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A Cost-Benefit Analysis of the Privatization of Canadian National Railway

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Dans cet article, nous évaluons, à partir d'une analyse coûts-avantages, les gains économiques qui ont résulté de l'une des plus importantes opérations de privatisation de l'histoire, celle de la Compagnie des chemins de fer nationaux (CN), en novembre 1995. Nous montrons également comment ces gains se répartissent entre les consommateurs (les expéditeurs), les producteurs (les actionnaires) et le gouvernement, ainsi que, plus largement, entre les Canadiens et les étrangers. Pour effectuer une comparaison plus exacte et fiable que celles qu'ont utilisées des études passées, nous avons eu recours aux chiffres du Canadien Pacifique. En nous basant sur une analyse hypothétique conservatrice, nous estimons que la privatisation du CN a engendré des gains d'au moins 4 milliards de dollars (en dollars de 1992) – et nous affirmons qu'ils pourraient se chiffrer à une somme allant jusqu'à 15 milliards de dollars. Les actionnaires ont profité de la plus grande partie de ces gains, et le gouvernement canadien de près de la moitié.

Mots clés : privatisation, analyse coûts-avantages, transport, industrie ferroviaire, effets socio-économiques distributifs

This article uses cost-benefit analysis to estimate the welfare gains from the privatization of Canadian National Railway (CN) in November 1995, one of the largest rail privatizations in history. It also shows how these gains have been distributed among consumers, producers, and government, and between Canadians and non-Canadians. The article uses the costs of Canadian Pacific Railway to create a more credible comparison than in previous privatization studies. Based on a conservative counterfactual, we estimate that CN's privatization generated welfare gains of at least \$4 billion (in 1992 dollars). However, the welfare gain was possibly as high as \$15 billion. The Canadian government captured almost half of these gains, while CN shareholders captured most of the rest.

Keywords: privatization, cost-benefit analysis, transportation, railway, distributional welfare impacts

INTRODUCTION

Over the past 30 years, there has been a well-documented global trend of privatizing formerly state-owned enterprises. In Canada, by far the largest transportation privatization has been Canadian National Railway (CN). Was the commercialization and subsequent privatization of CN worth it? This article uses cost-benefit analysis (CBA) to estimate the welfare gains to Canadians and examines how these welfare gains have been distributed among government, producers (domestic and foreign shareholders of CN), and consumers (shippers).

To some extent the privatization of CN was motivated, as were others around the world, by property rights theory (Alchian 1965; De Alessi 1969), which suggests that in competitive environments state-owned enterprises (SOEs) are less productive and less profitable than their private-sector equivalents. Empirical support for property rights theory has come from three broad empirical sources. First, it has come from comparisons of samples of state-owned firms to private-sector firms in similar circumstances—"like-like" studies (e.g., Boardman and Vining 1989; Cowie 1999; Gillen, Oum, and Tretheway 1989; Pollitt 1995). Second, and more recently, support has come from analyses of the performance of a sample of firms before and after their privatization—"before-after" performance studies (e.g., Boardman, Laurin, and Vining 2002; Boubakri and Cosset 1998; Chirwa 2004; Megginson and Netter 2001). Third, support has also come from "before-after" CBAs of specific privatizations (e.g., Boles de Boer and Evans 1996; Domah and Pollitt 2001; Galal et al. 1994; Newbery and Pollitt 1997; Pollitt and Smith 2002). There are a number of problems with the first two of these approaches that weaken their findings in regards to estimating the social benefits of privatization.

Like-like studies are certainly suggestive about the potential benefits that might flow from privatization, but they actually compare firms under different ownership regimes and do not directly

study the effect of privatization upon SOEs. In addition, like-like studies typically compare a sample of SOEs with a sample of private-sector firms that operate in many different industries. This makes it difficult to adequately control for important differences in the firms' competitive environments. Finally, these studies have generally examined changes in firm productivity or profitability, but have not attempted to assess the broader welfare impacts of privatization that are of most interest to policy-makers. In sum, like-like studies are only suggestive on the question of potential social benefits from privatization.

Before-after studies of a sample of privatizations also exhibit a number of weaknesses. First, they do not generally control for contemporaneous changes in the operating environment, especially major regulatory changes that often accompany a privatization program (Wallstein 2001). Additionally, most of these studies also treat performance in a limited way, again focusing on productivity or profitability changes rather than changes in social benefits.

In response to some of these problems, a number of authors have conducted before-after CBAs of specific privatizations, thereby explicitly focussing on the social-welfare effects. This approach provides the best method for a comprehensive assessment of the net social benefits of privatization. Newberry and Pollitt (1997) and Pollitt and Smith (2002) provide exemplars of this approach. The main challenge for studies of this kind is to credibly postulate a baseline counterfactual, i.e., what would have likely been the behaviour and performance of the enterprise under continued state ownership? The specific details of the counterfactual are crucial to determining both the sign and size of the social-welfare changes. For example, the expected benefits of a given privatization would be reduced if the counterfactual postulated that the SOE in question would have improved its performance because of a reformed regulatory regime that fostered significantly increased competition (Boles De Boer and Evans 1996; Newbery and Pollitt 1997), even in the absence of privatization. A plausible counterfactual

is particularly difficult to construct when the privatization occurs simultaneously with other major changes that will likely affect behaviour and performance, such as a major change in the regulatory environment.

There is one other aspect of previous empirical research that potentially limits its generalizeability. Much of the extant privatization research has focused on the behaviour and performance of firms that operate within somewhat competitive industries. A number of scholars have argued that one would not expect net social benefits from the privatization of SOEs in industries that are structurally less competitive (see, e.g., Peters 1993 and Willner 2003). These scholars make this argument on theoretical grounds (for one model, see De Fraja 1991), but they also argue that neither like-like studies nor before-after studies convincingly demonstrate that the benefits of privatization extend to less competitive industries. If this caveat concerning less competitive industries is generally true, it would clearly limit the generalizeability of the benefits of privatization.

This article presents a social CBA of CN. In both spirit and general methodology, our study follows Pollitt and Smith (2002), who conducted a CBA of the privatization of British Rail (BR). However, we have one advantage as we can use data from Canadian Pacific Railway (CP) to construct a more credible counterfactual. The availability of a privately owned comparator that operates in the same industry and is subject to virtually the same external environment is rare. Indeed, as far as we can ascertain, it is unique. Another difference between the studies is that Pollitt and Smith (2002) estimated the net social benefits primarily based on changes (reductions) in operating costs, while we also include changes in capital expenditures.

Although we, like Pollitt and Smith (2002), study a railway privatization, important differences between CN and BR suggest that it would be inappropriate to extrapolate similar net social benefits from the BR case, which were about £1.1 billion or \$2.56 billion (in 1999/2000 Canadian dollars)

after subtracting restructuring costs of about £1.4 billion or \$3.26 billion (in 1999/2000 Canadian dollars). Indeed, on a priori grounds, it is not obvious whether one would predict larger or smaller welfare gains from the CN privatization. The most important difference between the railways is that CN (and CP) is almost exclusively a freight carrier, while BR operates a mainly passenger rail system (passenger revenues amount to close to 90 percent of BR revenues). Because of this and associated regulatory factors, it is likely that the privatization of BR would have had less of an impact on its behaviour, performance, and net social benefits than the privatization of CN. On the other hand, because of the presence of CP, CN already faces competition. Based on this, privatization might make less difference to CN's behaviour, performance, and net social benefits.

To summarize, our particular research context offers four advantages over most previous research. First, comparison of CN and CP over time allows us to estimate a more reliable counterfactual and to focus on estimating the effects of a change in ownership (privatization), controlling for contemporaneous industry-wide changes. Second, we use CBA and measure costs and benefits fairly comprehensively, thereby estimating the total net social benefits of privatization. Third, we examine the distributional impacts and provide estimates of the welfare gains to each stakeholder group. Fourth, as CN operates in a duopolistic market, we provide insights into the welfare effects of privatization in less competitive environments, an area where there is more disagreement on the potential for efficiency improvements and welfare gains from privatization.¹ In addition, we perform careful sensitivity analyses with respect to the counterfactual (discussing both a base case and a conservative case), social discount rate, future growth rate of CN, marginal excess tax burden, and shadow price of capital.

The article is organized as follows. First, we present a brief history of CN and review key changes in the regulation of Canadian railways. Next, we describe our data sources. Our section on method-

ology and results outlines our preferred, base-case estimate as well as a conservative estimate of the overall welfare change attributable to the commercialization and privatization of CN, and of its distribution among the various groups. The subsequent section presents many careful sensitivity analyses and discusses potentially omitted impacts. Last, we offer a brief conclusion.

To preview our findings, we find that the privatization of CN increased efficiency and generated substantial welfare gains—approximately \$15 billion (in 1992 dollars) using our base-case counterfactual or approximately \$4 billion using our conservative counterfactual. We estimate that government captured slightly less than half of these gains; CN shareholders captured most of the rest, with a bit less than half going to Canadian shareholders, and the remainder to non-Canadian shareholders.

A BRIEF HISTORY OF CN AND ITS REGULATORY ENVIRONMENT

CN was formed as a government-owned corporation through the amalgamation of several financially troubled, privately owned railways between 1917 and 1923. Since that time, CN and CP have dominated railway freight services in Canada. During much of the period of public ownership, CN was in various forms of financial stress. The Canadian government swapped CN's debt for equity or recapitalized it in 1937, 1952, and 1978. With the final recapitalization in 1978, the government imposed a hard budget constraint and mandated that it pay a 20-percent dividend on any profits earned. Between 1978 and 1989, CN was profitable in nine out of the 11 years and paid \$237 million (current dollars) to the federal government (Bruce 1997, 15).² Over time, CN became more focused on freight transportation. By 1989, it had become primarily a rail-freight company with a labour force of approximately 40,000 (Bruce 1997, 17).³

The 1967 *National Transportation Act* significantly reduced the scope of rate regulation of the

two railways with the exception of grain transportation. However, the act permitted the railways to co-operate in rate setting, exempting them from antitrust investigation (Bonsor 1995). In 1983, the *Western Grain Transportation Act* shifted the burden of the so-called Crow's Nest Pass rates for grain (price controls that provided large shipper subsidies) from the railways to the taxpayer (Heaver and Waters 2004).

Since the beginning of our data (1981), there have been two major policy-regime changes in the Canadian rail industry in addition to the privatization of CN. One, the 1987 *National Transportation Act* (NTA) allowed shippers located on only one of the railways' lines greater access to the other's line, it allowed confidential negotiation of rates, it encouraged reliance on market forces and arbitration rather than on regulation of most non-grain rates, and it allowed both railways somewhat greater freedom to abandon uneconomic branch lines. Two, the 1996 *Canada Transport Act* extended the 1987 NTA provisions and allowed both railways to eliminate low-density lines, resulting in the formation of more short-line railways.

In spite of improvements in the regulatory regime, by the early 1990s both CN and CP were markedly less productive and profitable than their US counterparts (Waters 1997). Both faced increasing intermodal competition from trucking and shipping. The 1987 NTA marked a transition from an era of tacit collusion to one of more direct intramodal competition (Bonsor 1995).⁴ While both railway companies experienced rapid improvements in total factor productivity throughout the 1980s and into the 1990s, these gains were more than offset by relative declines in real output prices relative to input prices, leading to a deterioration in financial performance (Waters 1997).

DATA

Most of our data are drawn from the annual reports of *Rail in Canada* 1981–2003, which contain

detailed data on output, revenues and costs for both CN and CP in Canada, along with the number of Canadian employees and their remuneration (Statistics Canada 1981–2003). Table 1 summarizes the key variables and their sources. We measure output by “revenue tonne-kilometres” of Canadian freight, which represents more than 95 percent of CN’s and CP’s revenue-generating output and approximately 90 percent of overall revenues.⁵ The revenue and

cost data are for the Canadian freight and non-freight activities combined and therefore inflate the freight figures. However, since welfare changes are calculated as the differences between CN’s and CP’s costs, any measurement errors are likely to be minimal. The richness of these data allow for a comprehensive analysis of CN’s and CP’s cost structures, including capital costs as well as operating costs.

TABLE 1
Description of the Data

<i>Variable</i>	<i>Measure</i>	<i>Source</i>
Output ^a	Revenue-tonne kilometres of freight	RIC ^b Table 9
Revenue ^c	Dollar amount	RIC Table 1-1
Variable costs		
Fuel ^d	Overall cost of diesel (\$)	RIC Table 6
Direct labour	Labour used for transportation or equipment maintenance	RIC Table 11
Fixed costs		
Indirect labour	Road maintenance plus general administrative services	RIC Table 11
Benefits		RIC Table 1-1
Capital ^e	Total expenditures on “ways and structures” and “equipment” minus labour costs for “ways and structures” and maintenance of “equipment”	RIC Table 1-1
Miscellaneous	Total rail operating expenses minus the above costs	RIC Table 1-1
Other railroad data		
Employment	Number of employees in Canada	RIC Table 11
Annual compensation	Average annual pay	RIC Table 11
Hourly compensation	Average hourly pay	RIC Table 11
Other variables		
Privatization transactions cost	Cost per share x number of shares sold	
Cost per share	\$1.0125 (the amount that the government agreed to pay to the underwriters for each share sold)	RBC Dominion Securities 1995
Number of shares sold at privatization	83.8 million	Bruce 1997, 149

Notes:

^a Railways produce multiple outputs but the data do not allow us to disaggregate output by type of freight, its origin or destination.

^b RIC = Rail in Canada (Statistics Canada 2003). The table numbers may differ in other years.

^c Freight revenues are approximately 90 percent of total revenues.

^d Freight fuel costs represent about 98 percent of total fuel costs.

^e Does not include investment on new track, although it does include depreciation on new track.

Source: Authors’ compilation.

All revenue and cost data are converted to constant 1992 dollars using the GDP (Gross Domestic Product) Implicit Price Deflator for Canada (International Monetary Fund, International Financial Statistics, frequency: annual, with 1992 = 100). Data on annual or hourly remuneration, which is used to estimate employee-welfare impacts, are deflated to 1992 dollars using the Consumer Price Index – All Items (CPI). The cost of employment benefits or miscellaneous costs are extraordinarily high in some years because they include restructuring costs which must be expensed in the year that they are announced for accounting purposes. In practice, though, these amounts are paid out over several years: for example, “the majority of payments related to workforce reductions are expected to occur over the next six years” (Canadian National Railway Company 1998, 62). Where benefits or miscellaneous costs are unusually high we smooth the data to make the figures better reflect actual cash flows.⁶ Specifically, we estimate the amount by which the recorded cost in that year is excessive and spread that amount over that year and the following five years.⁷ Finally, to estimate the distribution of welfare gains, we include stock market information, including stock prices variation associated with underpricing of shares and the long-run stock price performance (Boardman et al. 2002).

A new CEO of CN, Paul Tellier, was appointed in October 1992 with the understanding that he would privatize it. The goals of the top management explicitly changed with his appointment and CN began to be run on a more commercial basis (Bruce 1997; Canadian National Railway Company 1995). CN was privatized in November 1995. For the purpose of this study, we treat the pre-1992 period as one of government operation, 1992 as a transition year, and 1993 as the beginning of the commercialization-privatization period. Our data end in 2003, but the effects of privatization continued beyond this date.

METHODOLOGY AND RESULTS

Following Jones, Tandon, and Vogelsang (1990), the change in total welfare due to a privatization can be written:

$$\Delta W = V_{sp} - V_{sg} + (\lambda_g - \lambda_p)Z \quad (1)$$

where W is social welfare, V_{sp} is the value to society of the firm under private operation, V_{sg} is the value to society of the firm under government operation, Z is the sale price of the firm, and λ_g and λ_p are shadow multipliers on government revenue and private funds, respectively. We initially assume that there is no difference between the two shadow multipliers and focus on the difference between the first two terms of equation (1).

Cost Savings at CN Due to Commercialization-Privatization

Suppose commercialization and privatization (hereafter commercialization-privatization) simply resulted in lower costs (due to greater X-efficiency) for CN's Canadian operations, relative to what would have been achieved under continued government ownership. Also, suppose that demand is perfectly inelastic and privatization of CN has no effect on CP. The difference between the first two terms of equation (1) will consist of the present value (PV) of the cost savings (relative to the counterfactual) at CN, less any costs of the privatization itself:

$$V_{sp} - V_{sg} = C_g^{CN} - C_p^{CN} + F - T \quad (2)$$

where C_i^{CN} , $i = g, p$, are the 1992 PVs of CN's Canadian freight-rail operating costs under unchanged government ownership and under “private ownership,” respectively, from 1993 through 2003 (the end of our data), F represents the 1992 PV of the projected future gains attributable to privatization from 2004 on, and T is the 1992 PV of the transaction costs of privatization.

CN's 1993–2003 Canadian freight-rail operating costs under “private ownership” are CN's actual, annual observed costs. Therefore, C_p^{CN} is simply the PV of CN's total costs in constant 1992 dollars, from 1993 through 2003, discounted back to 1992:

$$C_p^{CN} = \sum_t \frac{ATC_t^{CN}}{(1+s)^t} Q_t^{CN} \quad (3)$$

where $t = 1$ for 1993, $= 2$ for 1994, ..., $t = 11$ for 2003; s is the real social discount rate (SDR); ATC_t^{CN} is CN's actual average total cost (in 1992 dollars per revenue-tonne kilometre) in year t ; and Q_t^{CN} is CN's actual Canadian freight rail output in revenue-tonne kilometres in year t .

We use two different approaches to estimate what CN's costs would have been under continued government ownership. In our base-case approach, we compare the real average total costs (ATCs) per revenue-tonne kilometre of freight shipped for CN versus CP over the four-year period immediately prior to the change in management at CN, 1988 through 1991.⁸ We find that CN's real ATC is, on average, 6.66 percent higher than CP's real ATC during this period. We then assume that if there were continued government ownership, CN's real ATCs would remain higher than CP's by this same percentage in subsequent years. Thus, we construct a series of annual, counterfactual real ATCs for CN by inflating CP's actual real ATCs by 6.66 percent. Next, we multiply these counterfactual real ATCs for CN by CN's actual annual outputs to arrive at CN's 1993–2003 counterfactual total operating costs. Finally, we discount these real costs at the real social discount rate, s , to obtain the PV of CN's counterfactual 1993–2003 total costs, C_g^{CN} :

$$C_g^{CN} = \sum_t \frac{1.066 ATC_t^{CP}}{(1+s)^t} Q_t^{CN} \quad (4)$$

where t , s and Q_t^{CN} are defined above, and ATC_t^{CP} is the actual real unit cost of CP (in 1992 dollars per revenue-tonne kilometre) in year t .

Our analysis assumes that the unit-cost differences can be attributed to commercialization-privatization. It is conceivable that the cost differences are partially attributable to returns to scale (Pollitt and Smith 2002). However, we do not believe that there are significant scale effects at CN's (or CP's) size. There is a broad consensus that the major US rail carriers do not have unexploited economies of scale, in other words, they operate at, or beyond, minimum efficient scale (Laurin and Bozec 2001; Caves and Christensen 1980; Griliches 1972). Furthermore, both CN and CP are large relative to the US carriers. Although both companies have seen their dollar assets almost double since 1980, we do not believe that this change significantly affects their unit costs.

Consequently, the PV of the cost savings from 1993–2003 that can be attributed to commercialization-privatization is given by:

$$C_g^{CN} - C_p^{CN} = \sum_t \frac{(1.066 ATC_t^{CP} - ATC_t^{CN})}{(1+s)^t} Q_t^{CN} \quad (5)$$

Following Moore et al. (2004) we use a real SDR of 3.5 percent.⁹ The ATCs are computed by dividing total costs (variable costs plus fixed costs, as defined in Table 1) by freight output (revenue-tonne kilometres). Using equation (5), the total estimated present value of the cost savings from 1993–2003 is \$3,114 million in 1992 dollars—just over \$3 billion.¹⁰ As seen from Figure 1a, the estimated cost savings due to commercialization-privatization are negligible in 1993 and 1994, they take a step up in 1996 and another step up in 1999, after which the savings remain fairly constant through 2003.

FIGURE 1a
CN Total Costs Smoothed: Actual, Non-Privatization Base-Case Counterfactual, and Difference
(in millions of 1992 dollars), 1993–2003

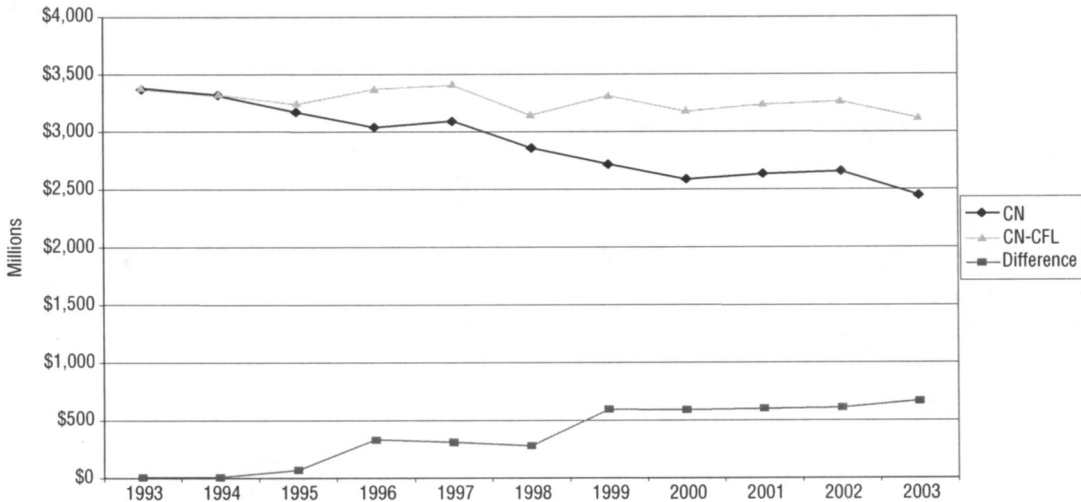
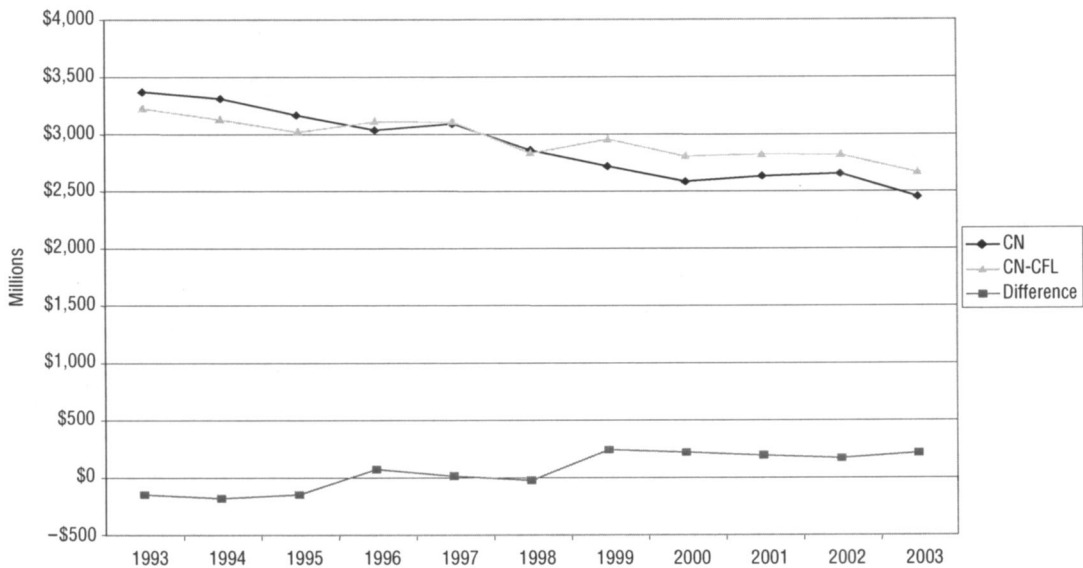


FIGURE 1b
CN Total Costs Smoothed: Actual, Non-Privatization Conservative Counterfactual, and Difference
(in millions of 1992 dollars), 1993–2003



Source: Authors' compilation.

To calculate F , the PV in 1992 dollars of the projected future gains attributable to privatization from 2004 forward, we estimate a continuation benefit, CB , which represents the real annual savings expected from privatization in 2004 and subsequent years. We measure this as the average of our calculated annual savings due to privatization from 1999 through 2003:

$$CB = \frac{\sum_{99-03} (1.066ATC_t^{CP} - ATC_t^{CN})Q_t^{CN}}{5} \quad (6)$$

Relative to the counterfactual, we find the average savings for 1999 through 2003 are \$614 million in 1992 dollars; see Figure 1a. We then divide by the SDR to find the 2003 present value of this perpetuity, and then discount this value back to 1992:

$$F = \frac{1}{(1+s)^{11}} \frac{CB}{s} \quad (7)$$

Using a real SDR of 3.5 percent yields a PV of the projected future cost savings of \$12,015 million in 1992 dollars. Despite the slight upward secular trend in CN's output throughout our data period (see Figure 3a, below), we conservatively presume that CN's output will not grow past 2003. In the next section, we perform sensitivity analysis with respect to CN's future growth rates.

Finally, we calculate the total cost of organizing the sale of CN by multiplying \$1.0125, the amount that the government agreed to pay per share sold to the underwriters (RBC Dominion Securities 1995), by the 83.8 million shares sold (Bruce 1997, 149). This gives a total cost of \$84.8475 million in 1995 dollars. We deflate this by the GDP deflator to find the cost in 1992 dollars, and then discount this back to 1992 using our SDR of 3.5 percent. This method estimates the transactions costs associated with the sale of shares were approximately \$73 million in 1992 dollars. Combining our estimates yields a total welfare change of \$15,056 million (\$3,114 +

\$12,015 – \$73), which is approximately \$15 billion in 1992 dollars.

Our estimate of the welfare gain implicitly assumes that any decrease in CN's costs has no impact on prices, CN's output, or CP's output.¹¹ A variety of evidence supports these assumptions. The faster decline in CN's ATCs relative to CP's ATCs following privatization is driven by CN's faster reduction in average fixed costs, not in average variable costs; see Figures 2a–2c. There is no reason to expect that relative marginal costs change and, therefore, that there is any effect on prices or output shares. Indeed, from 1986–2003 CN's and CP's prices (computed as average revenues per revenue-tonne kilometre) were very similar, differing by no more than 2 percent in any year. Furthermore, the downward trend in freight prices is slower after privatization than before; see Figure 2d.

Concerning outputs, as in Pollitt and Smith (2002), we treat increases in CN's output as exogenous and not attributable to privatization. This seems reasonable from Figure 3a: there is no clear change in the rate of increase in CN's output following privatization. CN's market share is consistently about 13 percentage points higher than CP's market share in terms of revenues; see Figure 3b. While there are slight year-to-year variations, there is no discernable change in the trend. This evidence is consistent with experts' views that the railways seek to maximize their revenues, regardless of the structure of their costs (confirmed in a conversation on 5 July 2006 between Anthony E. Boardman and William Waters). Because many costs are common to multiple products, it may be difficult for the railways to even know their incremental costs (Waters 1985, 110).

A Conservative Counterfactual

Figure 2a shows that CN's ATC disadvantage relative to CP's decreased throughout the 1980s. Assuming that this trend would have continued at the same rate provides a conservative counterfactual. During 1981–1991, CN's ATC fell on average

FIGURE 2a
CN and CP Smoothed Average Total Costs (ATC, 1992 dollars per revenue tonne-kilometre of output), 1981–2003

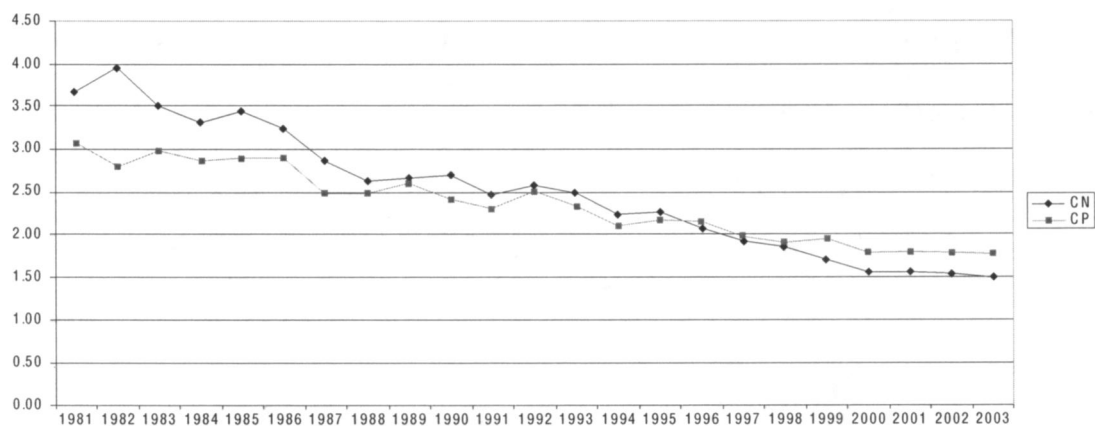
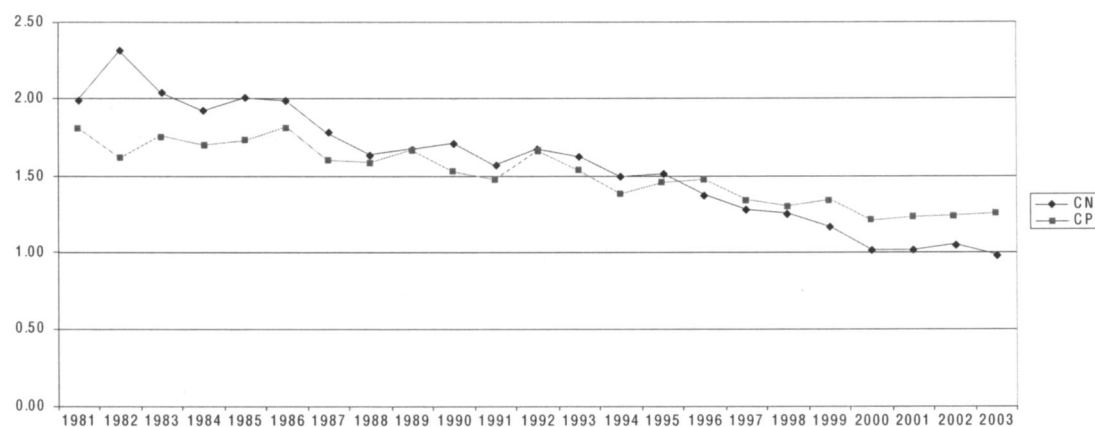


FIGURE 2b
CN and CP Smoothed Average Fixed Costs (AFC, 1992 dollars per revenue tonne-kilometre of output), 1981–2003



Source: Authors' compilation.

FIGURE 2c

CN and CP Average Variable Costs (AVC, 1992 dollars per revenue tonne-kilometre of output), 1981–2003

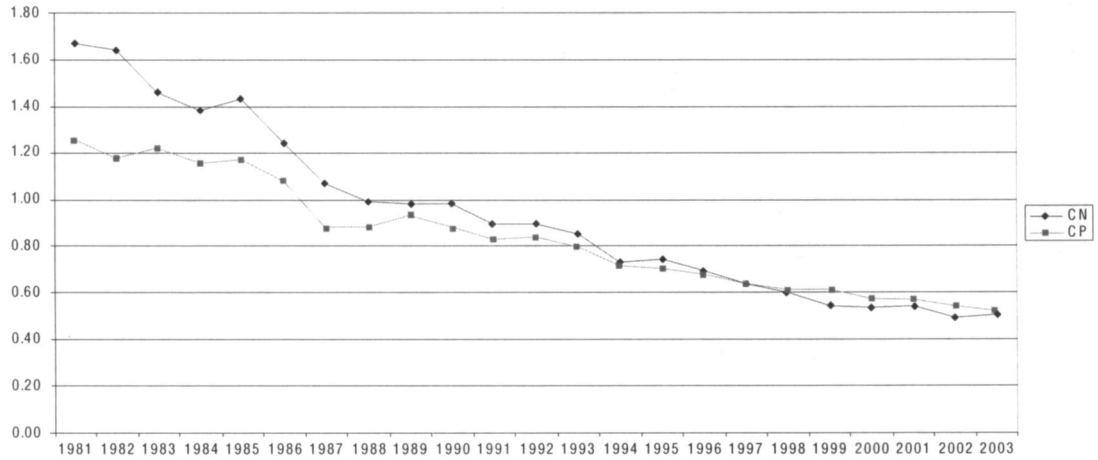
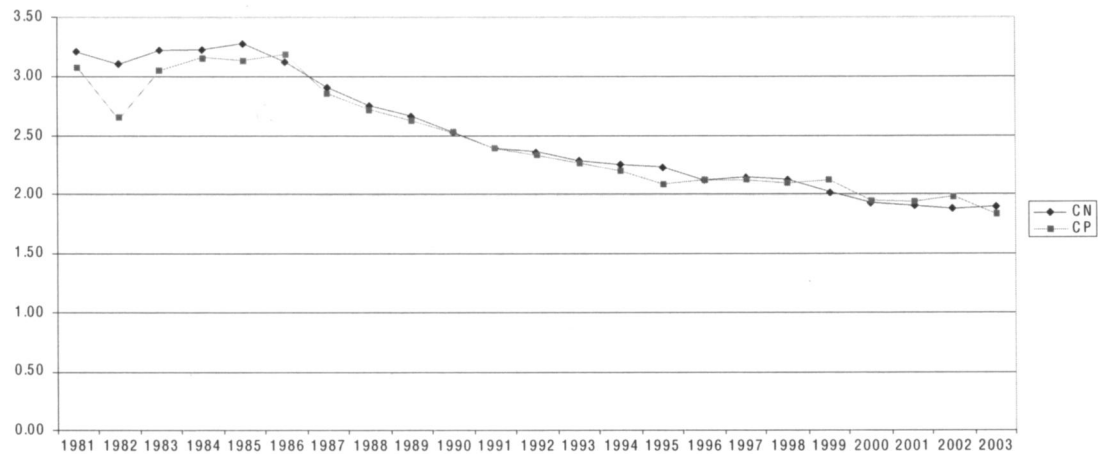


FIGURE 2d

CN and CP Average Revenues (AR, 1992 dollars per revenue tonne-kilometre of output), 1981–2003



Source: Authors' compilation.

FIGURE 3a
CN and CP Output (revenue tonne-kilometres), 1981–2003

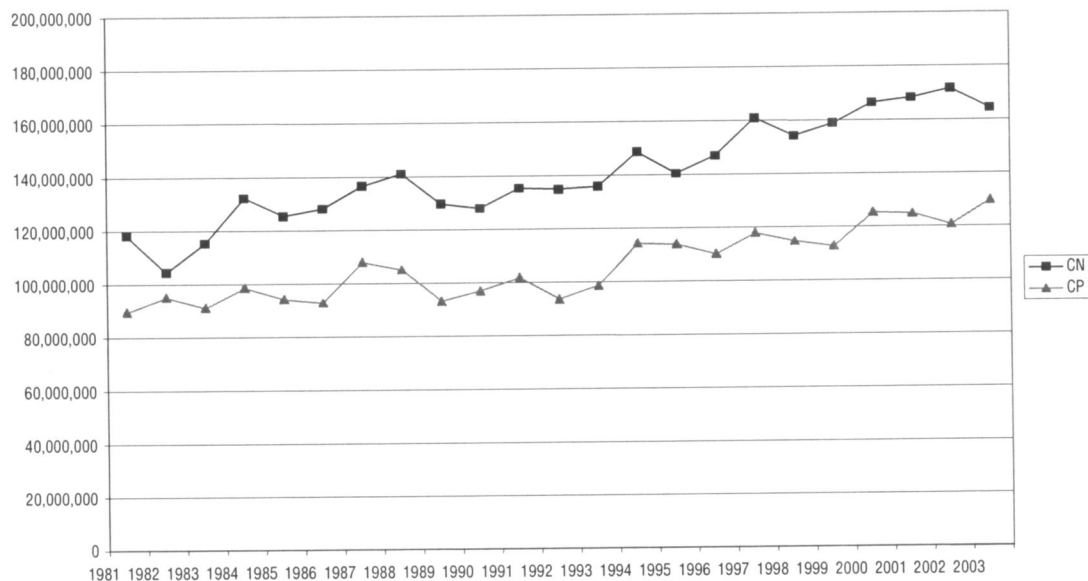
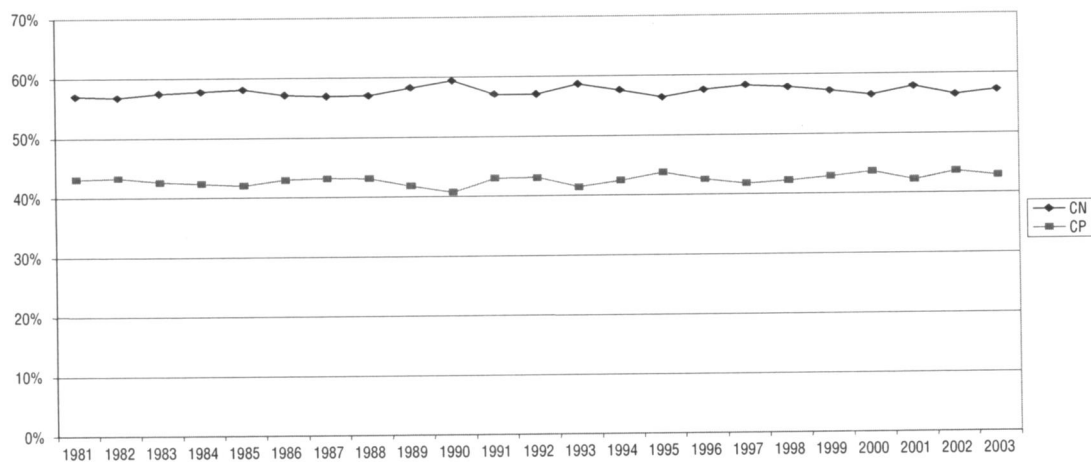


FIGURE 3b
CN and CP Relative Market Shares
(total revenue of each railroad as a percentage of the sum of the two railroads' revenues), 1981–2003



Source: Authors' compilation.

by 1.062 percent per year faster than CP's. Consequently, the conservative counterfactual ATC for CN in 1993 equals CN's actual ATC in 1992, times CP's rate of decrease in ATC for 1992–1993, minus 1.062 percent.¹² CN's counterfactual ATC in each subsequent year (through 2003) uses a similar formula.¹³ As before, the net benefits (cost savings) for 1999–2003 are estimated by substituting the new, more conservative estimate of CN's counterfactual ATCs into equation (5). Also as before, we calculate F , the present value of future gains, based on the average of the estimated annual cost savings for 1999–2003.

This approach provides a considerably lower measure of the overall welfare gain to privatization—\$4,346 million in 1992 dollars. As Figure 1b shows, for the first three years after commercialization but before privatization (1993–1995), CN's actual costs were higher than our new counterfactual estimates, producing a net welfare loss of \$445 million in 1992 dollars. CN enjoyed small efficiency gains in 1996 and 1997, while 1998 showed a small loss relative to the counterfactual. After that (1999–2003) there were significant cost savings that averaged just over \$200 million per year (undiscounted). As before, most of the overall welfare gain came from the discounted value of the continuing benefit.

We can never know what would have happened in the absence of privatization. It is certainly reasonable to use historical trends in unit-cost reductions to estimate the counterfactual. However, we prefer our initial estimate for two reasons. First, most of the convergence between CN's and CP's ATCs occurred during the 1981–1988 period, as shown in Figure 2a. Between 1988 and 1991, the period used for the base-case counterfactual, the differences remained reasonably constant and showed no clear converging or diverging trend. Second, the estimated welfare impacts under the conservative counterfactual are very sensitive to the historical period used to estimate the trends in cost

reductions.¹⁴ Given that the conservative approach provides negative estimates of the effect of privatization during the first years after privatization, projecting a continued narrowing of the unit-cost differential based on the previous decade's trend gives a very conservative lower bound to the welfare gains.

Distribution of the Welfare Gains

Having estimated the total change in welfare due to commercialization-privatization, we now calculate how the effects are distributed among buyers (shippers), CN's shareholders, and the Canadian government:

$$\Delta W = \Delta CS + \Delta PS + \Delta GS \quad (8)$$

where ΔCS is the change in consumer surplus accruing to shippers, ΔPS is the change in producer surplus (shareholders' profits), and ΔGS is the change in the government surplus (government revenues minus expenditures).¹⁵

Shippers are potentially affected by price changes. It makes sense to estimate the change in their consumer surplus as equal to the PV of the difference in price (measured by average revenue) between the actual and counterfactual cases, for 1993 through 2003, times the CN output for each year plus the PV of the projected impact on buyers from 2004 on, F^{CS} :¹⁶

$$\Delta CS = \sum_t \frac{(P_t^{g,CN} - P_t^{p,CN})}{(1+s)^t} Q_t^{CN} + F^{CS} \quad (9)$$

where $t = 1$ for 1993, $t = 2$ for 1994, ..., $t = 11$ for 2003, where s is the real SDR; $P_t^{g,CN}$ is CN's estimated real price in year t under government ownership (in 1992 dollars of revenue per revenue-tonne kilometre shipped); and $P_t^{p,CN}$ is CN's actual real price in year t . However, our earlier discussion suggests that CN's prices are the same as they would have been under government ownership and,

therefore, we estimate $\Delta CS = 0$. To the extent that prices are actually lower than they would have been under government ownership, we underestimate the total welfare gain and the benefits to shippers in particular.

If $\Delta CS = 0$, then the total welfare gain is the sum of government surplus and producer surplus. Earlier we estimated the welfare gain focusing on the PV of the cost savings under commercialization-privatization relative to continued government ownership. Given that prices and outputs are the same in the factual and counterfactual, the change in costs is the same as the change in profits and consequently the change in welfare can be written as:

$$\Delta W = \Delta \Pi^{93-95} + \Pi_p - \Pi_g - T \quad (10)$$

where $\Delta \Pi^{93-95}$ denotes the 1992 PVs of the profits under the period of commercialization prior to privatization relative to the counterfactual, and Π_i , $i = g, p$, are the 1992 PVs of CN's Canadian freight-rail profits under unchanged government ownership and under private ownership, respectively, from 1996 onward.

For future purposes, it is useful to decompose the profits of CN after privatization (1996 and beyond) into the PV of all current and future anticipated profits at the time of privatization, Π_p^e , and the PV of all unanticipated profits, Π_p^u . The sale price, Z , should reflect the PV of the future, anticipated after-tax profits under private ownership, less any underpricing:

$$Z = (1 - \tau) \Pi_p^e - U \quad (11)$$

where U is the 1992 PV of the amount of underpricing and τ is the tax rate on CN profits.¹⁷

The change in government surplus due to commercialization-privatization, ΔGS , equals the PV of the change in profits due to commercialization from 1993 to 1995, $\Delta \Pi_p^{93-95}$, plus the PV of the sale price

at privatization, Z , taxes on the profits to shareholders from underpricing the share offering, U , and the PV of the corporate taxes on the future (anticipated and unanticipated) profits under private ownership, $\tau \Pi_p$, less the PV of the profits after 1996 under the counterfactual case of continued government ownership, Π_g , and the sale transactions costs, T :

$$\Delta GS = \Delta \Pi_p^{93-95} + Z + (0.6 \times 0.75 t^c + 0.4 t^w) U + \tau \Pi_p - \Pi_g - T \quad (12)$$

where t^c is the marginal tax rate on capital gains in Canada and t^w is the withholding tax rate on foreigners' capital gains. Approximately 60 percent of the shares were initially sold to Canadians and 40 percent were sold to foreigners (Bruce 1997, 144). Between 1990 and 1999, Canadians were taxed on 75 percent of their capital gains.

To estimate the change in government surplus, we rewrite equation (12) as:

$$\Delta GS = \Delta \Pi_p^{93-95} + Z + (0.6 \times 0.75 t^c + 0.4 t^w) U + \tau (\Pi_p - \Pi_g) - (1 - \tau) \Pi_g - T \quad (13)$$

Under our base-case counterfactual (where CN's unit costs are 1.066 times CP's), the PV of the cost savings during the commercialization (1993–95) period, $\Delta \Pi_p^{93-95}$, is \$80 million. Under the conservative counterfactual (CN's unit costs decrease by 1.062 percent per year faster than CP's), the PV of the cost savings during the commercialization (1993–95) period, $\Delta \Pi_p^{93-95}$, is minus \$445 million.

The sale price, Z , equals \$1,907 million. This is calculated by multiplying the number of shares sold (83.8 million) by the prices of the two instalments: \$16.25 on 17 November 1995, and \$10.75 on 26 November 1996, then deflating these amounts into 1992 dollars and discounting back to 1992.

As a simplifying assumption, we assume that everyone who obtained shares at the offer price sells

them immediately, pays taxes on the gains (equal to the underpricing), and then repurchases at the market price. CN was underpriced by \$4 per share (24.62 percent), based on the closing price at the end of the first day. Multiplying this amount by 83.8 million (the number of shares sold), deflating by the GDP deflator, and discounting back to 1992 using a 3.5 percent SDR implies that there was underpricing of approximately \$288 million in 1992 dollars. Assuming that 75 percent of the capital gains to Canadians are taxed at a marginal tax rate, t^c , of 40 percent,¹⁸ the government receives \$52 million ($0.4 \times 0.6 \times 0.75 \times \288 million) in incremental capital gains tax revenues (in 1992 dollars) from the initial Canadian shareholders. Assuming that non-residents pay withholding tax, t^w , equal to 15 percent of their capital gains, the government receives \$17 million ($0.15 \times 0.4 \times \288 million) in withholding taxes from the initial foreign shareholders. Thus, the government recoups \$69 million of the \$288 million underpricing.

To find the tax revenues on the incremental profits following privatization, $\tau(\Pi_p - \Pi_g)$, we multiply each year's real discounted, estimated cost savings due to commercialization-privatization from 1996 on by the prevailing, combined federal-provincial corporate tax rate reported by CN and sum them.¹⁹ This yields a PV of \$6,015 million in 1992 dollars under our base-case counterfactual, and a PV of \$1,934 million in 1992 dollars under our conservative counterfactual.

We do not have a direct estimate of the after-tax profit under continued government ownership (the counterfactual) from 1996 on, $(1-\tau)\Pi_g$. However, it is likely to range between zero and the PV of all expected future after-tax profits under private ownership at the time of privatization, $(1-\tau)\Pi_p^e$.

If Π_g equals zero, equation (13) implies the change in government surplus is about \$7,998 million in 1992 dollars under our base-case counterfactual, and about \$3,393 million in 1992 dollars under the conservative counterfactual. At the other

extreme, where we anticipate no efficiency gain from privatization (Π_g equals Π_p^e), we use equation (11) to estimate $(1-\tau)\Pi_g$ as $Z + U$, the actual sale price of \$1,907 million plus the amount of underpricing, \$288 million. Substituting this amount (\$2,195 million) and our other estimates into equation (13) implies the change in government surplus is approximately \$5,803 million under the base-case counterfactual and \$1,198 under the alternative. Without further information, we estimate the change in government surplus at the average of the two extremes, or \$6,901 million using our first counterfactual, and about \$2,296 using the second.

Assuming no effect on shippers, competitors, or employees, we estimate the total gain to shareholders as a group, ΔPS , as being equal to the total welfare gain due to commercialization-privatization: \$15,056 million or \$4,436 million, depending on the selected counterfactual, minus the increase in government surplus, \$6,901 million or \$2,296 million, which equals \$8,155 million under the base-case counterfactual or \$2,051 under the conservative one. Shareholders gain from the initial underpricing and they benefit from subsequent unanticipated efficiency improvements. Evidence from a variety of sources clearly indicates that the market underestimated the gains from privatization. For example, abnormal (market adjusted) cumulative buy and hold returns to CN shareholders from three days after privatization to five years after privatization were 66.5 percent (Boardman et al. 2002).

Distribution of the Welfare Gains to Canadians and Non-Canadians

At privatization, Canadians owned 60 percent of the shares, but within weeks their ownership share had dropped to 35 percent (Bruce 1997, 147). A decade later, Canadians owned 55 percent of CN.²⁰ Since the change in ownership from 35 percent back up to 55 percent appears to have occurred gradually, we estimate that, on average, Canadians have owned 45 percent of CN since the first few weeks after privatization. As above, we assume everyone who obtained shares at the offer price sold them

immediately, paid taxes on the gains from underpricing, repurchased the shares at the market price, and held them indefinitely. Canadian shareholders receive 60 percent of the gains from underpricing, which amounts to \$121 million after-tax, and 45 percent of the difference between the PV of the after-tax profits from late 1995 on and the cost of purchasing the (trading) shares. To calculate the latter, we use equations (8), (10), (12) and set the change in consumer surplus to zero. Doing so, we obtain:

$$(1 - \tau)\Pi_p = \Delta PS + Z + 0.24U \quad (14)$$

which we estimate to be \$3,571 million under our base-case counterfactual, and \$824 under the alternative counterfactual.²¹ Therefore, the total change in Canadian producer surplus is calculated as:

$$\begin{aligned} \Delta PS^{can} = & 0.45[(1 - \tau)\Pi_p - (Z + U)] \\ & + 0.6 \times 0.75(1 - t^c)U \end{aligned} \quad (15)$$

for a total of \$3,692 million under the base-case counterfactual, and \$945 under the alternative (see Table 2).

Foreign shareholders receive 40 percent of the gains from underpricing, which amounts to \$98 million after withholding tax, and 55 percent of the difference between the PV of the after-tax profits

and the cost of purchasing the (trading) shares, which we estimate as \$4,365 million under our base-case, and as \$1,008 under our conservative counterfactual. In sum, under the base-case we estimate that aggregate Canadian welfare increases \$10,593 million (the change in government surplus of \$6,901 million plus the change in Canadian producer surplus of \$3,692 million) and foreign welfare increases \$4,463 million, ignoring any shadow pricing. Under the conservative counterfactual, aggregate Canadian welfare increases \$3,241 million (the change in government surplus of \$2,296 million plus the change in Canadian producer surplus of \$945 million) and foreign welfare increases by \$1,106 million.

SENSITIVITY ANALYSIS AND OTHER IMPACTS

Our estimate of the total welfare gain due to privatization is large. In this section we first perform a simple check of our welfare estimate based on stock-price data. The following subsections perform sensitivity analyses with respect to the SDR, the projected growth in CN output, alternative values of the shadow multipliers on government revenue and private investment funds, and changes in tax rates and tax revenues. We also consider the effects of privatization on accidents, safety, and other externalities; on CN's employees; on CP; and on CN's worldwide operations.

TABLE 2

Summary of the Welfare Gains Due to Privatization of CN and Their Distribution
(in millions of 1992 dollars)

	ΔW	ΔGS	ΔPS	$\Delta PS^{Canadian}$	$\Delta PS^{Foreign}$	$\Delta W^{Canadian}$
Base-case counterfactual ^a	15,056	6,901	8,155	3,692	4,463	10,593
Conservative counterfactual ^b	4,346	2,296	2,051	945	1,106	3,241

Notes:

^a CN's unit costs = 1.066*CP unit costs.

^b CN's unit costs fall 1.062 percent/year faster than CP's unit costs

Source: Authors' compilation.

A Check of Our Aggregate Welfare Estimate

We estimate that if CN had remained in government ownership it would have been worth \$1.97 billion, while its value at sale was \$3.95 billion, representing a difference of nearly \$2 billion in 1992 dollars. In contrast, we estimate under our base-case counterfactual that the privatization of CN created a welfare gain of over \$15 billion in 1992 dollars, and under our conservative counterfactual we estimate a welfare gain of \$4.35 billion. Both estimates are significantly higher than \$2 billion. Of our estimated \$15 billion welfare increase, we estimate that \$13 billion reflects unanticipated cost savings. Shareholders received the after-tax value of this, which amounts to about \$7.9 billion. Of our \$4.35 billion welfare increase under the conservative counterfactual, we estimate that nearly \$2.4 billion represents unanticipated cost savings. As a reality check, these amounts can be compared to the unanticipated increase in the market value of CN.

On 31 March 2006, there were 532.7 million shares outstanding, each worth \$54, which implies a market value of \$28.77 billion. Converting this amount into real 1992 dollars and discounting back to 1992 at the SDR yields a PV of \$13.6 billion. CN was sold for \$1.907 billion in 1992 dollars implying the unanticipated increase in producer surplus equals \$11.7 billion, which is *higher* than even our larger base-case estimate, thereby suggesting that neither estimate is too high. One potential reason the estimate based on the stock price is higher than our estimate is that we focus on CN's Canadian freight operations while CN's stock price reflects its acquisition of Illinois Central and all of its worldwide activities.

Sensitivity to the Discount Rate and the Projected Growth of CN Output

Our preferred estimate of the SDR for Canada is 3.5 percent. However, some economists argue that the SDR should be set equal to the real marginal return in the private sector. For Canada, this equals just over 5 percent, using a measure from the corporate bond market as suggested by Moore et al.

(2004). Some argue that one should use the real average return to a stock market index like the S&P-TSX as a proxy. This equals about 7.5 percent over the period we study, although we prefer the use of the bond rate because of the equity premium puzzle, survivor bias, the need for a measure of marginal rather than average returns, and difficulties in estimating the effective corporate marginal tax rate (see Moore et al. 2004, 801). To test the sensitivity of our results to alternative measures of the SDR, we discount using rates of 3.5, 5.5, and 7.5 percent.

Earlier, we conservatively assumed the future growth rate of CN output from 2004 onward as zero. However, Figure 3a shows some growth in CN output over the past two decades. For the 1984–2003 period, which roughly corresponds to the beginning of the recovery from the recession of the early 1980s to the beginning of the recovery from the recession that began in 2001–2, the average annual CN output growth rate was 1.14 percent. It was 0.32 percent from 1984 to 1991, and 1.9 percent during the 1993–2003 post-privatization period. To test the sensitivity of our results to alternative future growth rates of CN output, we use output growth rates of zero, 1 and 2 percent per year, and perform this sensitivity analysis for both counterfactuals.

As shown in Table 3, our results are quite sensitive to the choice of the SDR and of the projected future growth rate of CN output. This is attributable to the large effect of projected future cost savings. Under our base-case counterfactual, at a 3.5 percent SDR with a 2 percent projected growth rate, the estimated change in total welfare is \$31 billion, but it is \$6 billion at a 7.5 percent SDR with a zero projected growth rate. Using the conservative counterfactual, at a 3.5 percent SDR with a 2 percent projected growth rate, the estimated change in total welfare is \$10 billion, but it is only \$1.4 billion at a 7.5 percent SDR with a zero projected growth rate. The overall welfare change is always positive, but can vary fivefold depending on the choice of these two key parameters.

TABLE 3
Sensitivity to the SDR and the Future Growth Rate of CN Output

<i>Base-Case Counterfactual (in millions of 1992 dollars)</i>						
<i>SDR</i>	ΔW	ΔGS	ΔPS	$\Delta PS^{Canadian}$	$\Delta PS^{Foreign}$	$\Delta W^{Canadian}$
Future output growth rate = 0%						
3.5	15,056	6,901	8,155	3,692	4,463	10,593
5.5	8,810	4,463	4,347	1,977	2,370	6,441
7.5	5,955	3,327	2,628	1,203	1,426	4,530
Future output growth rate = 1%						
3.5	19,862	8,745	11,117	5,025	6,092	13,770
5.5	10,187	4,991	5,196	2,359	2,836	7,350
7.5	6,524	3,545	2,979	1,360	1,618	4,906
Future output growth rate = 2%						
3.5	31,076	13,048	18,029	8,135	9,893	21,183
5.5	12,350	5,821	6,529	2,959	3,570	8,780
7.5	7,299	3,843	3,456	1,575	1,881	5,418
<i>Conservative Counterfactual (in millions of 1992 dollars)</i>						
<i>SDR</i>	ΔW	ΔGS	ΔPS	$\Delta PS^{Canadian}$	$\Delta PS^{Foreign}$	$\Delta W^{Canadian}$
Future output growth rate = 0%						
3.5	4,346	2,296	2,051	945	1,106	3,241
5.5	2,285	1,467	818	389	429	1,856
7.5	1,361	1,077	284	148	136	1,225
Future output growth rate = 1%						
3.5	5,965	2,917	3,049	1,394	1,654	4,311
5.5	2,748	1,645	1,104	518	586	2,163
7.5	1,552	1,151	402	201	201	1,352
Future output growth rate = 2%						
3.5	9,743	4,366	5,377	2,442	2,935	6,808
5.5	3,477	1,924	1,553	720	833	2,644
7.5	1,814	1,251	563	273	289	1,524

Source: Authors' compilation.

Sensitivity to the Shadow Prices on Government Revenues and Private Capital

In equation (1), λ_g and λ_p are shadow multipliers on government revenue and private investment funds, respectively. Earlier we assumed that there is no difference between these two shadow multipliers and, in the distributional analysis, implicitly set each

equal to unity. However, distortions in the economy imply that neither is likely to be unity. The marginal excess tax burden, λ_g , is likely to exceed one as virtually all taxes impose efficiency losses, implying that an increase in government revenue of \$1 allows a tax reduction (or avoided tax increase) which creates an increase in domestic net social

benefits of more than \$1. Galal et al. (1994) suggest a central estimate of $\lambda_g = 1.33$, while Boardman et al. (2006, 429) suggest that $\lambda_g = 1.4$ approximately. The shadow price of capital, λ_p , is likely to exceed one because the before-tax return on investment exceeds the rate at which individuals discount future personal consumption; due to corporate and personal income taxes and other factors, displaced private investment has a greater opportunity cost than displaced consumption (Moore et al. 2001, 2004). Moore et al. (2004) estimate $\lambda_p = 1.1$ for the US, assuming the SDR equals 3.5 percent and the real rate of return on private capital equals 4.5 percent. This implies $\lambda_p = 1.16$ for Canada, assuming the SDR equals 3.5 percent, the real rate of return on private capital equals 5.3 percent, and using other data from Moore et al. (2001).

Under our base-case counterfactual, using the higher values of these shadow multipliers and assuming that all gains to shareholders result dollar for dollar in more private-sector investment, our estimate of the gain in Canadian welfare increases from \$10,593 million (in 1992 dollars) to:

$$\Delta W^{\text{Canadian}} = \lambda_g \Delta GS + \lambda_p \Delta PS^{\text{Canadian}} = 1.4 \times 6,901 + 1.16 \times 3,692 = \$13,944 \text{ million.}$$

Using the lower estimates of these multipliers yields an estimated gain in Canadian welfare of:

$$\Delta W^{\text{Canadian}} = \lambda_g \Delta GS + \lambda_p \Delta PS^{\text{Canadian}} = 1.33 \times 6,901 + 1.1 \times 3,692 = \$13,240 \text{ million.}$$

Under the conservative counterfactual, using the higher values of these shadow multipliers increases our estimate of the gain in Canadian welfare from \$3,241 million (in 1992 dollars) to \$4,310 million, while using the lower estimates yields an estimated gain in Canadian welfare of \$4,093 million.

Using these shadow multipliers would increase the estimated gain in Canadian welfare by about 25 to 32 percent under either counterfactual. From a Canadian welfare perspective, of course, the shadow

multiplier on the gain in foreign-producer surplus is zero. There is some controversy over the magnitude of these shadow prices and whether they should be used in developed, relatively non-distorted economies. Canada was experiencing fiscal retrenchment in the mid-1990s, so treating the shadow multiplier on government revenue as greater than one makes some sense, and since we use a relatively low SDR, arguably we should use a shadow price of capital that is greater than unity as well.

Sensitivity of the Estimates of Government Surplus and Producer Surplus

Two reasons suggest that we may overestimate the gains to the Canadian government, and therefore to aggregate Canadian welfare; and one reason why we may underestimate it. First, we assume that CN's effective corporate tax rate remains at 38.37 percent after 2003. However, corporate tax rates have been trending down in Canada, as elsewhere. A lower effective corporate tax rate implies smaller gains for the government and larger gains for producers (shareholders). Assuming the tax rate after 2003 is 35 percent, the estimate of the increase in government surplus falls by about \$400 million under our base-case, and about \$137 million under the conservative counterfactual.

Second, the estimate of government surplus is based partially on estimating $(1-\tau)\Pi_g$ using the sale price plus underpricing, $Z + U$. The private sector uses a higher discount rate than the SDR, so the future expected profits discounted using the SDR will give a larger number than if we had used the private sector's discount rate. Consequently, we underestimate the PV of future expected, after-tax profits under government ownership and overestimate the gains to the government (and to Canadian welfare). The magnitude of this effect is roughly \$600 million.²²

Equation (12) implicitly assumes that shareholders hold their shares indefinitely. In practice, the government will receive capital gains taxes on the (now) 55 percent of the shares that are Canadian-owned when they are sold. We therefore underestimate the gain to

the government. Very rough calculations suggest that this equals approximately \$1.4 billion in 1992 dollars.²³ The net effect of these three adjustments is less than \$0.5 billion.

Negative Externalities and Quality Effects

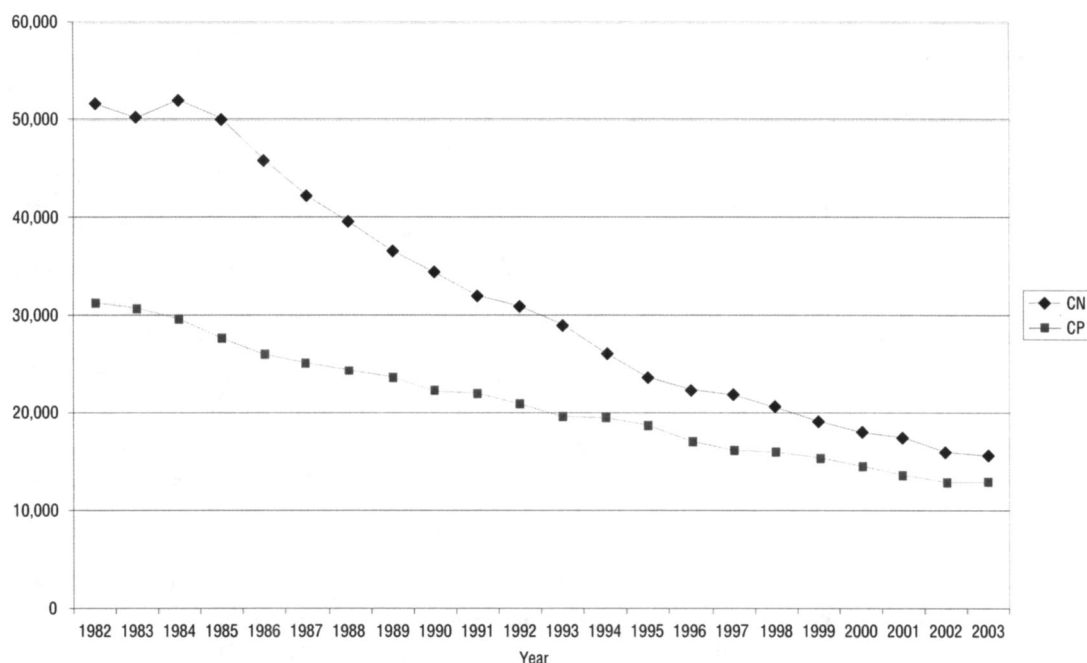
Railway accidents and safety can be a controversial issue, especially in passenger rail. They were certainly very important in the privatization of BR (Pollitt and Smith 2002). At CN, there have been a number of high-profile accidents, for example, a toxic spill in 2005 and a 2006 derailment (which killed two employees). However, systematic appropriate data are hard to find. Evidence from Transport Canada and Statistics Canada indicates that while accidents and fatalities have increased over time, this has more to do with increased activity than decreased safety. Unfortunately, the accident data are not broken down by company. Passenger rail

measures of quality, such as delays and overcrowding, are not so important for freight traffic.

Effects on CN Employees

Our analysis assumes that CN employees experience neither a gain nor a loss in welfare due to privatization. To the extent that employees earned rents prior to 1992, and these rents are reduced afterwards, some of the estimated efficiency gains may be a transfer from employees to shareholders or to the government, and our estimate of the aggregate welfare gain may be too high. Figure 4 shows that both CN and CP reduce their employees throughout our dataset, with faster reductions at CN, especially during the 1984–1995 period. However, it is unclear that employment at CN is lower than it would have been without privatization. While CP's rate of employment decrease is virtually unchanged before and after 1992, CN has a slower rate of employment decrease after 1992.

FIGURE 4
CN and CP Employment, 1981–2003



Source: Authors' compilation.

Turning to compensation, there is little evidence that commercialization-privatization reduces CN employees' rents. Prior to 1992, compensation at CN grew more slowly than at CP (0.35 percent per year from 1982–1991, versus 0.68 percent per year at CP), but from 1993–2003 the average annual rate of growth at CN is higher than at CP (1.98 percent versus 1.03 percent). Pay at the two railways was roughly equal in 1991, but was 12 percent higher at CN by 2003. The data on real wages, which grew slightly over the entire period (less than one percent per annum, on average), are similar.²⁴ Prior to 1992, CN's real wages actually decrease, but post-1992 they increase at a faster rate (over one percent a year) than at CN. If we take compensation growth minus wage growth as a rough indication of the increase in hours worked, there is faster growth in hours worked pre-1992 than post-1992 at CN, so there is little evidence that CN employees are having their rents reduced at a faster rate post-privatization by being required to work harder. Given the evidence on CN's relatively slower decrease in employment and faster increases in compensation and wages following privatization, we see no evidence that CN employees were adversely affected by privatization.

Effects on CN's Competitors

Our estimates of the welfare gains due to the commercialization-privatization of CN assume that it has no effect on CP. However, if CN becomes a more efficient competitor, this may spur CP to likewise become more efficient (Bruce 1997, 151-2), implying that we have underestimated the total welfare gains. However, the evidence of any effect on CP is weak. Generally, CP's costs fall after the privatization of CN at about the same rate until 1998, after which cost reductions slow at both firms; see Figure 2. Employment, compensation, and wages at CP appear unaffected. Although CP's output increased slightly following the privatization of CN, looking at the trend over the whole period and comparing it to CN does not reveal any obvious effects of CN's privatization on CP's output; see Figure 3.

Effects on CN's US Acquisitions and Operations

This article focuses on the welfare gain stemming from efficiency improvements in CN's Canadian freight business. Privatization also enhanced CN's ability to make acquisitions in the US, such as the purchase of Illinois Central in 1999. This would probably have been impossible if it had remained a SOE. These acquisitions may have a positive impact on the efficiency of CN's Canadian operations and are reflected in our estimated welfare impacts. However, they may also increase both producer and government surplus by amounts that are not reflected in our aggregate estimate, since our data include only Canadian operations. If US acquisitions became more efficient due to CN ownership, there are gains to Canadian shareholders through stock-price appreciation and to the Canadian government through taxes on incremental corporate profits that are not reflected in our estimates.

CONCLUSION

This article uses CBA to estimate the welfare gains from the privatization of CN. One unique characteristic of this study is that we are able to construct a more plausible counterfactual than in previous privatization CBAs. The available CP data relate to the same industry, covers the same time period, is subject to the same institutional environment, and is subject to very similar external forces. Using our conservative counterfactual, we estimate the efficiency gain attributable to privatization is about \$4.35 billion in 1992 dollars, which is similar to Pollitt and Smith's (2002) finding of £2.5 billion (C\$5.82 billion) in efficiency gains resulting from the privatization of BR. However, our estimate of the aggregate welfare gain from the privatization of CN is higher than Pollitt and Smith's estimate of the welfare gain from privatizing BR because BR incurred substantial restructuring costs of about £1.4 billion (C\$3.26 billion).

Using our base-case counterfactual we find gains in aggregate welfare that amount to just over \$15 billion in 1992 dollars. Most of these gains were unanticipated at the time of privatization and are projected to occur after 2003. We argue that consumers (shippers) were not affected because prices and quantities did not change relative to the counterfactual. We also argue that effects on employees were negligible. The welfare gains were divided between producer surplus and Canadian government surplus. Under our base-case counterfactual, shareholders gain \$8.16 billion and the government nets \$6.9 billion. \$3.69 billion in producer surplus gains goes to Canadians and \$4.46 billion goes to the rest of the world. In aggregate, Canadians gain \$10.59 billion. Under our conservative counterfactual, the Canadian government gains \$2.3 billion, with \$2.05 billion going to shareholders, of which Canadian shareholders receive \$0.95 billion and \$1.1 billion goes to the rest of the world. In aggregate, Canadian welfare gains under this approach amount to \$3.25 billion.

Both of our aggregate welfare estimates are conservative, in that we assume CN's output growth is zero after 2003, there is no marginal excess tax burden, the shadow price of capital equals one, there are no efficiency gains outside of Canada, and there are no beneficial impacts on CP. On the other hand, our results are quite sensitive to the SDR. However, even using a 7.5 percent SDR and the conservative counterfactual, the welfare gain is about \$1.36 billion, of which \$1.23 billion goes to Canadians. Changes in negative externalities and quality effects are hard to measure. With shadow pricing of government revenue and Canadian private investment funds, the gain in Canadian welfare increases by 25 to 32 percent, depending on the values of the multipliers.

While it is now fairly well accepted that privatization leads to efficiency and welfare improvements in competitive environments, the evidence of such gains in non-competitive environments is mixed. Since freight-rail service in Canada at the aggregate

level is basically a duopoly, this article provides some additional support for the argument that privatization leads to welfare gains in less competitive environments. Future research that disaggregates the welfare impacts of CN's commercialization-privatization according to the extent of competition in its various product markets may shed more light on this issue.

NOTES

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¹ Since 1995, CN has held between 51 and 53 percent share of freight-transport revenues generated in Canada; CP has held between 38 and 39 percent. The remaining 10 percent is generated by short-line railroads (Statistics Canada 1995–2003).

² For histories of the regulation of the Canadian rail industry, see Bonsor (1995), the Canadian Transportation Act Review Panel (2001), and Heaver and Waters (2004).

³ CN continued to own oil and gas assets, non-rail real estate, and a subsidiary that manufactured transport equipment. These were mainly divested prior to privatization. The manufacturing subsidiary was finally sold in 1996 (Canadian National Railway Company 1995, 1996).

⁴ Both Bonsor and Waters have confirmed this in private communications.

⁵ A revenue-tonne kilometre means that one tonne of revenue-generating freight is transported one kilometre. On average, freight generates about 89 percent of the total revenues of each firm while passengers generate three percent. Other sources of revenue include government subsidies (four percent), compensation for services rendered to Via Rail (one percent) and other miscellaneous revenues (three percent) (Statistics Canada 1995–2003).

⁶ Three CN numbers are excessively high (benefits in 1992 and 1998, and miscellaneous costs in 1996) and four CP numbers are excessively high (benefits in 1991 and

1992, and miscellaneous costs in 1995 and 1999). These amounts exceed the previous year's amounts by at least \$190 million, often much more. Because this adjustment is simply time shifting and does not affect the total amounts, it has little effect on the welfare estimates.

⁷ For an unusual item at time t we compute the excess as the difference between its reported value at time t and the average of the same series at $t-1$ and $t+1$. We then spread this excess over year t and the following five years. Thus the value for the series at time t equals the average of the series at $t-1$ and $t+1$ plus one sixth of the excess, and the value for the series at time $t+i$ equals the reported value plus one sixth of the excess (for $i = 1, 2, \dots, 5$).

⁸ Using four years is somewhat arbitrary, but our results change by less than one percent if we average over only three years (1989–1991) to construct the counterfactual and are nine percent higher if we average over five years (1987–1991).

⁹ This is our best estimate of the SDR, using recent Canadian data and the method suggested in Moore et al. (2004) based on an optimal growth-rate model.

¹⁰ Beginning the calculation in 1996, the first year after actual privatization, only changes this total by \$80 million 1992 dollars or less than three percent of the total present value of these cost savings.

¹¹ Even if prices decreased due to privatization, this is unlikely to have a significant impact on the overall measured welfare gains as the gain would be second order (see Newbery and Pollitt 1997, 280).

¹² CN's counterfactual ATC in 1993 = CN's actual ATC in 1992 $\times$ (the ratio of CP's ATC in 1993 to CP's ATC in 1992 minus 1.062).

¹³ For 1994–2003, CN's counterfactual ATC in year t = CN's counterfactual ATC in year $t-1 \times$ (the ratio of CP's ATC in year t to CP's ATC in year $t-1$ minus 1.062).

¹⁴ For example, estimating the counterfactual based on the convergence in CN's and CP's ATC from the period 1981–1991 to the period 1982–1991 or to 1983–1991 changes the welfare estimates considerably. In contrast, changing the base case counterfactual from 1998–1991 to 1997–1991 or to 1999–1991 affect the welfare estimates by less than 10 percent; see endnote nine.

¹⁵ We assume that there are no significant welfare

effects on employees or on rivals (CP) for reasons discussed below. Also, we assume there are no significant changes in any externalities associated with CN's operations.

¹⁶ For the reasons given above, we assume that change in ownership does not affect CN's output.

¹⁷ For a discussion of underpricing generally, and especially in the context of privatization, see Laurin, Boardman, and Vining (2004).

¹⁸ The marginal tax rate varies from province to province. In 1995, it was 39.89 percent in Ontario, 34.55 percent in Alberta, and 40.62 percent in B.C. We use 40 percent as an estimate of the average marginal tax rate in Canada.

¹⁹ CN reported a combined federal-provincial corporate tax rate, τ , of 44.4 percent from 1995 through 2001; 42.37 percent in 2002; 40.37 percent in 2003; and 38.37 percent in 2004 (Canadian National Railway Company 1995–2004). We use the latter rate on all the incremental profits (cost savings) projected forward from 2004.

²⁰ Confirmed in e-mail correspondence between author Mark A. Moore and Mark Hallman, Director of Public Affairs, CN, on 5 July 2006.

²¹ Forty-five percent of the difference between the after-tax profits and the sum of the sale price and the underpricing.

²² To estimate the bias we multiply our estimate of $(1-\tau)\Pi_g$, which equals $(Z+U)/2$, by the ratio of our preferred estimate of the private sector's real discount rate, 5.5 percent, to our preferred estimate of the SDR, 3.5 percent, and subtract our estimate of $(1-\tau)\Pi_g$.

²³ The market value of CN on 31 March 2006 was \$28,766 million current dollars. The market value one day after privatization was \$2,598 million. If the 55 percent of the shares owned by Canadians were sold, Canadians would realize capital gains of $0.55 \times (28,766 - 2,598) = \$14,392$ current dollars, 50 percent of which is currently taxable. Assuming a marginal tax rate of 40 percent, this would yield $0.5 \times 0.4 \times 14,392 = \$2,878$ current dollars of tax revenue. Deflating into 1992 dollars and discounting back to 1992 yields a real PV of \$1,389 million.

²⁴ We ignore CN's 2003 figure which is an outlier and appears to be a mistake.

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