South Dakota in the County of Union First Judicial Circuit, Case No. 12-292. Deposition testimony August 25, 2016.

*In Re Harman International Industries, Inc. Securities Litigation.* In the United States District Court for the District of Columbia, Case No. 1:07-cv-01757-RC. Deposition testimony July 27, 2016.

*Avisep, S.A. de C.V., and Bevisep, S.A. de C.V., Claimants, v. The Sherwin-Williams Company, and Sherwin-Williams (Caribbean) N.V., Respondents.* In the International Court of Arbitration, International Chamber of Commerce, No. 20169/RD. Arbitration testimony April 18, 2016.

*Federal Trade Commission, et al., Plaintiffs v. Staples, Inc. and Office Depot, Inc., Defendants.* In the United States District Court for the District of Columbia, Civil Action No. 1:15-cv-02115-EGS. Deposition testimony March 14, 2016.

*In Re Groupon, Inc. Securities Litigation.* In the United States District Court for the Northern District of Illinois, Eastern Division, 12-CV-2450. Deposition testimony November 5, 2015. Declaration filed January 15, 2016.

*Exelon Corporation, as successor by merger to Unicom Corporation and Subsidiaries, et al., Petitioner, v. Commissioner of Internal Revenue Service, Respondent.* In the United States Tax Court, Docket Nos. 29183-13 and 29184-13. Trial testimony August 20, 2015.

*Ahmed D. Hussein, Plaintiff, v. Sheldon Razin et al., Defendants.* In the Superior Court of the State of California For the County of Orange, Case No. 30-2013-00679600-CU-NP-CJC. Deposition testimony June 10, 2015.

*Lavastone Capital LLC, Plaintiff, v. Coventry First LLC, LST I LLC, LST II LLC, LST Holdings Ltd., Montgomery Capital, Inc., Alan Buerger, Reid Buerger, Constance Buerger, and Krista Lake, Defendants.* In the United States District Court for the Southern District of New York, Case No. 14-CF-7139 (JSR)(DCF). Deposition testimony April 29, 2015. Trial testimony October 23, 2015.

# Exhibit 1

## Railroad Percentiles within Sample - STB Definition of Return on Invested Capital (ROIC) and STB Definition of Cost of Capital (COC) (Railroads' Return on Invested Capital and Cost of Capital Using STB Data)

|                                                                                                             | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | Min | Max  | Median | Average |
|-------------------------------------------------------------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|-----|------|--------|---------|
| <b>Panel A: S&amp;P 500 Companies Excluding Railroads, Financial Institutions and Real Estate Companies</b> |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |      |        |         |
| <u>Sample Number of Observations, Median, 25th Percentile, and % Positive ROIC minus COC:</u>               |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |      |        |         |
| Number of Observations in Sample                                                                            | 398  | 395  | 402  | 405  | 402  | 401  | 397  | 395  | 392  | 383  | 371  | 368  | 378  | 380  | 368 | 405  | 395    | 391     |
| Median ROIC minus COC                                                                                       | 16%  | 16%  | 16%  | 13%  | 18%  | 19%  | 19%  | 21%  | 20%  | 22%  | 22%  | 20%  | 29%  | 25%  | 13% | 29%  | 19%    | 20%     |
| 25th Percentile ROIC minus COC                                                                              | 5%   | 5%   | 3%   | -1%  | 5%   | 6%   | 5%   | 4%   | 5%   | 4%   | 4%   | 5%   | 6%   | 5%   | -1% | 6%   | 5%     | 4%      |
| % with ROIC minus COC > 0.0%                                                                                | 90%  | 89%  | 86%  | 73%  | 89%  | 91%  | 89%  | 90%  | 90%  | 88%  | 85%  | 89%  | 90%  | 89%  | 73% | 91%  | 89%    | 88%     |
| <u>Railroad Percentile in the Distribution of ROIC minus COC:</u>                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |      |        |         |
| Industry Weighted Average ROIC                                                                              | 11   | 9    | 12   | 21   | 10   | 10   | 13   | 15   | 19   | 18   | 18   | 12   | 12   | 22   | 9   | 22   | 13     | 15      |
| BNSF Railway                                                                                                | 15   | 9    | 11   | 23   | 10   | 11   | 16   | 17   | 19   | 22   | 17   | 12   | 11   | 21   | 9   | 23   | 15     | 15      |
| CSX Corporation                                                                                             | 8    | 6    | 10   | 20   | 10   | 9    | 11   | 7    | 9    | 12   | 15   | 9    | 13   | 24   | 6   | 24   | 10     | 12      |
| Grand Trunk Corporation                                                                                     | 10   | 9    | 10   | 16   | 7    | 5    | 10   | 12   | 13   | 14   | 15   | 8    | 3    | 7    | 3   | 16   | 10     | 10      |
| Kansas City Southern                                                                                        | 9    | 8    | 8    | 18   | 9    | 8    | 10   | 5    | 6    | 9    | 12   | 8    | 4    | 6    | 4   | 18   | 8      | 9       |
| Norfolk Southern Corporation                                                                                | 24   | 18   | 22   | 21   | 11   | 12   | 12   | 12   | 14   | 12   | 16   | 11   | 10   | 19   | 10  | 24   | 13     | 15      |
| Soo Line Corporation                                                                                        | 15   | 23   | 10   | 17   | 6    | 3    | 5    | 12   | 2    | 26   | 16   | 12   | 14   | 18   | 2   | 26   | 13     | 13      |
| Union Pacific Corporation                                                                                   | 8    | 8    | 11   | 23   | 13   | 13   | 22   | 25   | 30   | 28   | 27   | 22   | 22   | 28   | 8   | 30   | 22     | 20      |
| <b>Panel B: S&amp;P 500 Companies in the Industrials Sector Excluding Railroads</b>                         |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |      |        |         |
| <u>Sample Number of Observations, Median, 25th Percentile, and % Positive ROIC minus COC:</u>               |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |      |        |         |
| Number of Observations in Sample                                                                            | 48   | 52   | 55   | 53   | 54   | 56   | 53   | 56   | 57   | 59   | 63   | 62   | 62   | 61   | 48  | 63   | 56     | 57      |
| Median ROIC minus COC                                                                                       | 20%  | 23%  | 21%  | 14%  | 17%  | 21%  | 22%  | 22%  | 23%  | 24%  | 28%  | 28%  | 30%  | 31%  | 14% | 31%  | 23%    | 23%     |
| 25th Percentile ROIC minus COC                                                                              | 11%  | 13%  | 13%  | 4%   | 10%  | 13%  | 12%  | 14%  | 11%  | 13%  | 9%   | 14%  | 13%  | 13%  | 4%  | 14%  | 13%    | 12%     |
| % with ROIC minus COC > 0.0%                                                                                | 96%  | 92%  | 98%  | 83%  | 94%  | 96%  | 96%  | 96%  | 96%  | 97%  | 94%  | 100% | 95%  | 97%  | 83% | 100% | 96%    | 95%     |
| <u>Railroad Percentile in the Distribution of ROIC minus COC:</u>                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |      |        |         |
| Industry Weighted Average ROIC                                                                              | 6    | 6    | 4    | 11   | 7    | 5    | 6    | 7    | 10   | 12   | 9    | 2    | 6    | 8    | 2   | 12   | 7      | 7       |
| BNSF Railway                                                                                                | 10   | 6    | 4    | 11   | 7    | 5    | 6    | 7    | 10   | 13   | 9    | 2    | 6    | 8    | 2   | 13   | 7      | 7       |
| CSX Corporation                                                                                             | 4    | 6    | 4    | 9    | 7    | 5    | 6    | 4    | 5    | 5    | 8    | 2    | 6    | 11   | 2   | 11   | 5      | 6       |
| Grand Trunk Corporation                                                                                     | 6    | 6    | 4    | 7    | 4    | 2    | 6    | 5    | 9    | 7    | 8    | 2    | 2    | 3    | 2   | 9    | 5      | 5       |
| Kansas City Southern                                                                                        | 6    | 6    | 4    | 9    | 5    | 5    | 6    | 4    | 3    | 3    | 6    | 2    | 2    | 3    | 2   | 9    | 4      | 5       |
| Norfolk Southern Corporation                                                                                | 14   | 9    | 9    | 11   | 7    | 5    | 6    | 5    | 9    | 5    | 8    | 2    | 6    | 8    | 2   | 14   | 8      | 7       |
| Soo Line Corporation                                                                                        | 10   | 13   | 4    | 7    | 2    | 2    | 2    | 5    | 2    | 15   | 8    | 2    | 6    | 8    | 2   | 15   | 6      | 6       |
| Union Pacific Corporation                                                                                   | 4    | 6    | 4    | 11   | 9    | 5    | 7    | 9    | 21   | 15   | 11   | 6    | 13   | 15   | 4   | 21   | 9      | 10      |
| <b>Panel C: Railroad Customer Sample of S&amp;P 500 Companies</b>                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |      |        |         |
| <u>Sample Number of Observations, Median, 25th Percentile, and % Positive ROIC minus COC:</u>               |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |      |        |         |
| Number of Observations in Sample                                                                            | 80   | 80   | 81   | 82   | 84   | 84   | 84   | 83   | 84   | 86   | 85   | 83   | 84   | 82   | 80  | 86   | 84     | 83      |
| Median ROIC minus COC                                                                                       | 13%  | 12%  | 9%   | 3%   | 12%  | 13%  | 10%  | 7%   | 7%   | 8%   | 6%   | 8%   | 11%  | 8%   | 3%  | 13%  | 8%     | 9%      |
| 25th Percentile ROIC minus COC                                                                              | 4%   | 4%   | 1%   | -4%  | 3%   | 3%   | 2%   | 2%   | 1%   | 2%   | -1%  | 2%   | 2%   | 1%   | -4% | 4%   | 2%     | 2%      |
| % with ROIC minus COC > 0.0%                                                                                | 88%  | 86%  | 79%  | 61%  | 86%  | 85%  | 83%  | 87%  | 83%  | 81%  | 72%  | 83%  | 85%  | 79%  | 61% | 88%  | 83%    | 81%     |
| <u>Railroad Percentile in the Distribution of ROIC minus COC:</u>                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |      |        |         |
| Industry Weighted Average ROIC                                                                              | 14   | 7    | 18   | 30   | 15   | 19   | 25   | 24   | 34   | 28   | 36   | 20   | 20   | 36   | 7   | 36   | 22     | 23      |
| BNSF Railway                                                                                                | 17   | 7    | 16   | 33   | 14   | 20   | 27   | 29   | 34   | 36   | 35   | 20   | 16   | 35   | 7   | 36   | 24     | 24      |
| CSX Corporation                                                                                             | 11   | 5    | 13   | 30   | 15   | 16   | 15   | 10   | 16   | 18   | 29   | 17   | 20   | 39   | 5   | 39   | 16     | 18      |
| Grand Trunk Corporation                                                                                     | 12   | 7    | 13   | 24   | 14   | 8    | 14   | 17   | 24   | 21   | 29   | 13   | 5    | 18   | 5   | 29   | 14     | 16      |
| Kansas City Southern                                                                                        | 12   | 7    | 10   | 28   | 14   | 13   | 13   | 7    | 13   | 16   | 22   | 12   | 5    | 16   | 5   | 28   | 13     | 13      |
| Norfolk Southern Corporation                                                                                | 28   | 20   | 30   | 30   | 15   | 21   | 18   | 17   | 25   | 18   | 29   | 18   | 15   | 33   | 15  | 33   | 20     | 23      |
| Soo Line Corporation                                                                                        | 17   | 27   | 13   | 24   | 12   | 6    | 6    | 17   | 6    | 43   | 30   | 20   | 21   | 31   | 6   | 43   | 19     | 20      |
| Union Pacific Corporation                                                                                   | 11   | 6    | 16   | 33   | 16   | 21   | 35   | 42   | 49   | 46   | 45   | 36   | 34   | 45   | 6   | 49   | 35     | 31      |

Sources: Bloomberg; Compustat; Ibbotson Yearbook (2006-2019); STB Revenue Adequacy Determination Report (2006-2018); RevAd 2019 AAR workpaper1 pdf, titled "AAR Duplication of STB Workpapers "

## Exhibit 2

**Railroad Percentiles within Sample - Adjusted STB Definition of Return on Invested Capital (ROIC) and STB Definition of Cost of Capital (COC)**  
**(Railroads' Return on Invested Capital and Cost of Capital Using STB Data)**

|                                                                                                             | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | Min | Max | Median | Average |
|-------------------------------------------------------------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|-----|-----|--------|---------|
| <b>Panel A: S&amp;P 500 Companies Excluding Railroads, Financial Institutions and Real Estate Companies</b> |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |     |        |         |
| <b>Sample Number of Observations, Median, 25th Percentile, and % Positive ROIC minus COC:</b>               |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |     |        |         |
| Number of Observations in Sample                                                                            | 405  | 401  | 409  | 415  | 413  | 414  | 413  | 412  | 410  | 408  | 402  | 393  | 395  | 394  | 393 | 415 | 409    | 406     |
| Median ROIC minus COC                                                                                       | 9%   | 9%   | 9%   | 5%   | 11%  | 11%  | 10%  | 11%  | 9%   | 10%  | 9%   | 7%   | 12%  | 10%  | 5%  | 12% | 10%    | 9%      |
| 25th Percentile ROIC minus COC                                                                              | 1%   | 2%   | 1%   | -2%  | 3%   | 3%   | 3%   | 2%   | 2%   | 2%   | 2%   | 2%   | 2%   | 1%   | -2% | 3%  | 2%     | 2%      |
| % with ROIC minus COC > 0.0%                                                                                | 81%  | 82%  | 80%  | 68%  | 86%  | 87%  | 86%  | 87%  | 87%  | 84%  | 82%  | 82%  | 84%  | 82%  | 68% | 87% | 83%    | 83%     |
| <b>Railroad Percentile in the Distribution of ROIC minus COC:</b>                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |     |        |         |
| Industry Weighted Average ROIC                                                                              | 14   | 9    | 12   | 22   | 9    | 12   | 13   | 11   | 13   | 17   | 18   | 11   | 11   | 25   | 9   | 25  | 13     | 14      |
| BNSF Railway                                                                                                | 17   | 10   | 12   | 24   | 10   | 16   | 13   | 12   | 14   | 20   | 18   | 11   | 8    | 22   | 8   | 24  | 14     | 15      |
| CSX Corporation                                                                                             | 10   | 8    | 10   | 20   | 9    | 10   | 12   | 6    | 8    | 11   | 15   | 10   | 12   | 26   | 6   | 26  | 10     | 12      |
| Grand Trunk Corporation                                                                                     | 13   | 9    | 10   | 14   | 7    | 6    | 8    | 7    | 9    | 15   | 15   | 9    | 4    | 10   | 4   | 15  | 9      | 10      |
| Kansas City Southern                                                                                        | 15   | 11   | 10   | 20   | 11   | 10   | 13   | 9    | 9    | 12   | 14   | 9    | 5    | 9    | 5   | 20  | 10     | 11      |
| Norfolk Southern Corporation                                                                                | 16   | 12   | 17   | 21   | 7    | 11   | 11   | 8    | 9    | 10   | 15   | 11   | 8    | 21   | 7   | 21  | 11     | 13      |
| Soo Line Corporation                                                                                        | 28   | 34   | 10   | 16   | 7    | 5    | 4    | 13   | 1    | 23   | 18   | 11   | 14   | 17   | 1   | 34  | 13     | 14      |
| Union Pacific Corporation                                                                                   | 10   | 8    | 14   | 23   | 11   | 13   | 17   | 16   | 30   | 30   | 26   | 17   | 22   | 35   | 8   | 35  | 17     | 19      |
| <b>Panel B: S&amp;P 500 Companies in the Industrials Sector Excluding Railroads</b>                         |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |     |        |         |
| <b>Sample Number of Observations, Median, 25th Percentile, and % Positive ROIC minus COC:</b>               |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |     |        |         |
| Number of Observations in Sample                                                                            | 48   | 53   | 56   | 54   | 55   | 57   | 56   | 60   | 61   | 63   | 66   | 65   | 65   | 64   | 48  | 66  | 59     | 59      |
| Median ROIC minus COC                                                                                       | 13%  | 15%  | 15%  | 5%   | 12%  | 15%  | 13%  | 13%  | 12%  | 12%  | 11%  | 12%  | 13%  | 14%  | 5%  | 15% | 13%    | 12%     |
| 25th Percentile ROIC minus COC                                                                              | 9%   | 8%   | 7%   | 1%   | 6%   | 8%   | 6%   | 6%   | 4%   | 7%   | 7%   | 7%   | 6%   | 9%   | 1%  | 9%  | 7%     | 6%      |
| % with ROIC minus COC > 0.0%                                                                                | 92%  | 91%  | 95%  | 80%  | 95%  | 95%  | 93%  | 95%  | 90%  | 90%  | 92%  | 97%  | 94%  | 94%  | 80% | 97% | 93%    | 92%     |
| <b>Railroad Percentile in the Distribution of ROIC minus COC:</b>                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |     |        |         |
| Industry Weighted Average ROIC                                                                              | 6    | 6    | 4    | 13   | 5    | 7    | 9    | 5    | 10   | 13   | 7    | 2    | 3    | 11   | 2   | 13  | 7      | 7       |
| BNSF Railway                                                                                                | 6    | 6    | 4    | 15   | 5    | 9    | 9    | 5    | 11   | 16   | 6    | 2    | 3    | 9    | 2   | 16  | 6      | 7       |
| CSX Corporation                                                                                             | 4    | 4    | 4    | 13   | 5    | 5    | 9    | 3    | 3    | 8    | 6    | 2    | 6    | 11   | 2   | 13  | 5      | 6       |
| Grand Trunk Corporation                                                                                     | 4    | 6    | 4    | 7    | 4    | 2    | 5    | 3    | 6    | 11   | 6    | 2    | 2    | 3    | 2   | 11  | 4      | 5       |
| Kansas City Southern                                                                                        | 6    | 6    | 4    | 11   | 5    | 5    | 9    | 5    | 6    | 8    | 6    | 2    | 2    | 3    | 2   | 11  | 5      | 5       |
| Norfolk Southern Corporation                                                                                | 6    | 6    | 5    | 13   | 4    | 5    | 9    | 5    | 6    | 5    | 6    | 2    | 3    | 9    | 2   | 13  | 5      | 6       |
| Soo Line Corporation                                                                                        | 16   | 19   | 4    | 7    | 4    | 2    | 4    | 7    | 2    | 17   | 6    | 2    | 8    | 8    | 2   | 19  | 6      | 7       |
| Union Pacific Corporation                                                                                   | 4    | 4    | 4    | 13   | 5    | 7    | 12   | 7    | 23   | 17   | 10   | 3    | 8    | 14   | 3   | 23  | 7      | 9       |
| <b>Panel C: Railroad Customer Sample of S&amp;P 500 Companies</b>                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |     |        |         |
| <b>Sample Number of Observations, Median, 25th Percentile, and % Positive ROIC minus COC:</b>               |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |     |        |         |
| Number of Observations in Sample                                                                            | 80   | 80   | 81   | 82   | 84   | 84   | 84   | 83   | 84   | 87   | 86   | 84   | 85   | 83   | 80  | 87  | 84     | 83      |
| Median ROIC minus COC                                                                                       | 9%   | 7%   | 6%   | 0%   | 7%   | 8%   | 5%   | 4%   | 3%   | 3%   | 3%   | 3%   | 5%   | 4%   | 0%  | 9%  | 5%     | 5%      |
| 25th Percentile ROIC minus COC                                                                              | 1%   | 2%   | 0%   | -5%  | 2%   | 2%   | 0%   | 1%   | 0%   | 1%   | -2%  | 0%   | 1%   | 0%   | -5% | 2%  | 0%     | 0%      |
| % with ROIC minus COC > 0.0%                                                                                | 84%  | 81%  | 70%  | 52%  | 81%  | 83%  | 76%  | 81%  | 74%  | 79%  | 67%  | 76%  | 81%  | 75%  | 52% | 84% | 78%    | 76%     |
| <b>Railroad Percentile in the Distribution of ROIC minus COC:</b>                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |     |        |         |
| Industry Weighted Average ROIC                                                                              | 12   | 7    | 20   | 34   | 15   | 16   | 21   | 17   | 27   | 22   | 31   | 15   | 16   | 40   | 7   | 40  | 18     | 21      |
| BNSF Railway                                                                                                | 14   | 7    | 18   | 36   | 15   | 20   | 22   | 19   | 27   | 33   | 31   | 14   | 12   | 38   | 7   | 38  | 20     | 22      |
| CSX Corporation                                                                                             | 9    | 6    | 17   | 31   | 15   | 16   | 18   | 10   | 15   | 16   | 29   | 13   | 16   | 40   | 6   | 40  | 16     | 18      |
| Grand Trunk Corporation                                                                                     | 12   | 7    | 15   | 22   | 14   | 9    | 11   | 10   | 16   | 22   | 29   | 13   | 5    | 21   | 5   | 29  | 14     | 15      |
| Kansas City Southern                                                                                        | 12   | 9    | 15   | 31   | 15   | 16   | 19   | 15   | 16   | 16   | 25   | 13   | 6    | 20   | 6   | 31  | 16     | 16      |
| Norfolk Southern Corporation                                                                                | 12   | 11   | 24   | 33   | 15   | 16   | 18   | 12   | 16   | 15   | 28   | 14   | 12   | 36   | 11  | 36  | 16     | 19      |
| Soo Line Corporation                                                                                        | 32   | 36   | 15   | 25   | 14   | 6    | 8    | 20   | 6    | 39   | 31   | 15   | 17   | 26   | 6   | 39  | 19     | 21      |
| Union Pacific Corporation                                                                                   | 9    | 7    | 22   | 36   | 15   | 16   | 29   | 24   | 49   | 49   | 47   | 24   | 29   | 49   | 7   | 49  | 26     | 29      |

Sources: Bloomberg; Compustat; Ibbotson Yearbook (2006-2019); STB Revenue Adequacy Determination Report (2006-2018); RevAd 2019 AAR workpaper1 pdf, titled "AAR Duplication of STB Workpapers "

## S&P 500 Companies by Year

[illegible]

# Appendix A, Exhibit A1

## S&P 500 Companies by Year

| Company Name                                                 | Company Ticker | GICS Sector            | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|--------------------------------------------------------------|----------------|------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Number of S&P 500 Companies                                  |                |                        | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  |
| Railroads, Financial Institutions, and Real Estate Companies |                |                        | 92   | 99   | 90   | 85   | 87   | 86   | 87   | 87   | 89   | 91   | 96   | 104  | 103  | 101  |
| Sample Number of S&P 500 Companies                           |                |                        | 408  | 401  | 410  | 415  | 413  | 414  | 413  | 413  | 411  | 409  | 404  | 396  | 397  | 399  |
| VIACOMCBS INC                                                | VIAC           | Communication Services | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| WINDSTREAM HOLDINGS INC                                      | WINMQ          | Communication Services | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    |
| ABERCROMBIE & FITCH -CL A                                    | ANF            | Consumer Discretionary | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| ADTALEM GLOBAL EDUCATION INC                                 | ATGE           | Consumer Discretionary | 0    | 0    | 0    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| ADVANCE AUTO PARTS INC                                       | AAP            | Consumer Discretionary | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    |
| ALTABA INC                                                   | AABA           | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    |
| AMAZON.COM INC                                               | AMZN           | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| APOLLO EDUCATION GROUP INC                                   | APOL           | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| APTIV PLC                                                    | APTIV          | Consumer Discretionary | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| AUTONATION INC                                               | AN             | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    |
| AUTOZONE INC                                                 | AZO            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| BED BATH & BEYOND INC                                        | BBBY           | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    |
| BEST BUY CO INC                                              | BBY            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| BIG LOTS INC                                                 | BIG            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| BLACK & DECKER CORP                                          | BDK            | Consumer Discretionary | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| BLOCK H & R INC                                              | HRB            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| BOOKING HOLDINGS INC                                         | BKNG           | Consumer Discretionary | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| BORGWARNER INC                                               | BWA            | Consumer Discretionary | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| BRUNSWICK CORP                                               | BC             | Consumer Discretionary | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| CAESARS ENTERTAINMENT CORP                                   | CZR            | Consumer Discretionary | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| CAPRI HOLDINGS LTD                                           | CPRI           | Consumer Discretionary | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| CARMAX INC                                                   | KMX            | Consumer Discretionary | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| CARNIVAL CORPORATION & PLC                                   | CCL            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| CENTEX CORP                                                  | CTX.2          | Consumer Discretionary | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| CHIPOTLE MEXICAN GRILL INC                                   | CMG            | Consumer Discretionary | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| CIRCUIT CITY STORES INC                                      | CCTYQ          | Consumer Discretionary | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| D R HORTON INC                                               | DHI            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| DARDEN RESTAURANTS INC                                       | DRI            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| DILLARDS INC -CL A                                           | DDS            | Consumer Discretionary | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| DIRECTV                                                      | DTV.2          | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    |
| DOLLAR GENERAL CORP                                          | DG             | Consumer Discretionary | 1    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| DOLLAR TREE INC                                              | DLTR           | Consumer Discretionary | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| DOW JONES & CO INC                                           | DJ             | Consumer Discretionary | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| EBAY INC                                                     | EBAY           | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| EXPEDIA GROUP INC                                            | EXPE           | Consumer Discretionary | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| FAMILY DOLLAR STORES                                         | FDO            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    |
| FOOT LOCKER INC                                              | FL             | Consumer Discretionary | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 0    |
| FORD MOTOR CO                                                | F              | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| FOSSIL GROUP INC                                             | FOSL           | Consumer Discretionary | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    |
| GAMESTOP CORP                                                | GME            | Consumer Discretionary | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    |

## S&P 500 Companies by Year

| Company Name                                                 | Company Ticker | GICS Sector            | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|--------------------------------------------------------------|----------------|------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Number of S&P 500 Companies                                  |                |                        | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  |
| Railroads, Financial Institutions, and Real Estate Companies |                |                        | 92   | 99   | 90   | 85   | 87   | 86   | 87   | 87   | 89   | 91   | 96   | 104  | 103  | 101  |
| Sample Number of S&P 500 Companies                           |                |                        | 408  | 401  | 410  | 415  | 413  | 414  | 413  | 413  | 411  | 409  | 404  | 396  | 397  | 399  |
| GAP INC                                                      | GPS            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| GARMIN LTD                                                   | GRMN           | Consumer Discretionary | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| GENERAL MOTORS CO                                            | GM             | Consumer Discretionary | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| GENUINE PARTS CO                                             | GPC            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| GOODYEAR TIRE & RUBBER CO                                    | GT             | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    |
| GRAHAM HOLDINGS CO                                           | GHC            | Consumer Discretionary | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    |
| HANESBRANDS INC                                              | HBI            | Consumer Discretionary | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    |
| HARLEY-DAVIDSON INC                                          | HOG            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| HARMAN INTERNATIONAL INDS                                    | HAR            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    |
| HASBRO INC                                                   | HAS            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| HILTON WORLDWIDE HOLDINGS                                    | HLT            | Consumer Discretionary | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    |
| HOME DEPOT INC                                               | HD             | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| INTL GAME TECHNOLOGY                                         | IGT.1          | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    |
| JONES GROUP INC                                              | JNY            | Consumer Discretionary | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| KATE SPADE & CO                                              | KATE           | Consumer Discretionary | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| KB HOME                                                      | KBH            | Consumer Discretionary | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| KOHL'S CORP                                                  | KSS            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| L BRANDS INC                                                 | LB             | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| LAS VEGAS SANDS CORP                                         | LVS            | Consumer Discretionary | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    |
| LEGGETT & PLATT INC                                          | LEG            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| LENNAR CORP                                                  | LEN            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| LKQ CORP                                                     | LKQ            | Consumer Discretionary | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    |
| LOWE'S COS INC                                               | LOW            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| MACY'S INC                                                   | M              | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| MARRIOTT INTL INC                                            | MAR            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| MATTEL INC                                                   | MAT            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    |
| MCDONALD'S CORP                                              | MCD            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| MGM RESORTS INTERNATIONAL                                    | MGM            | Consumer Discretionary | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    |
| MOHAWK INDUSTRIES INC                                        | MHK            | Consumer Discretionary | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| NEWELL BRANDS INC                                            | NWL            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| NIKE INC -CL B                                               | NKE            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| NORDSTROM INC                                                | JWN            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| NORWEGIAN CRUISE LINE HLDGS                                  | NCLH           | Consumer Discretionary | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    |
| NVR INC                                                      | NVR            | Consumer Discretionary | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    |
| ODP CORP                                                     | ODP            | Consumer Discretionary | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| OFFICEMAX INC                                                | OMX            | Consumer Discretionary | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| O'REILLY AUTOMOTIVE INC                                      | ORLY           | Consumer Discretionary | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| PENNEY (J C) CO                                              | JCPNQ          | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| PETSMART INC                                                 | PETM           | Consumer Discretionary | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    |
| PULTEGROUP INC                                               | PHM            | Consumer Discretionary | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |

## S&P 500 Companies by Year

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# Appendix A, Exhibit A1

## S&P 500 Companies by Year

| Company Name                                                 | Company Ticker | GICS Sector      | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|--------------------------------------------------------------|----------------|------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Number of S&P 500 Companies                                  |                |                  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  |
| Railroads, Financial Institutions, and Real Estate Companies |                |                  | 92   | 99   | 90   | 85   | 87   | 86   | 87   | 87   | 89   | 91   | 96   | 104  | 103  | 101  |
| Sample Number of S&P 500 Companies                           |                |                  | 408  | 401  | 410  | 415  | 413  | 414  | 413  | 413  | 411  | 409  | 404  | 396  | 397  | 399  |
| CONAGRA BRANDS INC                                           | CAG            | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| CONSTELLATION BRANDS                                         | STZ            | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| COSTCO WHOLESALE CORP                                        | COST           | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| COTY INC                                                     | COTY           | Consumer Staples | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    |
| DEAN FOODS CO                                                | DFODQ          | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| DR PEPPER SNAPPLE GROUP INC                                  | DPS            | Consumer Staples | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    |
| GENERAL MILLS INC                                            | GIS            | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| HERSHEY CO                                                   | HSY            | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| HILLSHIRE BRANDS CO                                          | HSI            | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| HORMEL FOODS CORP                                            | HRL            | Consumer Staples | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| KELLOGG CO                                                   | K              | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| KEURIG DR PEPPER INC                                         | KDP            | Consumer Staples | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 0    | 0    | 0    | 0    |
| KIMBERLY-CLARK CORP                                          | KMB            | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| KRAFT FOODS GROUP INC                                        | KRFT           | Consumer Staples | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    |
| KRAFT HEINZ CO                                               | KHC            | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 1    | 1    | 1    | 1    | 1    |
| KROGER CO                                                    | KR             | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| LAMB WESTON HOLDINGS INC                                     | LW             | Consumer Staples | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    |
| LAUDER (ESTEE) COS INC -CL A                                 | EL             | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| LORILLARD INC                                                | LO             | Consumer Staples | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    |
| MCCORMICK & CO INC                                           | MKC            | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| MEAD JOHNSON NUTRITION CO                                    | MJN            | Consumer Staples | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    |
| MOLSON COORS BEVERAGE CO                                     | TAP            | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| MONDELEZ INTERNATIONAL INC                                   | MDLZ           | Consumer Staples | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| MONSTER BEVERAGE CORP                                        | MNST           | Consumer Staples | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| PEPSI BOTTLING GROUP INC                                     | PBG            | Consumer Staples | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| PEPSICO INC                                                  | PEP            | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| PHILIP MORRIS INTERNATIONAL                                  | PM             | Consumer Staples | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| PROCTER & GAMBLE CO                                          | PG             | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| REYNOLDS AMERICAN INC                                        | RAI            | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    |
| SAFEWAY INC                                                  | SWY            | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    |
| SMUCKER (JM) CO                                              | SJM            | Consumer Staples | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| SUPERVALU INC                                                | SVU            | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| SYSCO CORP                                                   | SY             | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| TYSON FOODS INC -CL A                                        | TSN            | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| UST INC                                                      | UST.1          | Consumer Staples | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| WALGREENS BOOTS ALLIANCE INC                                 | WBA            | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| WALMART INC                                                  | WMT            | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| WHOLE FOODS MARKET INC                                       | WFM            | Consumer Staples | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    |
| WRIGLEY (WM) JR CO                                           | WWY            | Consumer Staples | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| ALPHA NATURAL RESOURCES INC                                  | ANRZQ          | Energy           | 0    | 0    | 0    | 0    | 0    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |

## S&P 500 Companies by Year

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### S&P 500 Companies by Year

| Company Name                                                 | Company Ticker | GICS Sector | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|--------------------------------------------------------------|----------------|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Number of S&P 500 Companies                                  |                |             | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  |
| Railroads, Financial Institutions, and Real Estate Companies |                |             | 92   | 99   | 90   | 85   | 87   | 86   | 87   | 87   | 89   | 91   | 96   | 104  | 103  | 101  |
| Sample Number of S&P 500 Companies                           |                |             | 408  | 401  | 410  | 415  | 413  | 414  | 413  | 413  | 411  | 409  | 404  | 396  | 397  | 399  |
| CBOE GLOBAL MARKETS INC                                      | CBOE*          | Financials  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    |
| CHUBB CORP                                                   | CB.1*          | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    |
| CHUBB LTD                                                    | CB*            | Financials  | 1    | 1    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| CINCINNATI FINANCIAL CORP                                    | CINF*          | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| CIT GROUP INC                                                | CIT*           | Financials  | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| CITIGROUP INC                                                | C*             | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| CITIZENS FINANCIAL GROUP INC                                 | CFG*           | Financials  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    |
| CME GROUP INC                                                | CME*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| COMERICA INC                                                 | CMA*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| COMMERCE BANCORP INC/NJ                                      | CBH.1*         | Financials  | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| COUNTRYWIDE FINANCIAL CORP                                   | CFC.3*         | Financials  | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| DISCOVER FINANCIAL SVCS                                      | DFS*           | Financials  | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| E TRADE FINANCIAL CORP                                       | ETFC*          | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| EQUITY OFFICE PROPERTIES TR                                  | EOP*           | Financials  | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| EVEREST RE GROUP LTD                                         | RE*            | Financials  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    |
| FEDERAL HOME LOAN MORTG CORP                                 | FMCC*          | Financials  | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| FEDERAL NATIONAL MORTGA ASSN                                 | FNMA*          | Financials  | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| FEDERATED HERMES INC                                         | FHI*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| FIFTH THIRD BANCORP                                          | FITB*          | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| FIRST HORIZON NATIONAL CORP                                  | FHN*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| FIRST REPUBLIC BANK                                          | FRC*           | Financials  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    |
| FRANKLIN RESOURCES INC                                       | BEN*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| GENWORTH FINANCIAL INC                                       | GNW*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    |
| GLOBE LIFE INC                                               | GL*            | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| GOLDMAN SACHS GROUP INC                                      | GS*            | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| HARTFORD FINANCIAL SERVICES                                  | HIG*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| HUDSON CITY BANCORP INC                                      | HCBK*          | Financials  | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    |
| HUNTINGTON BANCSHARES                                        | HBAN*          | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| INTERCONTINENTAL EXCHANGE                                    | ICE*           | Financials  | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| INVESCO LTD                                                  | IVZ*           | Financials  | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| JANUS CAPITAL GROUP INC                                      | JNS*           | Financials  | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| JEFFERIES FINANCIAL GRP INC                                  | JEF*           | Financials  | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    |
| JPMORGAN CHASE & CO                                          | JPM*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| KEYCORP                                                      | KEY*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| LEGG MASON INC                                               | LM*            | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    |
| LEHMAN BROTHERS HOLDINGS INC                                 | LEHMQ*         | Financials  | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| LINCOLN NATIONAL CORP                                        | LNC*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| LOEWS CORP                                                   | L*             | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| M & T BANK CORP                                              | MTB*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| MARKETAXESS HOLDINGS INC                                     | MKTX*          | Financials  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    |

## S&P 500 Companies by Year

| Company Name                                                 | Company Ticker | GICS Sector | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|--------------------------------------------------------------|----------------|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Number of S&P 500 Companies                                  |                |             | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  |
| Railroads, Financial Institutions, and Real Estate Companies |                |             | 92   | 99   | 90   | 85   | 87   | 86   | 87   | 87   | 89   | 91   | 96   | 104  | 103  | 101  |
| Sample Number of S&P 500 Companies                           |                |             | 408  | 401  | 410  | 415  | 413  | 414  | 413  | 413  | 411  | 409  | 404  | 396  | 397  | 399  |
| MARSH & MCLENNAN COS                                         | MMC*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| MARSHALL & ILSLEY CORP                                       | ML1*           | Financials  | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| MBIA INC                                                     | MBI*           | Financials  | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| MELLON FINANCIAL CORP                                        | MEL.3*         | Financials  | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| MERRILL LYNCH & CO INC                                       | BAC2*          | Financials  | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| METLIFE INC                                                  | MET*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| MGIC INVESTMENT CORP/WI                                      | MTG*           | Financials  | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| MOODY'S CORP                                                 | MCO*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| MORGAN STANLEY                                               | MS*            | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| MSCI INC                                                     | MSCI*          | Financials  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    |
| NASDAQ INC                                                   | NDAQ*          | Financials  | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| NATIONAL CITY CORP                                           | NCC*           | Financials  | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| NAVIENT CORP                                                 | NAVI*          | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    |
| NORTHERN TRUST CORP                                          | NTRS*          | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| NYSE EURONEXT                                                | NYX*           | Financials  | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| PEOPLE'S UNITED FINL INC                                     | PBCT*          | Financials  | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| PLUM CREEK TIMBER CO INC                                     | PCL*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    |
| PNC FINANCIAL SVCS GROUP INC                                 | PNC*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| PRICE (T. ROWE) GROUP                                        | TROW*          | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| PRINCIPAL FINANCIAL GRP INC                                  | PFG*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| PROGRESSIVE CORP-OHIO                                        | PGR*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| PRUDENTIAL FINANCIAL INC                                     | PRU*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| RAYMOND JAMES FINANCIAL CORP                                 | RJF*           | Financials  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    |
| REGIONS FINANCIAL CORP                                       | RF*            | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| S&P GLOBAL INC                                               | SPGI*          | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| SAFECO CORP                                                  | SAF.3*         | Financials  | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| SANTANDER HOLDINGS USA INC                                   | STD2*          | Financials  | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| SCHWAB (CHARLES) CORP                                        | SCHW*          | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| STATE STREET CORP                                            | STT*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| SUNTRUST BANKS INC                                           | STI*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    |
| SVB FINANCIAL GROUP                                          | SIVB*          | Financials  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    |
| SYNCHRONY FINANCIAL                                          | SYF*           | Financials  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    |
| SYNOVUS FINANCIAL CORP                                       | SNV*           | Financials  | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| TRAVELERS COS INC                                            | TRV*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| TRUIST FINANCIAL CORP                                        | TFC*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| U S BANCORP                                                  | USB*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| UNUM GROUP                                                   | UNM*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| WACHOVIA CORP                                                | WB.3*          | Financials  | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| WASHINGTON MUTUAL INC                                        | WAMUQ*         | Financials  | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| WELLS FARGO & CO                                             | WFC*           | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |

### S&P 500 Companies by Year

| Company Name                                                 | Company Ticker | GICS Sector | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|--------------------------------------------------------------|----------------|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Number of S&P 500 Companies                                  |                |             | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  |
| Railroads, Financial Institutions, and Real Estate Companies |                |             | 92   | 99   | 90   | 85   | 87   | 86   | 87   | 87   | 89   | 91   | 96   | 104  | 103  | 101  |
| Sample Number of S&P 500 Companies                           |                |             | 408  | 401  | 410  | 415  | 413  | 414  | 413  | 413  | 411  | 409  | 404  | 396  | 397  | 399  |
| WILLIS TOWERS WATSON PLC                                     | WLTW*          | Financials  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    |
| XL GROUP LTD                                                 | XL*            | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    |
| ZIONS BANCORPORATION NA                                      | ZION*          | Financials  | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| ABBOTT LABORATORIES                                          | ABT            | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| ABBVIE INC                                                   | ABBV           | Health Care | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| ABIOMED INC                                                  | ABMD           | Health Care | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    |
| AETNA INC                                                    | AET            | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    |
| AGILENT TECHNOLOGIES INC                                     | A              | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| ALEXION PHARMACEUTICALS INC                                  | ALXN           | Health Care | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| ALIGN TECHNOLOGY INC                                         | ALGN           | Health Care | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    |
| ALLERGAN INC                                                 | AGN.2          | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    |
| ALLERGAN PLC                                                 | AGN            | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| AMERISOURCEBERGEN CORP                                       | ABC            | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| AMGEN INC                                                    | AMGN           | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| ANTHEM INC                                                   | ANTM           | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| APPLIED BIOSYSTEMS INC                                       | ABI.3          | Health Care | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| BARD (C.R.) INC                                              | BCR            | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    |
| BARR PHARMACEUTICALS INC                                     | BRL            | Health Care | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| BAUSCH & LOMB HLDGS -REDH                                    | 6583B          | Health Care | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| BAXALTA INC                                                  | BXLT           | Health Care | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 0    | 0    | 0    | 0    |
| BAXTER INTERNATIONAL INC                                     | BAX            | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| BECTON DICKINSON & CO                                        | BDX            | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| BIOGEN INC                                                   | BIIB           | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| BIOMET INC                                                   | 5938B          | Health Care | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| BOSTON SCIENTIFIC CORP                                       | BSX            | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| BRISTOL-MYERS SQUIBB CO                                      | BMJ            | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| CARDINAL HEALTH INC                                          | CAH            | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| CAREFUSION CORP                                              | CFN            | Health Care | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    |
| CAREMARK RX INC                                              | CMX.1          | Health Care | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| CELGENE CORP                                                 | CELG           | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    |
| CENTENE CORP                                                 | CNC            | Health Care | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    |
| CEPHALON INC                                                 | CEPH           | Health Care | 0    | 0    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| CERNER CORP                                                  | CERN           | Health Care | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| CIGNA CORP                                                   | CI             | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| COOPER COS INC (THE)                                         | COO            | Health Care | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    |
| COVENTRY HEALTH CARE INC                                     | CVH            | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| COVIDIEN PLC                                                 | COV            | Health Care | 0    | 1    | 1    | 0    | 0    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    |
| CVS HEALTH CORP                                              | CVS            | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| DANAHER CORP                                                 | DHR            | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| DAVITA INC                                                   | DVA            | Health Care | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |

## S&P 500 Companies by Year

[illegible]

# Appendix A, Exhibit A1

## S&P 500 Companies by Year

| Company Name                                                 | Company Ticker | GICS Sector | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|--------------------------------------------------------------|----------------|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Number of S&P 500 Companies                                  |                |             | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  |
| Railroads, Financial Institutions, and Real Estate Companies |                |             | 92   | 99   | 90   | 85   | 87   | 86   | 87   | 87   | 89   | 91   | 96   | 104  | 103  | 101  |
| Sample Number of S&P 500 Companies                           |                |             | 408  | 401  | 410  | 415  | 413  | 414  | 413  | 413  | 411  | 409  | 404  | 396  | 397  | 399  |
|                                                              |                |             |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| QUEST DIAGNOSTICS INC                                        | DGX            | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| REGENERON PHARMACEUTICALS                                    | REGN           | Health Care | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| RESMED INC                                                   | RMD            | Health Care | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    |
| SCHERING-PLOUGH                                              | SGP            | Health Care | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| ST JUDE MEDICAL INC                                          | STJ            | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    |
| STERIS PLC                                                   | STE            | Health Care | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    |
| STRYKER CORP                                                 | SYK            | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| TELEFLEX INC                                                 | TFX            | Health Care | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    |
| TENET HEALTHCARE CORP                                        | THC            | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    |
| THERMO FISHER SCIENTIFIC INC                                 | TMO            | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| UNITEDHEALTH GROUP INC                                       | UNH            | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| UNIVERSAL HEALTH SVCS INC                                    | UHS            | Health Care | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    |
| VARIAN MEDICAL SYSTEMS INC                                   | VAR            | Health Care | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| VERTEX PHARMACEUTICALS INC                                   | VRTX           | Health Care | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| WATERS CORP                                                  | WAT            | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| WELLCARE HEALTH PLANS INC                                    | WCG            | Health Care | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    |
| WYETH                                                        | WYE            | Health Care | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| ZIMMER BIOMET HOLDINGS INC                                   | ZBH            | Health Care | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| ZOETIS INC                                                   | ZTS            | Health Care | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| 3M CO                                                        | MMM            | Industrials | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| ACUITY BRANDS INC                                            | AYI            | Industrials | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 0    | 0    |
| ADT CORP                                                     | ADT.4          | Industrials | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    |
| ALASKA AIR GROUP INC                                         | ALK            | Industrials | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    |
| ALLEGION PLC                                                 | ALLE           | Industrials | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| ALLIED WASTE INDUSTRIES INC                                  | AW             | Industrials | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| AMERICAN AIRLINES GROUP INC                                  | AAL            | Industrials | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    |
| AMERICAN POWER CONVERSION CP                                 | APCC.          | Industrials | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| AMETEK INC                                                   | AME            | Industrials | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| BOEING CO                                                    | BA             | Industrials | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| BURLINGTON NORTHERN SANTA FE                                 | BRK3           | Industrials | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| C H ROBINSON WORLDWIDE INC                                   | CHRW           | Industrials | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| CATERPILLAR INC                                              | CAT            | Industrials | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| CINTAS CORP                                                  | CTAS           | Industrials | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| COOPER INDUSTRIES PLC                                        | CBE            | Industrials | 1    | 1    | 1    | 0    | 0    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| COPART INC                                                   | CPRT           | Industrials | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    |
| CSX CORP                                                     | CSX            | Industrials | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| CUMMINS INC                                                  | CMI            | Industrials | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| DEERE & CO                                                   | DE             | Industrials | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| DELTA AIR LINES INC                                          | DAL            | Industrials | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| DONNELLEY (R R) & SONS CO                                    | RRD            | Industrials | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |

## S&P 500 Companies by Year

[illegible]

# Appendix A, Exhibit A1

## S&P 500 Companies by Year

| Company Name                                                 | Company Ticker | GICS Sector            | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|--------------------------------------------------------------|----------------|------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Number of S&P 500 Companies                                  |                |                        | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  |
| Railroads, Financial Institutions, and Real Estate Companies |                |                        | 92   | 99   | 90   | 85   | 87   | 86   | 87   | 87   | 89   | 91   | 96   | 104  | 103  | 101  |
| Sample Number of S&P 500 Companies                           |                |                        | 408  | 401  | 410  | 415  | 413  | 414  | 413  | 413  | 411  | 409  | 404  | 396  | 397  | 399  |
| PENTAIR PLC                                                  | PNR            | Industrials            | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| PITNEY BOWES INC                                             | PBI            | Industrials            | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    |
| PRECISION CASTPARTS CORP                                     | PCP            | Industrials            | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    |
| QUANTA SERVICES INC                                          | PWR            | Industrials            | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| RAYTHEON CO                                                  | RTN            | Industrials            | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| RAYTHEON TECHNOLOGIES CORP                                   | RTX            | Industrials            | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| REPUBLIC SERVICES INC                                        | RSG            | Industrials            | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| ROBERT HALF INTL INC                                         | RHI            | Industrials            | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| ROCKWELL AUTOMATION                                          | ROK            | Industrials            | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| ROCKWELL COLLINS                                             | COL            | Industrials            | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    |
| ROLLINS INC                                                  | ROL            | Industrials            | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    |
| ROPER TECHNOLOGIES INC                                       | ROP            | Industrials            | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| RYDER SYSTEM INC                                             | R              | Industrials            | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    |
| SMITH (A.O.)                                                 | AOS            | Industrials            | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    |
| SNAP-ON INC                                                  | SNA            | Industrials            | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| SOUTHWEST AIRLINES                                           | LUV            | Industrials            | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| STANLEY BLACK & DECKER INC                                   | SWK            | Industrials            | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| STERICYCLE INC                                               | SRCL           | Industrials            | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    |
| TEREX CORP                                                   | TEX            | Industrials            | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| TEXTRON INC                                                  | TXT            | Industrials            | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| TRANE INC                                                    | TT.2           | Industrials            | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| TRANE TECHNOLOGIES PLC                                       | TT             | Industrials            | 1    | 1    | 1    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| TRANSDIGM GROUP INC                                          | TDG            | Industrials            | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    |
| TYCO INTERNATIONAL PLC                                       | TYC            | Industrials            | 1    | 1    | 1    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    |
| UNION PACIFIC CORP                                           | UNP            | Industrials            | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| UNITED AIRLINES HOLDINGS INC                                 | UAL            | Industrials            | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    |
| UNITED PARCEL SERVICE INC                                    | UPS            | Industrials            | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| UNITED RENTALS INC                                           | URI            | Industrials            | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    |
| VERISK ANALYTICS INC                                         | VRSK           | Industrials            | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    |
| WABTEC CORP                                                  | WAB            | Industrials            | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    |
| WASTE MANAGEMENT INC                                         | WM             | Industrials            | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| XYLEM INC                                                    | XYL            | Industrials            | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| ACCENTURE PLC                                                | ACN            | Information Technology | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| ADC TELECOMMUNICATIONS INC                                   | ADCT.1         | Information Technology | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| ADOBE INC                                                    | ADBE           | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| ADVANCED MICRO DEVICES                                       | AMD            | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 1    | 1    | 1    |
| AFFILIATED COMPUTER SERVICES                                 | ACS            | Information Technology | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| AKAMAI TECHNOLOGIES INC                                      | AKAM           | Information Technology | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| ALLIANCE DATA SYSTEMS CORP                                   | ADS            | Information Technology | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| ALTERA CORP                                                  | ALTR.1         | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    |

# Appendix A, Exhibit A1

## S&P 500 Companies by Year

| Company Name                                                 | Company Ticker | GICS Sector            | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|--------------------------------------------------------------|----------------|------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Number of S&P 500 Companies                                  |                |                        | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  |
| Railroads, Financial Institutions, and Real Estate Companies |                |                        | 92   | 99   | 90   | 85   | 87   | 86   | 87   | 87   | 89   | 91   | 96   | 104  | 103  | 101  |
| Sample Number of S&P 500 Companies                           |                |                        | 408  | 401  | 410  | 415  | 413  | 414  | 413  | 413  | 411  | 409  | 404  | 396  | 397  | 399  |
| AMPHENOL CORP                                                | APH            | Information Technology | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| ANALOG DEVICES                                               | ADI            | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| ANSYS INC                                                    | ANSS           | Information Technology | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    |
| APPLE INC                                                    | AAPL           | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| APPLIED MATERIALS INC                                        | AMAT           | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| ARISTA NETWORKS INC                                          | ANET           | Information Technology | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    |
| AUTODESK INC                                                 | ADSK           | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| AUTOMATIC DATA PROCESSING                                    | ADP            | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| AVAYA INC                                                    | 5933B          | Information Technology | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| BMC SOFTWARE INC                                             | BMC            | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| BROADCOM CORP                                                | BRCM           | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    |
| BROADCOM INC                                                 | AVGO           | Information Technology | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    |
| BROADRIDGE FINANCIAL SOLUTNS                                 | BR             | Information Technology | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    |
| CA INC                                                       | CA             | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    |
| CADENCE DESIGN SYSTEMS INC                                   | CDNS           | Information Technology | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    |
| CDW CORP                                                     | CDW            | Information Technology | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    |
| CIENA CORP                                                   | CIEN           | Information Technology | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| CISCO SYSTEMS INC                                            | CSCO           | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| CITRIX SYSTEMS INC                                           | CTXS           | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| COGNIZANT TECH SOLUTIONS                                     | CTSH           | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| COMPUWARE CORP                                               | CPWR.1         | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| COMVERSE TECHNOLOGY INC                                      | CMVT           | Information Technology | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| CONVERGYS CORP                                               | CVG            | Information Technology | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| CORNING INC                                                  | GLW            | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| CSRA INC                                                     | CSRA           | Information Technology | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 0    | 0    |
| DELL TECHNOLOGIES INC                                        | DELL           | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| DXC TECHNOLOGY CO                                            | DXC            | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 1    | 1    | 1    |
| EASTMAN KODAK CO                                             | KODK           | Information Technology | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| ELECTRONIC DATA SYSTEMS CORP                                 | EDS.           | Information Technology | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| EMC CORP/MA                                                  | EMC            | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    |
| F5 NETWORKS INC                                              | FFIV           | Information Technology | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| FIDELITY NATIONAL INFO SVCS                                  | FIS            | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| FIRST DATA CORP                                              | FDC            | Information Technology | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| FIRST SOLAR INC                                              | FSLR           | Information Technology | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    |
| FISERV INC                                                   | FISV           | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| FLEETCOR TECHNOLOGIES INC                                    | FLT            | Information Technology | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    |
| FLIR SYSTEMS INC                                             | FLIR           | Information Technology | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| FORTINET INC                                                 | FTNT           | Information Technology | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    |
| GARTNER INC                                                  | IT             | Information Technology | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    |
| GLOBAL PAYMENTS INC                                          | GPN            | Information Technology | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    |

# Appendix A, Exhibit A1

## S&P 500 Companies by Year

| Company Name                                                 | Company Ticker | GICS Sector            | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|--------------------------------------------------------------|----------------|------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Number of S&P 500 Companies                                  |                |                        | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  |
| Railroads, Financial Institutions, and Real Estate Companies |                |                        | 92   | 99   | 90   | 85   | 87   | 86   | 87   | 87   | 89   | 91   | 96   | 104  | 103  | 101  |
| Sample Number of S&P 500 Companies                           |                |                        | 408  | 401  | 410  | 415  | 413  | 414  | 413  | 413  | 411  | 409  | 404  | 396  | 397  | 399  |
| HENRY (JACK) & ASSOCIATES                                    | JKHY           | Information Technology | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    |
| HEWLETT PACKARD ENTERPRISE                                   | HPE            | Information Technology | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    |
| HP INC                                                       | HPQ            | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| INTEL CORP                                                   | INTC           | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| INTL BUSINESS MACHINES CORP                                  | IBM            | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| INTUIT INC                                                   | INTU           | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| IPG PHOTONICS CORP                                           | IPGP           | Information Technology | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    |
| JABIL INC                                                    | JBL            | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    |
| JUNIPER NETWORKS INC                                         | JNPR           | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| KEYSIGHT TECHNOLOGIES INC                                    | KEYS           | Information Technology | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    |
| KLA CORP                                                     | KLAC           | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| LAM RESEARCH CORP                                            | LRCX           | Information Technology | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| LEIDOS HOLDINGS INC                                          | LDOS           | Information Technology | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 1    |
| LEXMARK INTL INC -CL A                                       | LXK            | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| LINEAR TECHNOLOGY CORP                                       | LLTC           | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    |
| LSI CORP                                                     | LSI.1          | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    |
| MASTERCARD INC                                               | MA             | Information Technology | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| MAXIM INTEGRATED PRODUCTS                                    | MXIM           | Information Technology | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    |
| MCAFEE INC                                                   | MFE            | Information Technology | 0    | 0    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| MICROCHIP TECHNOLOGY INC                                     | MCHP           | Information Technology | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| MICRON TECHNOLOGY INC                                        | MU             | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| MICROSOFT CORP                                               | MSFT           | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| MOLEX INC                                                    | MOLX           | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| MONSTER WORLDWIDE INC                                        | MWW            | Information Technology | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| MOTOROLA MOBILITY HLDGS INC                                  | MML3           | Information Technology | 0    | 0    | 0    | 0    | 0    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| MOTOROLA SOLUTIONS INC                                       | MSI            | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| NATIONAL SEMICONDUCTOR CORP                                  | NSM.2          | Information Technology | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| NCR CORP                                                     | NCR            | Information Technology | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| NETAPP INC                                                   | NTAP           | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| NORTONLIFELOCK INC                                           | NLOK           | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| NOVELL INC                                                   | NOVL           | Information Technology | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| NOVELLUS SYSTEMS INC                                         | NVLS.1         | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| NVIDIA CORP                                                  | NVDA           | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| ORACLE CORP                                                  | ORCL           | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| PAYCHEX INC                                                  | PAYX           | Information Technology | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| PAYPAL HOLDINGS INC                                          | PYPL           | Information Technology | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    |
| PMC-SIERRA INC                                               | PMCS           | Information Technology | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| PTC INC                                                      | PTC            | Information Technology | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| QLOGIC CORP                                                  | QLGC           | Information Technology | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| QORVO INC                                                    | QRVO           | Information Technology | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    |

## S&P 500 Companies by Year

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### S&P 500 Companies by Year

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### S&P 500 Companies by Year

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## Appendix A, Exhibit A1

### S&P 500 Companies by Year

| Company Name                                                 | Company Ticker | GICS Sector | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|--------------------------------------------------------------|----------------|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Number of S&P 500 Companies                                  |                |             | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  | 500  |
| Railroads, Financial Institutions, and Real Estate Companies |                |             | 92   | 99   | 90   | 85   | 87   | 86   | 87   | 87   | 89   | 91   | 96   | 104  | 103  | 101  |
| Sample Number of S&P 500 Companies                           |                |             | 408  | 401  | 410  | 415  | 413  | 414  | 413  | 413  | 411  | 409  | 404  | 396  | 397  | 399  |
|                                                              |                |             |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| CMS ENERGY CORP                                              | CMS            | Utilities   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| CONSOLIDATED EDISON INC                                      | ED             | Utilities   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| CONSTELLATION ENERGY GRP INC                                 | CEG            | Utilities   | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| DOMINION ENERGY INC                                          | D              | Utilities   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| DTE ENERGY CO                                                | DTE            | Utilities   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| DUKE ENERGY CORP                                             | DUK            | Utilities   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| DYNEGY INC                                                   | DYN            | Utilities   | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| EDISON INTERNATIONAL                                         | EIX            | Utilities   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| ENERGY FUTURE HOLDINGS CORP                                  | 0033A          | Utilities   | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| ENERGY CORP                                                  | ETR            | Utilities   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| EVERGY INC                                                   | EVERG          | Utilities   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    |
| EVERSOURCE ENERGY                                            | ES             | Utilities   | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| EXELON CORP                                                  | EXC            | Utilities   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| FIRSTENERGY CORP                                             | FE             | Utilities   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| INTEGRYS HOLDING INC                                         | WEC3           | Utilities   | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    |
| KEYSPAN CORP                                                 | KSE            | Utilities   | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| NEXTERA ENERGY INC                                           | NEE            | Utilities   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| NICOR INC                                                    | GAS.2          | Utilities   | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| NISOURCE INC                                                 | NI             | Utilities   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| NRG ENERGY INC                                               | NRG            | Utilities   | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| PEOPLES ENERGY CORP                                          | PGL.1          | Utilities   | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| PEPCO HOLDINGS INC                                           | POM            | Utilities   | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    |
| PG&E CORP                                                    | PCG            | Utilities   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    |
| PINNACLE WEST CAPITAL CORP                                   | PNW            | Utilities   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| PPL CORP                                                     | PPL            | Utilities   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| PROGRESS ENERGY INC                                          | DUK8           | Utilities   | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| PUBLIC SERVICE ENTRP GRP INC                                 | PEG            | Utilities   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| QUESTAR CORP                                                 | STR            | Utilities   | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| SCANA CORP                                                   | SCG            | Utilities   | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    |
| SEMPRA ENERGY                                                | SRE            | Utilities   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| SOUTHERN CO                                                  | SO             | Utilities   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| SOUTHERN CO GAS                                              | SO7            | Utilities   | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    |
| TECO ENERGY INC                                              | TE             | Utilities   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 0    | 0    | 0    | 0    |
| WEC ENERGY GROUP INC                                         | WEC            | Utilities   | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
| XCEL ENERGY INC                                              | XEL            | Utilities   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |

Source: Compustat.

Note: Ticker DD corresponds to Dow Chemical Company before 2017 and DowDuPont after 2017 following its merger with DuPont on August 31, 2017.

**Appendix B, Exhibit B1**  
**Railroad Return on Invested Capital (ROIC) minus Industry Cost of Capital (COC)**

|                                                                                                                          | 2006  | 2007  | 2008  | 2009  | 2010  | 2011  | 2012  | 2013  | 2014   | 2015  | 2016  | 2017  | 2018  | 2019  | Min    | Max   | Median | Average |
|--------------------------------------------------------------------------------------------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|--------|-------|-------|-------|-------|-------|--------|-------|--------|---------|
| <b>Panel A: Railroad STB Definition of Cost of Capital</b>                                                               |       |       |       |       |       |       |       |       |        |       |       |       |       |       |        |       |        |         |
| Railroad Industry Cost of Capital                                                                                        | 9.9%  | 11.3% | 11.8% | 10.4% | 11.0% | 11.6% | 11.1% | 11.3% | 10.7%  | 9.6%  | 8.9%  | 10.0% | 12.2% | 9.3%  | 8.9%   | 12.2% | 10.8%  | 10.7%   |
| <b>Panel B: Railroad ROIC minus COC - Based on STB Definition of ROIC and STB Definition of Cost of Capital</b>          |       |       |       |       |       |       |       |       |        |       |       |       |       |       |        |       |        |         |
| Industry Weighted Average ROIC                                                                                           | 0.2%  | -1.5% | -1.0% | -2.5% | -0.3% | 0.5%  | 1.4%  | 1.8%  | 2.2%   | 2.5%  | 1.5%  | 0.8%  | 0.5%  | 3.1%  | -2.5%  | 3.1%  | 0.7%   | 0.7%    |
| BNSF Railway                                                                                                             | 1.5%  | -1.4% | -1.2% | -1.8% | -0.8% | 0.8%  | 2.4%  | 2.7%  | 2.2%   | 3.2%  | 1.2%  | 0.7%  | -0.3% | 2.7%  | -1.8%  | 3.2%  | 1.0%   | 0.9%    |
| CSX Corporation                                                                                                          | -1.8% | -3.7% | -2.4% | -3.1% | -0.2% | 0.0%  | -0.3% | -1.3% | -0.5%  | -0.6% | -0.3% | -1.2% | 1.0%  | 3.5%  | -3.7%  | 3.5%  | -0.5%  | -0.8%   |
| Grand Trunk Corporation                                                                                                  | -0.5% | -1.2% | -1.9% | -4.4% | -1.8% | -2.8% | -0.9% | 0.5%  | 0.6%   | 1.2%  | -0.3% | -2.3% | -4.5% | -1.9% | -4.5%  | 1.2%  | -1.5%  | -1.4%   |
| Kansas City Southern                                                                                                     | -0.6% | -2.0% | -4.1% | -3.9% | -1.3% | -0.8% | -1.6% | -2.7% | -2.5%  | -2.4% | -2.6% | -2.9% | -4.2% | -3.1% | -4.2%  | -0.6% | -2.6%  | -2.5%   |
| Norfolk Southern Corporation                                                                                             | 4.4%  | 2.2%  | 2.0%  | -2.7% | -0.1% | 1.3%  | 0.4%  | 0.7%  | 1.0%   | -0.6% | 0.3%  | 0.0%  | -0.6% | 2.3%  | -2.7%  | 4.4%  | 0.6%   | 0.8%    |
| Soo Line Corporation                                                                                                     | 1.7%  | 3.9%  | -2.5% | -4.1% | -3.0% | -4.4% | -6.0% | 0.7%  | -11.1% | 4.9%  | 0.7%  | 0.7%  | 1.3%  | 2.0%  | -11.1% | 4.9%  | 0.7%   | -1.1%   |
| Union Pacific Corporation                                                                                                | -1.7% | -2.4% | -1.3% | -1.8% | 0.5%  | 1.5%  | 3.6%  | 4.1%  | 6.7%   | 5.9%  | 4.5%  | 4.0%  | 3.6%  | 6.2%  | -2.4%  | 6.7%  | 3.6%   | 2.4%    |
| <b>Panel C: Railroad ROIC minus COC - Based on Adjusted STB Definition of ROIC and STB Definition of Cost of Capital</b> |       |       |       |       |       |       |       |       |        |       |       |       |       |       |        |       |        |         |
| Industry Weighted Average ROIC                                                                                           | -2.2% | -3.5% | -2.5% | -3.1% | -1.7% | -0.5% | -0.9% | -1.0% | -0.3%  | 0.5%  | -0.3% | -2.6% | -1.5% | 1.4%  | -3.5%  | 1.4%  | -1.2%  | -1.3%   |
| BNSF Railway                                                                                                             | -0.7% | -3.1% | -2.7% | -2.2% | -1.5% | 1.1%  | -0.2% | -0.4% | 0.1%   | 1.2%  | -0.4% | -2.9% | -2.3% | 0.9%  | -3.1%  | 1.2%  | -0.5%  | -0.9%   |
| CSX Corporation                                                                                                          | -3.6% | -5.0% | -3.4% | -3.7% | -1.7% | -1.2% | -2.0% | -3.4% | -2.6%  | -1.9% | -1.7% | -4.0% | -1.0% | 1.5%  | -5.0%  | 1.5%  | -2.3%  | -2.4%   |
| Grand Trunk Corporation                                                                                                  | -2.3% | -3.3% | -4.3% | -5.5% | -2.9% | -3.1% | -3.4% | -2.8% | -1.8%  | -0.5% | -1.4% | -4.7% | -5.1% | -2.3% | -5.5%  | -0.5% | -3.0%  | -3.1%   |
| Kansas City Southern                                                                                                     | -1.3% | -2.7% | -3.8% | -3.8% | -1.1% | -0.9% | -1.3% | -1.7% | -1.8%  | -1.8% | -2.2% | -4.5% | -3.9% | -3.5% | -4.5%  | -0.9% | -2.0%  | -2.5%   |
| Norfolk Southern Corporation                                                                                             | -0.9% | -2.2% | -0.7% | -3.5% | -2.2% | -0.8% | -2.1% | -2.1% | -1.6%  | -2.4% | -1.7% | -3.1% | -2.3% | 0.8%  | -3.5%  | 0.8%  | -2.1%  | -1.8%   |
| Soo Line Corporation                                                                                                     | 2.3%  | 4.1%  | -4.0% | -5.0% | -3.1% | -4.7% | -7.1% | -0.1% | -13.7% | 1.9%  | -0.4% | -2.6% | -0.3% | 0.0%  | -13.7% | 4.1%  | -1.5%  | -2.3%   |
| Union Pacific Corporation                                                                                                | -3.6% | -4.1% | -2.1% | -2.5% | -1.1% | -0.2% | 1.2%  | 0.9%  | 3.0%   | 3.0%  | 2.0%  | -0.4% | 1.0%  | 4.0%  | -4.1%  | 4.0%  | 0.3%   | 0.1%    |

Sources: Bloomberg; Compustat; Ibbotson Yearbook (2006-2019); STB Revenue Adequacy Determination Report (2006-2018); RevAd 2019 AAR workpaper1.pdf, titled "AAR Duplication of STB Workpapers."

## Appendix C, Exhibit C1

Railroad Percentiles within Sample - STB Definition of Return on Invested Capital (ROIC) and STB Definition of Cost of Capital (COC)  
(Railroads' Return on Invested Capital and Cost of Capital Measured Using Non-STB Public Data)

|                                                                                                             | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | Min | Max  | Median | Average |
|-------------------------------------------------------------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|-----|------|--------|---------|
| <b>Panel A: S&amp;P 500 Companies Excluding Railroads, Financial Institutions and Real Estate Companies</b> |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |      |        |         |
| <b>Sample Number of Observations, Median, 25th Percentile, and % Positive ROIC minus COC:</b>               |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |      |        |         |
| Number of Observations in Sample                                                                            | 398  | 395  | 402  | 405  | 402  | 401  | 397  | 395  | 392  | 383  | 371  | 368  | 378  | 380  | 368 | 405  | 395    | 391     |
| Median ROIC minus COC                                                                                       | 16%  | 16%  | 16%  | 13%  | 18%  | 19%  | 19%  | 21%  | 20%  | 22%  | 22%  | 20%  | 29%  | 25%  | 13% | 29%  | 19%    | 20%     |
| 25th Percentile ROIC minus COC                                                                              | 5%   | 5%   | 3%   | -1%  | 5%   | 6%   | 5%   | 4%   | 5%   | 4%   | 4%   | 5%   | 6%   | 5%   | -1% | 6%   | 5%     | 4%      |
| % with ROIC minus COC > 0.0%                                                                                | 90%  | 89%  | 86%  | 73%  | 89%  | 91%  | 89%  | 90%  | 90%  | 88%  | 85%  | 89%  | 90%  | 89%  | 73% | 91%  | 89%    | 88%     |
| <b>Railroad Percentile in the Distribution of ROIC minus COC:</b>                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |      |        |         |
| Industry Weighted Average ROIC                                                                              | 15   | 15   | 14   | 20   | 15   | 12   | 17   | 19   | 25   | 23   | 24   | 27   | 23   | 25   | 12  | 27   | 19     | 20      |
| CSX Corporation                                                                                             | 16   | 17   | 22   | 26   | 22   | 14   | 16   | 16   | 19   | 18   | 20   | 20   | 23   | 28   | 14  | 28   | 19     | 20      |
| Kansas City Southern                                                                                        | 11   | 13   | 11   | 14   | 10   | 6    | 10   | 9    | 11   | 12   | 16   | 13   | 8    | 12   | 6   | 16   | 11     | 11      |
| Norfolk Southern Corporation                                                                                | 24   | 22   | 26   | 23   | 17   | 14   | 13   | 13   | 19   | 14   | 19   | 22   | 17   | 23   | 13  | 26   | 19     | 19      |
| Union Pacific Corporation                                                                                   | 10   | 9    | 9    | 16   | 12   | 12   | 23   | 26   | 32   | 29   | 28   | 33   | 25   | 28   | 9   | 33   | 24     | 21      |
| <b>Panel B: S&amp;P 500 Companies in the Industrials Sector Excluding Railroads</b>                         |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |      |        |         |
| <b>Sample Number of Observations, Median, 25th Percentile, and % Positive ROIC minus COC:</b>               |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |      |        |         |
| Number of Observations in Sample                                                                            | 48   | 52   | 55   | 53   | 54   | 56   | 53   | 56   | 57   | 59   | 63   | 62   | 62   | 61   | 48  | 63   | 56     | 57      |
| Median ROIC minus COC                                                                                       | 20%  | 23%  | 21%  | 14%  | 17%  | 21%  | 22%  | 22%  | 23%  | 24%  | 28%  | 28%  | 30%  | 31%  | 14% | 31%  | 23%    | 23%     |
| 25th Percentile ROIC minus COC                                                                              | 11%  | 13%  | 13%  | 4%   | 10%  | 13%  | 12%  | 14%  | 11%  | 13%  | 9%   | 14%  | 13%  | 13%  | 4%  | 14%  | 13%    | 12%     |
| % with ROIC minus COC > 0.0%                                                                                | 96%  | 92%  | 98%  | 83%  | 94%  | 96%  | 96%  | 96%  | 96%  | 97%  | 94%  | 100% | 95%  | 97%  | 83% | 100% | 96%    | 95%     |
| <b>Railroad Percentile in the Distribution of ROIC minus COC:</b>                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |      |        |         |
| Industry Weighted Average ROIC                                                                              | 10   | 9    | 4    | 9    | 11   | 5    | 6    | 7    | 17   | 13   | 9    | 11   | 13   | 13   | 4   | 17   | 10     | 10      |
| CSX Corporation                                                                                             | 10   | 9    | 9    | 15   | 13   | 5    | 6    | 7    | 10   | 10   | 9    | 6    | 13   | 15   | 5   | 15   | 10     | 10      |
| Kansas City Southern                                                                                        | 6    | 9    | 4    | 7    | 7    | 5    | 6    | 5    | 7    | 5    | 8    | 2    | 5    | 5    | 2   | 9    | 5      | 6       |
| Norfolk Southern Corporation                                                                                | 14   | 13   | 11   | 11   | 11   | 5    | 6    | 5    | 10   | 7    | 9    | 6    | 6    | 8    | 5   | 14   | 9      | 9       |
| Union Pacific Corporation                                                                                   | 6    | 6    | 4    | 7    | 7    | 5    | 9    | 9    | 21   | 15   | 11   | 14   | 16   | 15   | 4   | 21   | 9      | 10      |
| <b>Panel C: Railroad Customer Sample of S&amp;P 500 Companies</b>                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |      |        |         |
| <b>Sample Number of Observations, Median, 25th Percentile, and % Positive ROIC minus COC:</b>               |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |      |        |         |
| Number of Observations in Sample                                                                            | 80   | 80   | 81   | 82   | 84   | 84   | 84   | 83   | 84   | 86   | 85   | 83   | 84   | 82   | 80  | 86   | 84     | 83      |
| Median ROIC minus COC                                                                                       | 13%  | 12%  | 9%   | 3%   | 12%  | 13%  | 10%  | 7%   | 7%   | 8%   | 6%   | 8%   | 11%  | 8%   | 3%  | 13%  | 8%     | 9%      |
| 25th Percentile ROIC minus COC                                                                              | 4%   | 4%   | 1%   | -4%  | 3%   | 3%   | 2%   | 2%   | 1%   | 2%   | -1%  | 2%   | 2%   | 1%   | -4% | 4%   | 2%     | 2%      |
| % with ROIC minus COC > 0.0%                                                                                | 88%  | 86%  | 79%  | 61%  | 86%  | 85%  | 83%  | 87%  | 83%  | 81%  | 72%  | 83%  | 85%  | 79%  | 61% | 88%  | 83%    | 81%     |
| <b>Railroad Percentile in the Distribution of ROIC minus COC:</b>                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |      |        |         |
| Industry Weighted Average ROIC                                                                              | 17   | 19   | 22   | 30   | 19   | 21   | 31   | 32   | 41   | 37   | 44   | 44   | 35   | 42   | 17  | 44   | 31     | 31      |
| CSX Corporation                                                                                             | 17   | 20   | 32   | 37   | 28   | 21   | 27   | 25   | 34   | 26   | 41   | 33   | 36   | 45   | 17  | 45   | 30     | 30      |
| Kansas City Southern                                                                                        | 14   | 17   | 16   | 22   | 15   | 9    | 13   | 13   | 21   | 20   | 29   | 24   | 13   | 25   | 9   | 29   | 17     | 18      |
| Norfolk Southern Corporation                                                                                | 28   | 26   | 37   | 33   | 24   | 22   | 25   | 19   | 34   | 22   | 36   | 36   | 25   | 36   | 19  | 37   | 27     | 29      |
| Union Pacific Corporation                                                                                   | 14   | 9    | 13   | 23   | 16   | 21   | 36   | 43   | 51   | 46   | 48   | 50   | 38   | 45   | 9   | 51   | 37     | 32      |

Sources: Bloomberg; Compustat; Ibbotson Yearbook (2006-2019); STB Revenue Adequacy Determination Report (2006-2018); RevAd 2019 AAR workpaper1 pdf, titled "AAR Duplication of STB Workpapers "

## Appendix C, Exhibit C2

Railroad Percentiles within Sample - Adjusted STB Definition of Return on Invested Capital (ROIC) and STB Definition of Cost of Capital (COC)  
(Railroads' Return on Invested Capital and Cost of Capital Measured Using Non-STB Public Data)

|                                                                                                             | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | Min | Max | Median | Average |
|-------------------------------------------------------------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|-----|-----|--------|---------|
| <b>Panel A: S&amp;P 500 Companies Excluding Railroads, Financial Institutions and Real Estate Companies</b> |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |     |        |         |
| <b>Sample Number of Observations, Median, 25th Percentile, and % Positive ROIC minus COC:</b>               |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |     |        |         |
| Number of Observations in Sample                                                                            | 405  | 401  | 409  | 415  | 413  | 414  | 413  | 412  | 410  | 408  | 402  | 393  | 395  | 394  | 393 | 415 | 409    | 406     |
| Median ROIC minus COC                                                                                       | 9%   | 9%   | 9%   | 5%   | 11%  | 11%  | 10%  | 11%  | 9%   | 10%  | 9%   | 7%   | 12%  | 10%  | 5%  | 12% | 10%    | 9%      |
| 25th Percentile ROIC minus COC                                                                              | 1%   | 2%   | 1%   | -2%  | 3%   | 3%   | 3%   | 2%   | 2%   | 2%   | 2%   | 2%   | 2%   | 1%   | -2% | 3%  | 2%     | 2%      |
| % with ROIC minus COC > 0.0%                                                                                | 81%  | 82%  | 80%  | 68%  | 86%  | 87%  | 86%  | 87%  | 87%  | 84%  | 82%  | 82%  | 84%  | 82%  | 68% | 87% | 83%    | 83%     |
| <b>Railroad Percentile in the Distribution of ROIC minus COC:</b>                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |     |        |         |
| Industry Weighted Average ROIC                                                                              | 16   | 16   | 19   | 23   | 14   | 11   | 14   | 12   | 19   | 18   | 20   | 24   | 24   | 30   | 11  | 30  | 18     | 19      |
| CSX Corporation                                                                                             | 15   | 17   | 21   | 25   | 16   | 12   | 14   | 10   | 11   | 15   | 18   | 18   | 27   | 31   | 10  | 31  | 17     | 18      |
| Kansas City Southern                                                                                        | 17   | 18   | 14   | 14   | 14   | 10   | 14   | 12   | 16   | 16   | 18   | 17   | 10   | 16   | 10  | 18  | 15     | 15      |
| Norfolk Southern Corporation                                                                                | 19   | 18   | 21   | 21   | 11   | 11   | 12   | 9    | 12   | 13   | 17   | 19   | 14   | 25   | 9   | 25  | 16     | 16      |
| Union Pacific Corporation                                                                                   | 14   | 14   | 17   | 23   | 15   | 11   | 17   | 18   | 31   | 28   | 26   | 34   | 30   | 32   | 11  | 34  | 20     | 22      |
| <b>Panel B: S&amp;P 500 Companies in the Industrials Sector Excluding Railroads</b>                         |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |     |        |         |
| <b>Sample Number of Observations, Median, 25th Percentile, and % Positive ROIC minus COC:</b>               |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |     |        |         |
| Number of Observations in Sample                                                                            | 48   | 53   | 56   | 54   | 55   | 57   | 56   | 60   | 61   | 63   | 66   | 65   | 65   | 64   | 48  | 66  | 59     | 59      |
| Median ROIC minus COC                                                                                       | 13%  | 15%  | 15%  | 5%   | 12%  | 15%  | 13%  | 13%  | 12%  | 12%  | 11%  | 12%  | 13%  | 14%  | 5%  | 15% | 13%    | 12%     |
| 25th Percentile ROIC minus COC                                                                              | 9%   | 8%   | 7%   | 1%   | 6%   | 8%   | 6%   | 6%   | 4%   | 7%   | 7%   | 7%   | 6%   | 9%   | 1%  | 9%  | 7%     | 6%      |
| % with ROIC minus COC > 0.0%                                                                                | 92%  | 91%  | 95%  | 80%  | 95%  | 95%  | 93%  | 95%  | 90%  | 90%  | 92%  | 97%  | 94%  | 94%  | 80% | 97% | 93%    | 92%     |
| <b>Railroad Percentile in the Distribution of ROIC minus COC:</b>                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |     |        |         |
| Industry Weighted Average ROIC                                                                              | 6    | 9    | 5    | 13   | 9    | 5    | 11   | 5    | 18   | 14   | 9    | 8    | 9    | 11   | 5   | 18  | 9      | 9       |
| CSX Corporation                                                                                             | 6    | 9    | 7    | 15   | 9    | 7    | 9    | 5    | 10   | 11   | 7    | 5    | 11   | 11   | 5   | 15  | 9      | 9       |
| Kansas City Southern                                                                                        | 6    | 11   | 4    | 7    | 7    | 5    | 9    | 5    | 13   | 11   | 7    | 3    | 3    | 6    | 3   | 13  | 7      | 7       |
| Norfolk Southern Corporation                                                                                | 10   | 11   | 7    | 13   | 5    | 5    | 9    | 5    | 10   | 8    | 6    | 5    | 8    | 11   | 5   | 13  | 8      | 8       |
| Union Pacific Corporation                                                                                   | 6    | 9    | 5    | 13   | 9    | 5    | 12   | 7    | 23   | 17   | 10   | 14   | 14   | 11   | 5   | 23  | 11     | 11      |
| <b>Panel C: Railroad Customer Sample of S&amp;P 500 Companies</b>                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |     |        |         |
| <b>Sample Number of Observations, Median, 25th Percentile, and % Positive ROIC minus COC:</b>               |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |     |        |         |
| Number of Observations in Sample                                                                            | 80   | 80   | 81   | 82   | 84   | 84   | 84   | 83   | 84   | 87   | 86   | 84   | 85   | 83   | 80  | 87  | 84     | 83      |
| Median ROIC minus COC                                                                                       | 9%   | 7%   | 6%   | 0%   | 7%   | 8%   | 5%   | 4%   | 3%   | 3%   | 3%   | 3%   | 5%   | 4%   | 0%  | 9%  | 5%     | 5%      |
| 25th Percentile ROIC minus COC                                                                              | 1%   | 2%   | 0%   | -5%  | 2%   | 2%   | 0%   | 1%   | 0%   | 1%   | -2%  | 0%   | 1%   | 0%   | -5% | 2%  | 0%     | 0%      |
| % with ROIC minus COC > 0.0%                                                                                | 84%  | 81%  | 70%  | 52%  | 81%  | 83%  | 76%  | 81%  | 74%  | 79%  | 67%  | 76%  | 81%  | 75%  | 52% | 84% | 78%    | 76%     |
| <b>Railroad Percentile in the Distribution of ROIC minus COC:</b>                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |     |        |         |
| Industry Weighted Average ROIC                                                                              | 12   | 19   | 27   | 35   | 20   | 16   | 26   | 19   | 32   | 25   | 37   | 36   | 31   | 45   | 12  | 45  | 26     | 27      |
| CSX Corporation                                                                                             | 12   | 20   | 32   | 39   | 22   | 16   | 25   | 15   | 20   | 22   | 32   | 25   | 36   | 45   | 12  | 45  | 24     | 26      |
| Kansas City Southern                                                                                        | 12   | 20   | 22   | 23   | 20   | 15   | 24   | 18   | 29   | 22   | 31   | 24   | 16   | 25   | 12  | 31  | 22     | 21      |
| Norfolk Southern Corporation                                                                                | 17   | 20   | 32   | 34   | 19   | 16   | 18   | 14   | 22   | 20   | 30   | 28   | 19   | 40   | 14  | 40  | 20     | 24      |
| Union Pacific Corporation                                                                                   | 12   | 12   | 24   | 35   | 20   | 16   | 29   | 25   | 51   | 48   | 48   | 48   | 42   | 45   | 12  | 51  | 32     | 33      |

Sources: Bloomberg; Compustat; Ibbotson Yearbook (2006-2019); STB Revenue Adequacy Determination Report (2006-2018); RevAd 2019 AAR workpaper1 pdf, titled "AAR Duplication of STB Workpapers "