Research in Transportation Business & Management xxx (2012) xxx–xxx

Contents lists available at SciVerse ScienceDirect

Research in Transportation Business & Management

Efficiency, profitability and welfare gains from the Canadian National Railway privatization ☆

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ARTICLE INFO

Article history:
Received 19 June 2012
Received in revised form 21 November 2012
Accepted 22 November 2012
Available online xxxx

Keywords:
Privatization
Canadian National Railway
Operational performance
Social welfare

ABSTRACT

This article describes and analyzes the privatization of Canadian National Railway (CN), a large railroad privatization. First, it reviews the theory and evidence concerning railroad privatizations. Second, it presents a brief history of CN and the regulatory environment prior to and after CN's privatization. Third, it uses data from 1990 to 2011 to compare CN's post-privatization operating performance with its pre-privatization performance. Fourth, it uses cost–benefit analysis to estimate the social welfare gains from the privatization and the distribution of those gains. The overall results demonstrate that CN performed substantially better following privatization, both from an operational perspective and from a broader social welfare perspective. We find statistically significant increases over the long term (16 years following privatization) in sales, capital investment, assets, profit, profitability, productivity, dividends and corporate taxes paid. There was little change in the capital structure of CN and a significant decrease in employment. Using Canadian Pacific Railway as a basis for the counterfactual, we estimate that CN's privatization generated social welfare gains of approximately $25 billion in 2011 Canadian dollars. The Canadian government received almost half of these gains, while CN's shareholders (most of whom were non-Canadian) captured the rest.

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1. Introduction

The privatization of Canadian National Railway (CN) in 1995 was by far the largest transportation privatization in Canadian history. Alongside the privatizations of the Japanese National Railways and of the British Rail, the CN privatization represents one of the largest transportation privatizations globally. Both the Japanese and British railroad privatizations have been controversial, especially in the British Rail case (Mathieu, 2003; McCartney & Stittle, 2008; Smith, 2006; Yvrande-Billon & Ménard, 2005). As we discuss later, the evidence on the performance outcomes of the railroad privatizations is mixed, although freight privatization appears to have done better than other privatized railroad businesses, including passenger services.

The privatization of CN differs from the Japanese and British railroad privatizations in a number of important ways. First, the CN privatization primarily involved freight transport rather than passenger travel, which is the case in both Japan and Britain. Second, the CN privatization consisted of a one-time share issue sale of an integrated business (including track and rolling stock) and the maintenance of an existing organization, while the British and Japanese privatizations involved either separation of infrastructure and rolling stock (vertical separation) or geographic disintegration (horizontal separation). Third, the topographical footprint and conditions of the CN system are quite different to the other two systems. Fourth, both before and after privatization, CN faced a direct competitor over much of its network, which was not the case in Japan or Britain.

Our main purpose is to determine whether the privatization of CN was beneficial. We take two approaches. First, we use data from 1990 to 2011 to compare CN's post-privatization operating performance with its pre-privatization operating performance. We examine changes in output, capital expenditures, assets, employment, profit, productivity, profitability, capital structure, dividends and corporate taxes. The findings are important from a business strategy perspective, a shareholder perspective and a government perspective. Second, we use data from the 1981–2008 period to estimate the change in social welfare from the CN privatization and the distribution of these benefits and costs between the Canadian government and (Canadian and non-Canadian) shareholders of CN. We use cost–benefit analysis (CBA) to conduct this assessment. A key feature of this CBA is that we use cost data from Canadian Pacific Railway (CP), a direct competitor of CN, to compute the counterfactual, that is, what would have happened in the absence of privatization. These findings are most directly relevant for the government of Canada and policy analysts interested in the welfare consequences of privatization in general and,

☆ The authors would like to thank Leo Fankhänel and Robert Boardman for research assistance.

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2210-5395/$ – see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.rtbm.2012.11.011

more specifically, of railroad privatization. It also offers lessons to other governments considering railroad privatization or institutional reform.

In sum, we find that the privatization of CN was beneficial to shareholders, to the government of Canada and to the overall welfare of Canadians. The most important results can be summarized as follows. In the short run (which we consider to be the 5-year period following privatization), profit (net income), profitability (return on assets and return on sales), and productivity (measured by sales per employee and net income per employee) increased significantly relative to the (5-year) pre-privatization period, employment experienced a statistically significant drop and there was no statistically significant change in sales revenue, capital investment, assets, capital structure, dividends or corporate taxes. In the long run (which we consider to be the 16-year period following privatization), there were statistically significant increases in sales, capital investment, assets, profit, profitability (return on assets and return on sales), and productivity (sales per employee and net income per employee). There were also statistically significant increases in dividends and corporate taxes, demonstrating that the most significant stakeholders in the privatization – government and shareholders – benefited from the privatization. Capital structure (debt-to-assets) did not change substantially. There was, however, a significant reduction in employment, although we argue that employees were not adversely affected. Turning to the welfare results, CN's privatization generated social welfare gains of almost $25 billion in 2011 Canadian dollars (which we use hereafter unless explicitly stated otherwise). The Canadian government received almost half of these gains, while CN shareholders (over half of whom were non-Canadian) captured the rest.

The article is organized as follows. Section 2 briefly reviews the theory about privatization and summarizes the academic evidence concerning the outcomes of previous railroad privatizations in Japan, Britain, Australia, New Zealand and Chile. Section 3 presents a brief history of CN and of the regulation of Canadian railroads prior to privatization. It also describes some key events following privatization. Section 4 analyzes both the short-run and the long-run operational performance impacts of privatization. Section 5 presents our estimate of the overall welfare change attributable to the privatization of CN by using cost–benefit analysis, and of the distribution of these changes among different stakeholders. Section 6 summarizes the main results and identifies some of the factors that led to CN's success. It also offers lessons for private sector and government management, and includes some suggestions for future research.

2. Theory and evidence about railroad privatizations

The weight of the empirical evidence is that privatization of businesses in reasonably competitive markets increases firm competitiveness, improves productivity and generates positive welfare gains (Boardman, Laurin, & Vining, 2002; Boardman & Vining, 1989; Boubakri & Cosset, 1998; Megginson & Netter, 2001; Shirley & Walsh, 2001). However, the long-haul Canadian railroad industry has been and is effectively duopolistic. While the direct overlap of CN's and CP's networks has been estimated at between 25% and 50%, the effective competitive overlap, given feed-in complementors that have options, is considerably larger (McNish, Jang, & Silcoff, 2012). Unfortunately, the theory and evidence concerning the impact of privatization in highly oligopolistic or duopolistic markets is not resolved (Chirwa, 2004; De Fraja, 1991; Willner & Parker, 2007).

Both Canada and the United States have been unusual in enjoying a fairly high degree of direct competition in rail freight. The Secretariat of the OECD has noted: "competition in-the-market between vertically-integrated rail companies …requires the existence of at least two separate rail infrastructures capable of providing substitute rail services …this is the predominant form of competition in rail freight services in North America" (OECD Secretariat, 2006, 71). Furthermore, the Secretariat argues: "experience shows, at least in North America, that this approach has been able to deliver a degree of competition with relatively little regulatory intervention" (OECD Secretariat, 2006, 71). Evidence suggests that the presence of more than one railroad competitor reduces tariffs anywhere between 3% and 25% (Gomez-Ibanez, 2010; Grimm & Winston, 2000; Karikari, Brown, & Nadji, 2006; Winston, Maheshri, & Dennis, 2011). Furthermore, both CN and CP faced increasing inter-modal competition from trucking and shipping. In an important article, Caves and Christensen (1980) refer to Canadian railroads as operating in a competitive environment. Although the Canadian railroad industry was a duopoly on the long haul freight routes, this collective evidence suggests that it was "reasonably competitive" and, consequently, one might expect that the privatization of CN would lead to efficiency improvements and welfare gains.

The evidence on previous rail privatizations has been mixed. Only in Japan is the evidence clearly positive: privatization increased efficiency and profitability, especially for freight rail (Mizutani, 1999; Mizutani & Nakamura, 1996, 1997; Thompson, 2003). The privatization also improved safety (Evans, 2010; East Japan Railway Company Management Planning Department, 2008) and travel times (East Japan Railway Company Management Planning Department, 2008).

In Britain, the evidence is much less positive. The restructuring and privatization of British Rail (BR) took place during 1993–1996, when John Major's conservative government was in power. Thompson (2003, 347) argues that it "has been the most contentious of all railway system restructuring efforts". There was significant political and economic opposition to BR's privatization and significant disagreement as to how it should be privatized. Eventually, BR was fully privatized and resulted in over 100 different private firms. Many of these privatizations, including that of the Railtrack, which owned all of the track and the stations, were carried out rapidly (some would argue hastily) towards the end of Major's term.

Pollitt and Smith (2002) found evidence of significant operating cost savings in the first few years following privatization. Furthermore, Cowie (2009) found productivity gains in passenger rail on the order of 3–4% per annum over the first 4 years of privatization. In addition, there was substantial growth in passenger and freight traffic. However, there have been many criticisms of this privatization, including accusations of lower quality service (perceived reduced punctuality and overcrowding), a worse price-to-quality ratio and safety concerns (Mathieu, 2003), even though the evidence suggests that safety actually improved (Evans, 2007; Thompson, 2003). Following a huge cost escalation for the upgrade to the West Coast Main Line and the Hatfield derailment in 2000, the government decided to place Railtrack into administration and eventually replaced it with Network Rail, a not-for-profit company, owned by its members (Crompton & Jupe, 2007). Subsequently, annual industry cash costs rose by 47% and unit costs rose by 40%. Smith (2006) argues that this cost increase was largely due to an "excessive" concern with safety.

Under the provisions of the Railways Act 1993, BR freight was split into seven companies, each of which was separately offered for private sale. In the end, however, five were sold to a single purchaser, English, Welsh and Scottish Railway (EWS), controlled by Wisconsin Central. Following privatization, freight traffic grew 42% between 1994 and 2000 (Mathieu, 2003; Thompson, 2003). However, operators have only been marginally profitable (Fowkes & Nash, 2004). Furthermore, despite mandating open access to freight companies, which was an important feature of the British restructuring, there has been very little new entry into the rail freight business (Cowie, 2010).

In Australia there has also been extensive privatization of parts of the railroad system. Here, the record appears mixed. Williams, Greig, and Wallis (2005) note that the privatization of freight railroads has allowed consolidation across state boundaries and argue that, as a result, the industry is markedly stronger than in the past, although

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governments remain the funders of last resort. They also maintain that long-distance passenger privatization appears to have been successful and consider the urban and rural passenger rail concessions a "qualified success".

New Zealand Rail Limited (later re-named Tranz Rail) was privatized as a single integrated entity. In this case, the privatization appears to have been a failure on most dimensions (Clark, 2010; Wilson, 2010). New Zealand Rail was purchased in 1993 by a consortium of financiers and Wisconsin Central who jointly put up about one-third of the money and financed the rest by debt. In 1994, New Zealand Rail sold its stake in Clear Communications and, the next year, it made a capital repayment to the consortium members of $100 million (current Australian dollars), only slightly less than the initial amount of cash they had invested. In 1996, Tranz Rail issued new shares to the public, equivalent to 25% of the company, and it was listed on the New Zealand stock exchange. Despite significant investments in freight operations, the required volumes did not materialize and Tranz Rail lost money. In 2000, a new Board replaced the former management team and sold off many of the non-core assets. However, Tranz Rail continued to perform poorly and the stock price dropped. In 2003, Toll Holdings made a takeover offer for the company and, eventually, Toll became the operator and the government acquired the rail network. The company was renamed Toll NZ and its financial situation continued to worsen. In 2008 it was re-nationalized by the federal government. Although the Tranz Rail privatization was a failure on most dimensions, it was highly profitable for the initial consortium investors.

In Chile, railroad reforms resulted in the privatization of the entire Northern Railroad (sold to FERRONOR) and a state-owned Southern Railroad (EFE), which owned and maintained the track and carried passengers, but allowed private freight concessionaires (FEPASA and TRANSAP) to use the track (Soto, 2010). FERRONOR acquired the Northern Railroad in a competitive bid in 1995. It operated as an unregulated monopoly, concentrating on more profitable segments and eliminating others. From 1997 to 2000, freight volumes almost quintupled, revenues tripled, labor productivity tripled and profitability increased (see Soto, 2010, 16). On the Southern Railroad, FEPASA's freight volumes, revenues and productivity did not increase immediately following privatization, but did increase markedly after a decade of private ownership (see Soto, 2010, 18). Volumes rose partially due to the fact that prices were about 40% lower than prior to privatization (Thompson, Budin, & Estache, 2001), but despite this, profitability remained low. At this time, it is hard to reach a definitive conclusion on rail privatization in Chile, although the results appear positive in terms of freight.

This review demonstrates that railroad privatization has been conducted quite differently in different countries. Also, the outcomes have been very different, ranging from clearly beneficial to disastrous. In general, it appears that the evidence for freight privatization is considerably better than for the privatization of other railroad businesses, including passenger services. Apart from that result, given the relatively small number of railroad privatizations, and the diversity of situations and outcomes, it is difficult to generalize about the key success factors. However, the following factors appear to affect the efficiency and welfare outcomes of railroad privatizations: (1) how the privatization process was conducted, most importantly whether through a share issue or direct sale; (2) the regulatory framework following privatization; (3) whether the railroad was privatized as an integrated network or whether there was separation of 'wheel and rail'; (4) the market structure following privatization: the degree of direct competition, as well as the openness of the market and barriers to entry; (5) the price/quality characteristics of substitutes (especially road and sea); (6) the geography of the terrain over which the railroad operates, and economies of scale and density; (7) the degree and nature of technological change; (8) government policy following privatization, especially the extent of any government failures. Moreover, a myriad of relatively random, but politically salient, factors can affect whether or not the privatization is sustained (especially by governments elected *subsequent* to the privatizing government). For example, a single train crash that kills 10 people has greater political saliency than 10 road crashes that each kills one person.

Our primary purposes are to consider whether the privatization of CN has improved operating performance or social welfare. The net effect of the interplay of all the above factors over time in any particular privatization is impossible to predict ex ante. The answer lies in the empirical pudding.

3. Overview of CN and the Canadian freight rail regulatory environment

CN was formed as a government-owned corporation through the amalgamation of several financially troubled, privately owned railroads between 1917 and 1923. Since then, CN and CP have dominated railroad freight services in Canada. During much of the period of public ownership, CN was in various forms of financial stress. It is very difficult to determine the size of direct federal assistance to CN. Over the period 1927–1991, direct subsidy payments to the Canadian railroad *sector* amounted to almost $12 billion (1995 Canadian dollars), although over half of this amount was to subsidize passenger services (Bonsor, 1995). Much of the "subsidy" to CN was by way of recapitalizations: 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 CN should pay a 20% dividend on any profits earned. After 1978, CN appears to have operated more efficiently. Between 1978 and 1989, it was profitable in 9 out of the 11 years and remitted $237 million (current Canadian dollars) to the federal government (Bruce, 1997, 15).

In the early 1970s CN was highly diversified. However, over time, it has focused more on railroad freight transportation. Around 1977, Air Canada was spun off as a separate Crown Corporation (state-owned enterprise), CN's passenger services subsidiary became another separate Crown Corporation, later called Via Rail Canada, and CN Marine, which operated ferries in Atlantic Canada, also became a separate Crown Corporation. CN sold CN Route (a trucking business) to private investors in 1986. CNCP Telecommunications and a chain of hotels were sold to CP in 1988, along with telecommunications divisions in the Northwest Territories and Newfoundland. CN also owned oil and gas assets, non-rail real estate, and a subsidiary that manufactured transport equipment. Most of these businesses were divested prior to privatization, and the manufacturing subsidiary was finally sold in 1996 (Canadian National Railway Company, 1995, 1996).

The 1967 National Transportation Act significantly reduced the scope of rate regulation over both CN and CP, with the exception of grain transportation. But, Timur and Ponack (2002, 538) note that the 1967 Act still "emphasized cooperation between CN and CP and …the two companies exchanged cost information and set common freight rates." In 1983, the Western Grain Transportation Act shifted the burden of the so-called Crow Nest Pass rates for grain (essentially price controls) from the railroads to direct government subsidies (Heaver & Waters, 2004). In 1987, the National Transportation Act (NTA) allowed shippers located on only one of the railroads' lines greater access to the other's line, allowed confidential negotiation of rates, encouraged reliance on market forces and arbitration rather than on the regulation of most non-grain rates, and it allowed both railroads somewhat greater freedom to abandon uneconomic branch lines. The 1996 Canada Transport Act extended the 1987 NTA provisions and allowed both railroads to eliminate low-density lines, resulting in the formation of more independent short-line railroads. More importantly, the 1987 National Transportation Act initiated a transition from the era of tacit collusion to one of more direct intra-modal competition (Bonsor, 1995; Timur & Ponack, 2002).

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And, as mentioned above, both CN and CP faced increasing intermodal competition from trucking and shipping.

Paul Tellier was appointed CEO of CN in 1992 with the mandate to make CN more profitable and efficient prior to an ultimate privatization. Tellier began to run CN on a more commercial basis (Canadian National Railway Company, 1995; Bruce, 1997). The Canadian federal government privatized a number of Crown corporations between 1985 and 1997. Boardman and Vining (2012) provide a comprehensive discussion of the aggregate effects of these privatizations. The main reasons for the federal privatizations were the desire for more revenue or to reduce subsidies in the face of large deficits and government debts, and because it was consistent with the conservative government's ideological preferences (Boardman, Laurin, & Vining, 2003). Unlike many railroad privatizations in other countries, CN was privatized in its entirety and the infrastructure was not separated from operations.

All of the large Canadian privatizations, including the CN privatization, were carried out through fixed-price share issue privatizations (SIPs). These firms were in at least somewhat competitive industries and were expected to improve their efficiency under private ownership. CN was privatized in November 1995 in one tranche, with proceeds amounting to just over $2 billion in current Canadian dollars. Only the privatization of Petro-Canada in 1991 raised more money for the Canadian government (about $9 billion in aggregate in current Canadian dollars).

One issue of interest is whether the government left "money on the table." Laurin, Boardman, and Vining (2004) found that CN was underpriced by about 25%. Based on a sample of 104 SIPs across 25 countries, they also found that SIP underpricing averaged 15.2% in other developed countries, but only 6.3% in Canada. This comparison suggests that the Canadian government did leave significant money on the table with CN's privatization, unlike its other SIPs.

Since its privatization, CN has made a number of important acquisitions that have substantially expanded its North American network. Most significantly, it increased its presence in the U.S. with the acquisition of the Illinois Central Railroad in 1998 for $2.4 billion (current U.S. dollars). After this acquisition, Hunter Harrison of Illinois Central became CEO of CN. CN later acquired Wisconsin Central for $1.2 billion (current U.S. dollars) in 2001, Great Lakes Transportation for $380 million (current U.S. dollars) in 2003 and BC Rail for $1 billion (current Canadian dollars) in 2003. When CN acquired Wisconsin Central it also acquired interests in EWS Railways in the UK, Tranz Rail in New Zealand, and TasRail in Tasmania. CN quickly sold off these holdings.

As of 2012, the increased efficiency of CN has had an impact on the management and ownership of CP. In 2012, private equity shareholders of CP (most importantly, Pershing Square) won a proxy battle to have CP hire CN's retired CEO, Hunter Harrison, to run CP (Deveau, 2012; McNish et al., 2012).

4. Operational performance changes at CN

This section adopts the methods used by D'Souza and Megginson (1999), Boardman et al. (2002) and others to examine the impacts of the privatization on operational performance. One key difference is that this research uses data for a much longer period of time — from 5 years prior to privatization to 16 years post-privatization. The main results are presented in Table 1. Data are drawn from the annual reports, as reported by Compustat. All financial data are converted to real (inflation adjusted) 2011 Canadian dollars using the Canadian Consumer Price Index — All Items (CPI).

Given that Table 1 contains the raw data for each variable, one can clearly see how each performance measure has changed over time. Table 1 also contains the average value of each performance variable during the 5-year period prior to privatization (denoted Pre-Priv), during the short-run (5-year) period after privatization (denoted SR post-priv) and during the long-run (16-year) period after privatization (denoted LR post-priv). It also compares the average value of each variable during the 5-year (SR) post-privatization period and during the 16-year (LR) post-privatization period to the average value in the pre-privatization period (denoted SR post–pre and LR post–pre, respectively). Finally, we present the Mann-Whitney U statistic (also known as the Wilcoxon rank-sum test), which tests whether the post-privatization observations come from the same distribution as the pre-privatization observations.

In the following sub-sections we discuss changes in four major operational performance categories: overview (sales, capital investment, assets and employment); profit, profitability and productivity (net income, return on assets, return on sales, sales per employee and net income per employee); capital structure (debt-to-assets ratio); and payments to stakeholders (dividends and corporate taxes paid). In total, these measures provide a comprehensive picture of the effects of privatization on operational performance.

4.1. Overview

CN's assets, measured in real 2011 Canadian dollars, were about $10 billion in the years prior to privatization. They fell by more than 10% in the year of privatization, but soon rose rapidly. Assets increased by almost $14 billion from 1997 to 2001, due partly to the Illinois Central (1998) and Wisconsin Central (2001) acquisitions. Since 2001, assets have continued to increase, albeit at a slower rate. By 2011, assets were over 150% higher than during the 5-year pre-privatization period. As shown in Table 1, the increase in assets from the 5 years prior to privatization versus the 16 years after privatization was statistically significant at the 1% level.

CN's real sales did not increase as much as real assets during the post-privatization period. Like assets, they were relatively flat prior to privatization. Following privatization they decreased slightly. They picked up in 1998 and then grew slowly through 2008. In 2011, real sales were approximately 50% higher than during the 5-year pre-privatization period. Similar to assets, sales were not significantly higher in the 5-year post privatization period than in the 5-year pre-privatization period but they were significantly higher in the 16-year post-privatization period than in the pre-privatization period.

Employment at CN was declining prior to privatization and continued to decline during the first 3 years following privatization. By 1998, employment had been reduced by 1/3 compared to the average of the 3 years prior to privatization. Thereafter, employment levels remained stable until 2011. The decrease in employment following privatization was statistically significant for both the 5-year and 16-year post-privatization periods.

4.2. Profit, profitability and productivity

CN experienced losses (negative net income) in most years immediately prior to privatization. It took a major write-down (of over $1 billion in constant dollars) in 1992, the year Paul Tellier was appointed CEO and lost over $1 billion in 1995, the year of privatization. Following privatization, CN's net income (NI) was always positive and increased consistently, reaching over $2 billion in 2006 and 2007 (in both real and nominal terms). Profits fell slightly in 2008 and 2009 during the recession, but in 2011 profits reverted to their 2007 level. The differences in NI between both the 5-year and 16-year post-privatization periods, relative to the pre-privatization period, were both statistically significant.

In the 5-year post-privatization period, CN's return on assets (ROA) averaged 3.6% and its return on sales (ROS) averaged 8.2%, which were substantially better than prior to privatization. Thereafter, ROA increased slightly while ROS continued to increase substantially. This long, consistent increase in profitability is particularly impressive compared to other Canadian SIPs, where profitability gains were usually achieved in the first 3 years and did not increase thereafter (Boardman & Vining, 2012). Both ROA and ROS showed statistically

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Table 1
CN's pre-privatization and post-privatization operating performance, 1990–2011.

Year	Sales (millions)	Capital expenditures (millions)	Assets (millions)	Employment	Net income (millions)	Return on assets (%)	Return on sales (%)	Sales per employee (thousands)	Net income per employee (thousands)	Debt to assets (%)	Dividends (millions)	Corporate taxes (millions)
1990	6236	500	10,749	37,000	12	0.11	0.19	169	0	49.55	86	−3
1991	5827	346	10,085	35,300	−21	−0.20	−0.35	165	−1	49.30	0	−5
1992	5783	477	10,065	33,500	−1435	−14.26	−24.81	173	−43	64.67	111	−18
1993	5889	614	9953	33,000	−111	−1.11	−1.88	178	−3	66.06	0	18
1994	6476	803	10,925	30,770	343	3.14	5.29	210	11	65.98	0	17
1995	*5609*	*446*	*8483*	*26,951*	*−1485*	*−17.51*	*−26.48*	*208*	*−55*	*62.79*	*0*	*−25*
1996	5609	669	8411	24,060	192	2.28	3.41	233	8	61.83	92	15
1997	5772	765	9384	22,800	535	5.70	9.26	253	23	51.70	103	431
1998	5442	649	14,267	21,510	143	1.00	2.63	253	7	60.50	130	8
1999	6790	812	19,046	23,490	777	4.08	11.44	289	33	62.69	172	476
2000	6845	763	19,099	22,460	970	5.08	14.18	305	43	62.50	201	556
2001	6929	782	23,034	22,670	891	3.87	12.86	306	39	66.14	228	481
2002	7326	685	22,690	23,190	685	3.02	9.35	316	30	64.98	222	321
2003	6863	680	20,003	21,490	856	4.28	12.47	319	40	62.22	223	394
2004	7499	1228	22,069	22,470	1485	6.73	19.81	334	66	61.88	254	723
2005	8113	1322	24,863	21,540	1744	7.01	21.49	377	81	58.32	308	875
2006	8480	1426	26,380	21,810	2294	8.69	27.05	389	105	59.07	374	706
2007	8492	1491	25,227	22,700	2321	9.20	27.33	374	102	56.62	449	589
2008	8913	1496	28,078	22,230	1991	7.09	22.34	401	90	60.48	458	683
2009	7721	1469	26,386	21,500	1943	7.36	25.17	359	90	55.38	497	427
2010	8539	1632	25,942	22,300	2165	8.35	25.36	383	97	55.23	518	795
2011	9028	1625	26,026	23,200	2457	9.44	27.22	389	106	58.96	585	889
Pre-priv	6042	548	10,356	33,914	−242	−2.46	−4.31	179	−7	59.11	39	2
SR post-priv	6092	732	14,041	22,864	523	3.63	8.18	267	23	59.85	140	297
LR post-priv	7398	1093	21,306	22,464	1341	6	17	330	60	59.91	301	523
SR post–pre	49	184	3686	−11,050	766	6.09	12.50	88	30	0.74	100	295
SR Mann–Whitney U	10	4	10	0[a]	2[b]	2[b]	2[b]	0[a]	2[b]	10	5	4
LR post–pre	1355	546	10,951	−11,450	1583	8.29	21.27	151	67	0.80	261	521
LR Mann–Whitney U	15[b]	7[a]	10[b]	0[a]	2[a]	3[a]	2[a]	0[a]	2[a]	36	16[c]	4[a]

The figures for 1995 are in italics because CN was privatized in this year and these data are not included in the statistical analyses.
[a] Statistically significant at the 0.01 level of significance for a two-sided alternative.
[b] Statistically significant at the 0.05 level of significance for a two-sided alternative.
[c] Statistically significant at the 0.10 level of significance for a two-sided alternative.

significant increases following privatization in both the shorter and longer post-privatization periods.

Although both sales and employment dropped in the first 5 years following privatization, employment dropped relatively more, which resulted in an increase in labor productivity following privatization, measured in terms of real sales per employee. Thereafter, productivity continued to increase. Prior to privatization, CN's sales per employee were about $180,000 (in real dollars). From 2005 to 2011, they were about $380,000 per employee. The increases in sales per employee were statistically significant in both the 5-year post-privatization period and the 16-year post-privatization period relative to the pre-privatization period. Productivity, measured by NI per employee, experienced similar statistically significant increases. These results are consistent with Laurin and Bozec (2001) who found significant improvements in CN's total factor productivity following privatization.

4.3. Capital structure

Following privatization, we would expect that debt relative to assets would decrease for two reasons. First, CN now had direct access to capital markets and should have found it easier to raise equity. Second, the removal of government ownership would, in theory, increase the cost of debt. This assumes, however, that CN actually paid interest on its government debt, which it may not have done. In the longer run, the debt-to-assets ratio might increase as profitability increases, risk is reduced and lenders become more willing to lend to CN.

In fact, however, the most noticeable change in CN's capital structure occurred prior to privatization when the debt-to-assets ratio increased from about 50% (in 1990) to 66% (in 1993 and 1994). As expected, the debt-to-assets ratio did decrease following privatization, although the change from the 5-year pre-privatization period to the 5-year post-privatization period was not statistically significant. Thereafter the debt-to-assets ratio has changed little, although it has been slightly lower in recent years.

4.4. Dividends and corporate taxes paid

For three of the years during the 5-year pre-privatization period, and in the year of privatization, CN paid no dividend. It commenced paying dividends in the first year after privatization and has increased (in nominal dollars) the dividends paid in each subsequent year except 2002 when they dropped very slightly. In 2011, it paid dividends of $585 million. The difference in dividends between the long-run post-privatization period and the pre-privatization period was statistically significant (at the 0.10 level), but not between the short-run post-privatization period and the pre-privatization period.

Similarly, in the pre-privatization period, CN paid virtually no taxes. In fact, in some of these years, and the year of privatization, it received a tax rebate. In contrast, in the first 3 years following privatization, CN paid taxes of $151 million per year on average (in real dollars). The taxes paid have trended higher over time, although they have varied considerably from year-to-year. In 2011, for example, CN paid taxes of $889 million, but less than half this amount in 2009. The difference in taxes paid between the long-run post-privatization period and the pre-privatization period was statistically significant (at the 0.01 level), but not between the short-run post-privatization period and the pre-privatization period.

4.5. Conclusion on operational performance changes resulting from privatization

Our analysis shows that privatization has resulted in improved performance by CN, using a broad range of operational performance measures. The statistically significant growth in sales, NI, profitability as

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measured by ROA and ROS, and productivity as measured by the sales per employee ratio and the NI to employee ratio, convincingly demonstrate that CN's operating performance improved in the post-privatization period.

Some of these results were affected by CN's acquisitions in the U.S. and Canada. Certainly, assets, sales and employees were affected by the acquisitions. Improvements in profitability and productivity might also be partially due to these acquisitions if there were economies of scale or economies of density. However, we would argue that these improvements should be treated as benefits from privatization because, without privatization, it is very unlikely that the acquisitions would have occurred.

Our results also show that CN's privatization has provided significant benefits for the major stakeholders. The increase in profits generated liquidity that CN distributed to shareholders as increases in dividends and to the Canadian government as increases in taxes paid. The next section directly examines the social welfare impacts of CN's privatization.

5. A social welfare (CBA) assessment of the CN privatization

This section presents a CBA of CN (Domah & Pollitt, 2001; Florio, 2004; Galal, Jones, Tandon, & Vogelsang, 1994; Jones, Tandon, & Vogelsang, 1990; Pollitt & Smith, 2002). The methodology is similar to that employed in Boardman, Laurin, Moore, and Vining (2009), although some assumptions differ slightly. Also, our data extend five more years to 2008. It is important to note that these data pertain to Canadian freight operations, not to CN (or CP) as a whole. For some years, we applied a smoothing procedure for unusually high restructuring and miscellaneous costs (Boardman et al., 2009, 64). Our financial estimates are converted to present values (PV) as of 1995, the year of privatization, but are expressed in 2011 Canadian dollars.

An important advantage of this CBA vis-à-vis most other privatization CBAs is that we use data from CP, a private sector company operating in the same industry and in the same country, to control for contemporaneous industry-wide changes and other external factors. The use of such a closely-related external benchmark is, as far as we can ascertain, unique. It leads to a more accurate counterfactual and considerably strengthens the credibility of the estimated benefits.

From a normative perspective, the most appropriate measure of the social "value" of privatization is the net change in social welfare, which can be written as:

$$\Delta W = V_p - V_g + \lambda_g\left(Z - T_g\right) - \lambda_p\left(Z + T_p\right) \tag{1}$$

where, W is the social welfare, V_p is the value to society of CN after privatization, V_g is the value to society of CN under continued government ownership and Z is the proceeds received by the government. T_g and T_p denote the transaction costs that government and private sector actors incur, respectively, and λ_g and λ_p are shadow multipliers (weights) on government revenue and private funds, respectively. Later, we set these multipliers equal to unity. All variables in Eq. (1) are measured in terms of their PVs.

Although *aggregate* social welfare is the most relevant criterion by which we assess privatization, from a public policy perspective it is also informative to consider the *distribution* of benefits and costs among consumers, shareholders, government, and employees. For this purpose, we use the fact that the change in social welfare can be written (Boardman, Greenberg, Vining, & Weimer, 2011):

$$\Delta W = \lambda_c \Delta CS + \lambda_p \Delta PS + \lambda_g \Delta GS + \lambda_e \Delta ES \tag{2}$$

where, ΔCS is the change in consumer surplus (CS), ΔPS is the change in producer surplus (PS, economic profits or rents, after tax), ΔGS is the change in the government surplus (GS, government revenues minus expenditures), ΔES is the change in the employee surplus (ES), and λ_c and λ_e are shadow multipliers for CS and ES, respectively. Later, these multipliers are set equal to unity.

5.1. Change in consumer surplus

Any change in CS is largely determined by the magnitude of changes in prices and quantities following privatization. As mentioned above, the 1987 National Transportation Act marked a transition from an era of tacit collusion or parallelism to one of more direct intra-modal competition (Bonsor, 1995; Timur & Ponack, 2002). At the same time, both CN and CP faced increasing inter-modal competition from trucking and shipping. They responded to these pressures by reducing the track they owned and operated. In 1981, CN *owned* about twice as much track as CP and, as shown in Fig. 1, it *operated* about 32% more track than CP. Between 1982 and 1997, both CN and CP reduced the amount of track they operated in Canada by 27–28%. In 1998, CN reduced the amount of track it operated by more than CP, thereby reducing the gap between the two firms; this gap remained fairly constant until 2005. In 2005 and subsequent years, however, CN increased the amount of operational track, while CP continued to reduce track in each of these years, thereby increasing the gap again.

These competitive pressures resulted in falling real prices in Canada (measured by dividing real Canadian sales revenue by the number of revenue tonne-kilometres of Canadian freight) from 1986 to 2004, as shown in Fig. 2.[1] During this period, real prices at CN and CP fell by almost 50%. The downward trend was slightly faster in the 1986–1991 period, prior to Paul Tellier's appointment, than subsequently. Due in part to these falling prices, both CN and CP were markedly less profitable than their U.S. counterparts (Waters, 1997). Fig. 2 also shows that, with the exception of 1982, CN and CP charged very similar prices in Canada.

As real prices fell, output (in revenue tonne-kilometres of Canadian freight) increased at CN and CP, despite the reduction in tracks operated. As shown in Fig. 3, both firms experienced growth in freight volumes from 1981 until 2008 that was in excess of 50%. Fig. 3 also shows that throughout this period, CN's and CP's Canadian freight volumes grew at similar rates and these rates did not change significantly following privatization. Since the amount of track operated fell at both firms, the track usage of both improved considerably.

Given that CN and CP charged similar prices, and the output at both companies increased at similar rates, the market shares of both firms (measured in terms of total Canadian freight revenues) have remained very stable, as shown in Fig. 4.

As shown in Fig. 2, real prices fell following privatization and, although they were trending upwards during the 2005–2008 period, they were still lower in 2008 than prior to privatization. Also, as shown in Fig. 3, output increased following privatization. Consequently, railroad consumers were better off and enjoyed higher levels of CS following privatization than before privatization. However, we do not attribute this increase in CS to the CN privatization per se. Prices started to fall in 1986 and, in our view, would probably have continued to fall in the absence of privatization. Florio (2004) reaches the same conclusion concerning the long-term trends in prices following UK privatizations. Our evidence on pricing, output and market share suggests that the gains in CS that actually materialized post-privatization would have occurred in the absence of privatization. Although there may have been some improvements in CN's service quality and safety, we cannot measure them and therefore, we do not attribute any change in CS to privatization.

[1] A revenue tonne-kilometres means that 1 tonne of revenue-generating freight is transported 1 km. One tonne, also called a metric tonne, equals 1000 kilograms, which is about 2204.5 pounds. On average over the most recent five years, freight generated about 94% of the total Canadian revenues of both firms; passengers generated less than 1%. Other Canadian revenue sources included government subsidies (1.5%), compensation for services rendered to Via Rail (1%) and other miscellaneous revenues (3%) (Statistics Canada, 2003–2008).

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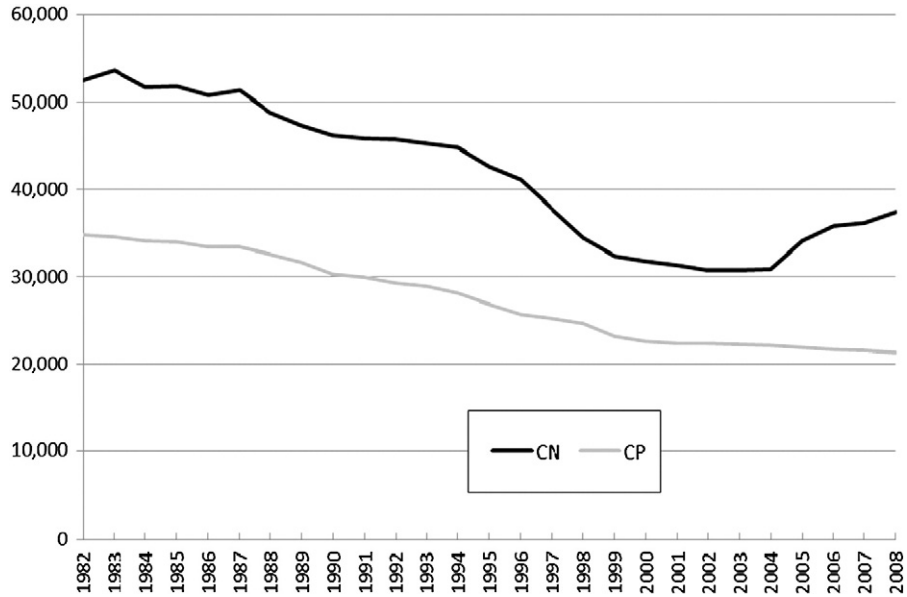

Fig. 1. CN and CP Canadian track operated (kilometres).

5.2. Change in employee surplus

Conceptually, any change in ES should include changes in producer surplus (rents) gained (or lost) by either employees or by others, such as consultants and investment bankers. Unions often argue that increased profits following privatization mostly come at the expense of lower employee salaries. If so, such effects would raise PS and lower ES. Furthermore, laid-off employees might not find jobs that pay as well, they may experience periods of unemployment before finding another job or they may incur transaction costs in finding a new job. Each of these factors would lower ES, especially during periods of negative or low economic growth.

Fig. 5 shows Canadian employment at both CN and CP over time. In 1982, employment at CN was 66% higher than at CP, while in 2008 it was only 22% higher. This might suggest a loss of ES at CN. However, CN actually reduced employment at a slower rate following privatization (5.4% per annum during the 1995–2002 period) than before it (6.6% per annum during the 1984–1994 period). Furthermore, CP increased the rate at which it reduced employment from 4.2% per annum during the 1984–1994 period to 5.3% per annum during the 1995–2002 period. Consequently, we conclude that the reduction in employment at CN would have occurred even in the absence of privatization.

We also examined real wages. In 1982, (real) wages at CN were slightly lower than (real) wages at CP, but the difference increased during the pre-privatization period. By 1995, wages at CN were slightly higher than at CP and they remained so until 2003. Thus, there is no evidence that CN employees experienced pay reductions due to the privatization. Overall, therefore, we conclude that there was no change in ES due to privatization.

5.3. Change in welfare, assuming zero CS and ES

Under the assumptions that CS and ES equal zero and $\lambda_p = \lambda_g = 1$ then, from Eq. (2), the change in welfare equals the sum of the changes in PS and GS. This change in welfare can also be written:

$$\Delta W = \Pi_p^{96+} - \Pi_g^{96+} - T_p - T_g. \tag{3}$$

That is, the change in welfare equals the PV of profits following privatization, denoted Π_p^{96+} (i.e., we treat 1995 as a transition year and compute the profits for 1996 and subsequent years), minus the profits that would have been earned under continued government ownership for the same years, denoted Π_g^{96+}, minus private sector and government transaction costs. Note that because of the assumption that $\lambda_p = \lambda_g = 1$, the amount paid for the company at privatization, Z, is a transfer from shareholders to the government.

Now consider the first two terms in Eq. (3). Economic profits equal revenues minus costs. Earlier we argued that prices and output were not affected by privatization and, therefore, sales revenues were not affected either. Thus, the difference in profits can be measured by the difference in costs. More specifically, suppose C_p^{CN} denotes the PV of CN's costs under privatization, that is, from 1996 and onwards:

$$C_p^{CN} = \sum_t \frac{ATC_t^{CN}}{(1+s)^t} Q_t^{CN} \tag{4}$$

where, ATC_t^{CN} and Q_t^{CN} are CN's actual real average total unit costs (ATC) and actual output levels in year t, respectively, and s is the social discount rate. Further suppose C_g^{CN} denotes the PV of what these costs would have been with continued government ownership. Now, the change in welfare due to privatization is given by:

$$\Delta W = C_g^{CN} - C_p^{CN} - T_p - T_g. \tag{5}$$

We use CP's actual costs to estimate the counterfactual; specifically, the PV of what CN's costs would have been if it had not been privatized, C_g^{CN}. Fig. 6 shows that CN's and CP's real ATCs fell more or less continuously from 1981 until 2004. From 1981 to 1987, CN's real ATC was higher than CP's ATC, but was falling slightly faster. Thereafter, for the 7 years prior to privatization, 1988–1994 inclusive, CN's ATCs were on average 6.1% higher than CP's ATCs, and this difference remained fairly constant from year to year. Based on this evidence, we conclude that if CN had remained government owned, its real ATCs would have been 6.1% higher than CP's ATCs.

Consequently, we construct a series of annual, counterfactual real ATCs for CN by inflating CP's actual real ATCs by 6.1%. We then multiply these ATCs by CN's actual annual outputs to arrive at CN's counterfactual total annual costs. Finally, we discounted these amounts at the social discount rate to obtain our estimate of the PV of CN's

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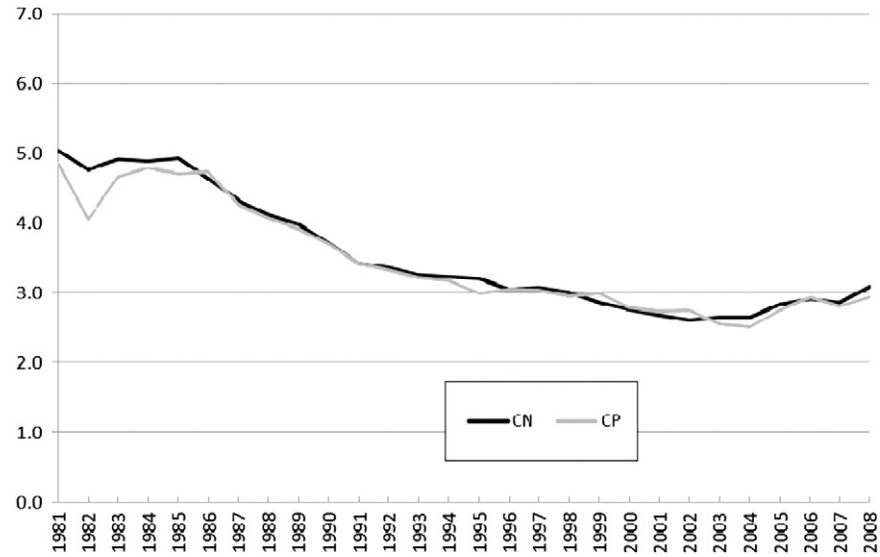

Fig. 2. CN and CP freight prices per revenue tonne-kilometres in Canada (2011$).

total costs if it had not been privatized, denoted as $\hat{C}_g^{CN}$:

$$\hat{C}_g^{CN} = \sum_t \frac{1.061ATC_t^{CP}}{(1+s)^t} Q_t^{CN}. \tag{6}$$

From Eq. (5), our estimate of the PV of the change in welfare due to privatization (ignoring transaction costs) is given by:

$$\hat{C}_g^{CN} - C_p^{CN} = \sum_t \frac{\left(1.061ATC_t^{CP} - ATC_t^{CN}\right)}{(1+s)^t} Q_t^{CN}. \tag{7}$$

It is important to note that this estimate of the change in welfare relies on the differences between CN's and CP's actual ATCs. By taking these differences, any industry-wide or economy-wide factor that might affect or bias CN's ATC, in effect, cancels out. Thus, using data from CP to compute our counterfactual provides a superior estimate of the welfare gains from privatization.

Our data extend to only 2008. Therefore, we estimate Eq. (7) by using actual annual data for 1996–2008 and then estimate separately the PV of the cost savings attributable to privatization from 2009 onwards. By using a real SDR of 3.5% (Boardman, Moore, & Vining, 2010; Moore, Boardman, Vining, Weimer, & Greenberg, 2004), we estimate that the PV (in 1995) of the cost savings due to privatization for the 1996–2008 period amounted to just under $8 billion (in 2011 dollars). From 2009 onwards, we assume that the real annual cost savings will equal the average of the estimated real annual cost savings for the 2004–2008 period, which were just under $1 billion per year (in 2011 dollars). Dividing this amount by the SDR implies that the value of this perpetuity as of 2008 is about $26.5 billion. Finally, we discount this amount back to 1995, resulting in a PV of just under $17 billion for the savings from 2009 onwards. Adding these two amounts provides an estimate of the cost savings due to privatization of $24.7 billion (in 2011 dollars).

To calculate the change in welfare, we must subtract transaction costs. Private sector transaction costs, T_p, were relatively small and can be ignored. It is reasonable to assume that the only non-trivial transaction costs that government incurred, T_g, were the costs of organizing the sale. These costs amounted to about $116 million in 2011 Canadian dollars, which are calculated by multiplying $1.0125 (the per share amount paid to the underwriters for the shares they

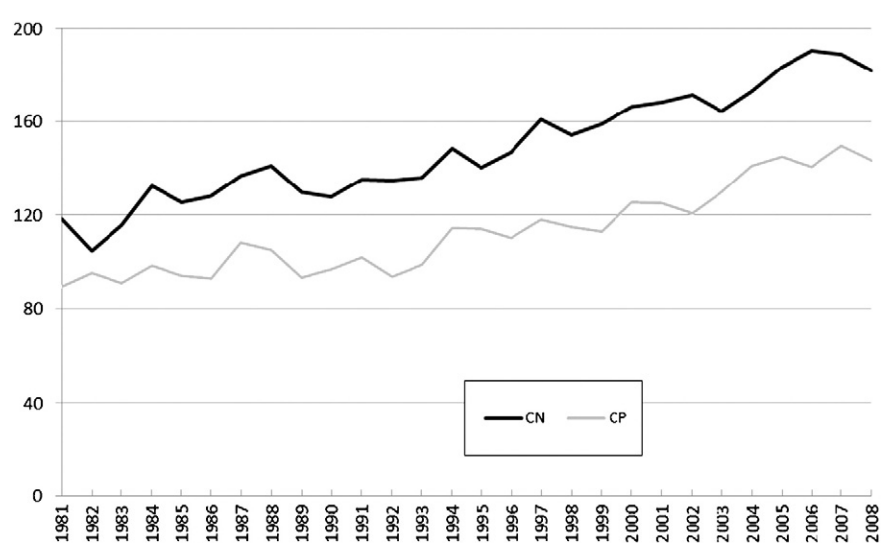

Fig. 3. CN and CP freight output in Canada (millions of revenue tonne-kilometres).

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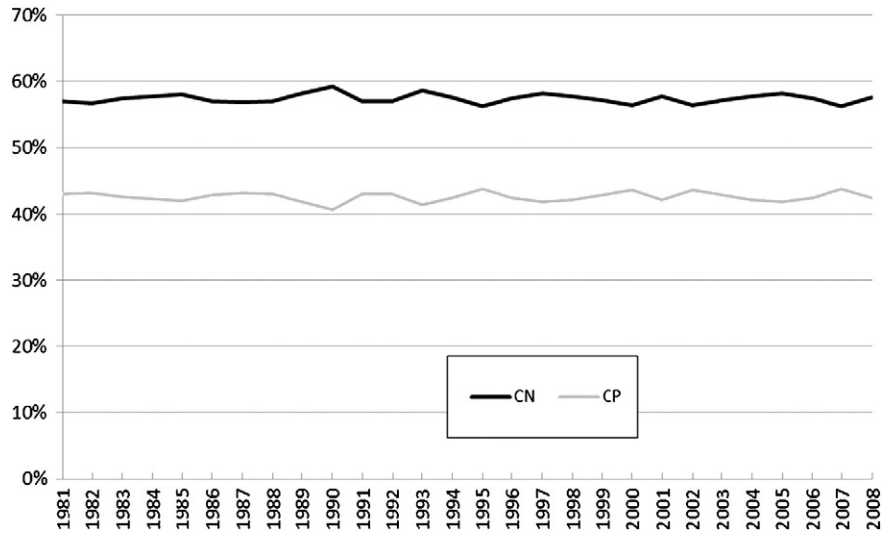

Fig. 4. CN and CP market shares in freight in Canada.

sold) by the 83.8 million shares sold (Bruce, 1997, 149) and then converting to 2011 dollars. Including these transaction costs, gives an estimate of the welfare gain from privatization of $24.6 billion (2011 dollars).

As discussed above, Paul Tellier started to make efficiency improvements at CN immediately after his appointment. Thus, there is some merit to the notion that the PV of the cost savings during the commercialization period (1993–1995) prior to actual privatization should also be included as a component benefit of privatization. In fact, however, the PV of these cost savings amounts to only $52 million (in 2011 dollars) and can, therefore, be ignored.

5.4. Change in government surplus

The change in government surplus, ΔGS, equals the proceeds from privatization, Z, plus personal taxes paid at the personal rate of tax, t_p, on the underpricing, U, that is t_pU, corporate taxes paid at the corporate rate of tax, t_c, on CN's subsequent profits Π_p^{96+}, that is $t_c\Pi_p^{96+}$, less the foregone profits if CN had not been privatized, Π_g^{96+}, and government transaction costs, T_g:

$$\Delta GS = Z + t_pU + t_c\Pi_p^{95+} - \Pi_g^{95+} - T_g. \tag{8}$$

Z equals the proceeds actually received by government, based on the issue price. While underpricing reduces this amount relative to what it could have been, this reduction is a transfer: it increases PS and reduces GS.

For convenience we rewrite Eq. (8) as:

$$\Delta GS = Z + t_pU + t_c\left(\Pi_p^{96+} - \Pi_g^{96+}\right) - (1-t_c)\left(\Pi_g^{96+}\right) - T_g. \tag{9}$$

Here, $t_c(\Pi_p^{96+} - \Pi_g^{96+})$ represents the change in corporate taxes due to privatization, assuming that the government would pay corporate taxes at the same rate as the private sector, and $(1-t_c)(\Pi_g^{96+})$ represents the after-tax profits under continued government ownership,

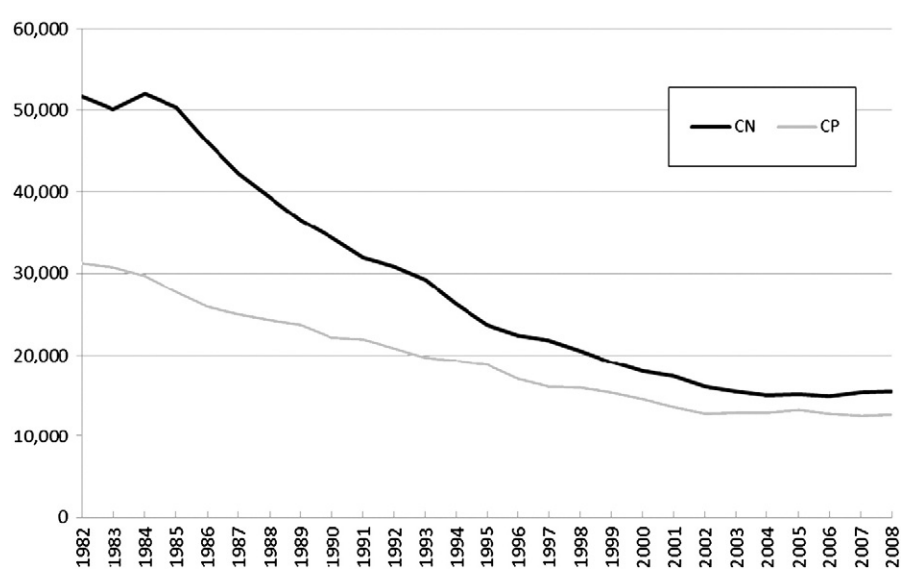

Fig. 5. CN and CP rail employment in Canada.

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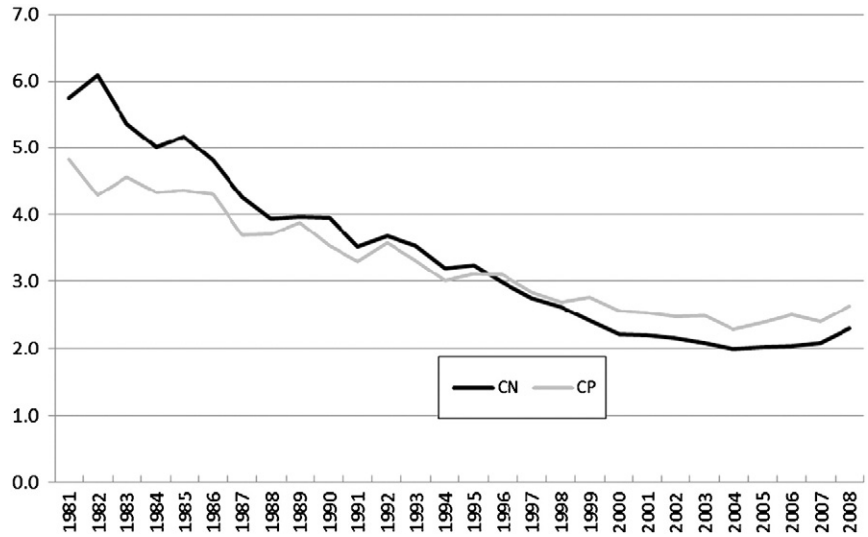

Fig. 6. CN and CP average total costs per revenue tonne-kilometre (2011$).

again assuming that the government would pay corporate taxes at the same rate as the private sector.

Using the procedure described in Boardman et al. (2009), we estimate that the sale price, Z, was just over $3 billion (in 2011 dollars) and that the government tax receipts on the underpricing, t_pU, amounted to $110 million (in 2011 dollars). To obtain the corporate tax revenues on the incremental profits following privatization, $t_c(\Pi_p^{96+} - \Pi_g^{96+})$, we multiply each year's real discounted, estimated cost savings due to privatization by the prevailing, combined federal–provincial corporate tax rate reported by CN and sum them. This yields a PV of $10,077 million (in 2011 dollars).

We do not have a direct estimate of the after-tax profit if CN had not been privatized, $(1-t_c)(\Pi_g^{96+})$. However, the before-tax profits under continued government ownership, Π_g^{96+}, are likely to have ranged between zero and the PV of the *expected* future profits under private ownership at the time of privatization, denoted Π_p^e. We further note that the sale price, Z, should equal the PV of the expected after-tax future profits under private ownership, less any underpricing:

$$Z = (1-t_c)\Pi_p^e - U. \tag{10}$$

Consequently, under the assumption that $\Pi_g^{96+} = \Pi_p^e$, Eq. (10) implies $(1-t_c)\Pi_g^{96+}$ equals $Z+U$, the actual sale price of $3038 million plus the underpricing, $459 million, which amounts to $3497 million (in 2011 dollars). The average of this extreme amount and $0 yields an estimate of the after-tax profit under continued government ownership of $1748 million.

Consequently, the estimated change in GS is about $11.4 billion (in 2011dollars) as shown in Table 2. The receipt from the sale is not the largest component of ΔGS; by far the largest benefit to government comes about as a result of increased tax receipts on increased profits.

5.5. Change in producer surplus

Assuming, as we have argued above, that privatization had no effect on the surplus of shippers (consumers) or employees ($\Delta CS = \Delta ES = 0$) and assuming, as we have above, that $\lambda_p = \lambda_g$, then the gains to shareholders, ΔPS, can be derived from Eq. (2) by subtracting the gain in government surplus from the total welfare gain. Given our estimate of ΔW equal to $24,580 million and our estimate of ΔGS equal to $11,361 million, we estimate ΔPS equals $13,219 million (in 2011 dollars).

The change in producer surplus, ΔPS, is the PV of the net benefits to shareholders discounted at the SDR. It equals the PV of the after-tax profits following privatization, denoted $(1-t_c)\Pi_p^{96+}$, less the amount paid for the shares, private-sector transaction costs, and capital gains taxes paid at the personal rate of tax t_p on the underpricing, U:

$$\Delta PS = (1-t_c)\Pi_p^{96+} - Z - T_p - t_pU. \tag{11}$$

If we subtract the sale price of $3038 million and the personal taxes on underpricing of $110 million from our estimate of the gain in producer surplus, we obtain an estimate of the increase in after-tax profits of $16,367 million, as shown in Table 2. As we discussed above, the expected after-tax increase in profits equals $3497 million. Consequently, we estimate that the unexpected increase in after-tax profits was $12,870 million, which is also shown in Table 2. Clearly, it paid shareholders to buy and hold their shares until after these increases were capitalized into the share price.

5.6. Distribution of the welfare effects

Table 2 shows how the benefits were distributed among Canadians and non-Canadians. Canadians, of course, received all of the ΔGS. The

Table 2
Summary of the welfare gains from the privatization of CN and their distribution[a].

	Total	Canadians	Rest of the world
Government surplus			
Proceeds from sale	3038	3038	
Taxes on underpricing	110	110	
Increased corporate taxes	10,077	10,077	
Total revenues	13,225	13,225	
Less			
Foregone govt profits after tax	1748	1748	
Transaction costs	116	116	
Net government surplus	11,361	11,361	
Producer surplus			
Expected after-tax profits	3497	2098	1399
Unexpected after-tax profits	12,870	5792	7079
Total after-tax profits	16,367	7890	8477
Less			
Taxes on underpricing	110	83	28
Sale price	3038	1823	1215
Transaction costs	0	0	0
Net producer surplus	13,219	5984	7235
Total increase in welfare	24,580	17,345	7235

[a] All figures are in millions of 2011 real Canadian dollars.

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distribution of ΔPS is based on the assumption that Canadians held about 60% of the shares when they were first listed (Bruce, 1997). Therefore, Canadians received 60% of the expected after-tax profits, amounting to just over $2098 million, but paid tax of $83 million on that gain and, of course, paid for their initial shares at the offering which was $1823 million. This amounted to $192 million. Soon after the stock was listed some Canadians sold their shares. About a decade after privatization, Canadians owned about 55% of CN (Boardman et al., 2009). Those who held on received their share of the unexpected after-tax profits, which amounted to $5792 million, resulting in a total benefit to Canadian shareholders of $5984 million.

5.7. Concluding comments on the welfare effects

One can never be certain that a state-owned operator would *not* have achieved the same cost reductions as the privatized CN. Nonetheless, we think this is unlikely. Our analysis makes conservative assumptions concerning the counterfactual. First, while CN had closed the cost gap with CP prior to privatization, the difference had not been eliminated and had remained stable (at about 6%) over the 7 years immediately prior to privatization (for an even more conservative counterfactual, see Boardman et al., 2009). Second, by using data from CP we are able to control for Canadian industry-wide effects. As we mention above, the use of a very close competitor for such purposes is unique. Most importantly, if there were economies of scale effects, as Pollitt and Smith (2002) argued in the UK, they would likely affect both CN and CP similarly. Because we take differences, these effects would cancel out.

We know of no other factor apart from privatization that would explain why CN's unit costs decreased relative to CP's unit costs after privatization. The effect of the U.S. acquisitions (such as Illinois Central) would be minor because our welfare analysis is restricted to Canadian freight operations, both before and after the takeover. Furthermore, even if these acquisitions did have a beneficial effect, it would be appropriate to include this effect because these acquisitions were unlikely to have occurred without privatization.

There are many other reasons to presume that our estimates of the welfare benefits are conservative. Most importantly, we assumed that price decreases and quantity increases were not attributable to privatization. Thus, we do not include any CS benefit to shippers or other customers. Furthermore, ΔPS should also include any changes in the profits of CN's competitors and suppliers as well as the change in CN's profits in its other (non-Canadian freight) businesses. We very conservatively assume these additional effects are zero even though CP achieved some efficiency gains following CN's privatization and there may well have been spillover benefits to other parts of CN. Similarly, we have not included any longer-term, dynamic benefits of the privatization. Since privatization, CN has initiated or participated in numerous railroad supply chain initiatives (Miller, 2010) that have transformed the North American transportation network and have benefitted shippers as reduced time-costs (Boyd, 2011; Rodrigue, 2008; Starling, 2011). These benefits are probably substantial, but they are very difficult to measure and cannot be attributed entirely to CN's privatization.

It is particularly important to point out that we have assumed that $\lambda_g = 1$. Boardman et al. (2011) and other cost–benefit analysts suggest that $\lambda_g = 1$ *plus* the marginal excess tax burden (METB). Based on a survey of relevant research, Boardman et al. (2011) suggest that the METB is about 0.23, that is, it costs society about $1.23 to raise $1 in taxes. Multiplying our estimated increase in GS by 1.23 implies that ΔGS equals $16,259 million and our estimate of the increase in social welfare would increase concomitantly to $27,620 million.

6. Conclusion: the aggregate impact of privatization

Our main findings are that the privatization of CN improved sales, efficiency, profitability and social welfare. The total social welfare gains amounted to approximately $24.5 billion 2011 Canadian dollars. The increase in government surplus was about $11 billion, and the increase in producer surplus was about $13 billion with just under half of this amount going to Canadian citizens.

The considerable size of these estimates demonstrates the potential value of a well-conducted privatization. Factors that contributed to the success in CN's case include the following. First, CN was well prepared for privatization and the privatization was not rushed. Non-core businesses were divested over a number of years prior to privatization. A few years before privatization, a new CEO was appointed with a mandate to improve efficiency and profitability in preparation for an eventual sale. Second, CN focused almost exclusively on freight, and provided no passenger services (although VIA Rail Canada and the Rocky Mountaineer provide some passenger services over parts of the network). Third, it was privatized as a vertically integrated company without separation of 'wheels and rail', thereby reducing transaction costs. Fourth, it was privatized through a share-issue privatization, rather than as a direct sale privatization. This ensured that CN was listed on the stock exchange and that ownership was not concentrated in a few hands. (In theory, this aspect could have been either advantageous or disadvantageous.) Fifth, there was a direct competitor. Sixth, there was some inter-modal competition from trucking and shipping, although these alternative modes were not as close substitutes as in many other countries, given the long-haul distances in Canada.

This privatization offers some lessons for private sector and government management. This case study shows that company management can matter a great deal. While CN's average total costs were about 6% higher than CP's ATC prior to privatization, they were about 13% lower than CP's 5 years after privatization and thereafter. Tellier and Harrison took CN from underperforming relative to CP to outperforming it. According to Thompson (2003, 331) CN "is currently considered perhaps the best managed railroad in North America." Management focused clearly on the core business and eliminated non-core assets, such as Wisconsin Central's holdings in a number of smaller railroads.

Government managers carefully prepared CN for privatization, as we discussed above. Most importantly, they did not rush the privatization process. Tellier had 3 years to prepare CN for privatization. Another important lesson is that vertical disintegration (unbundling) may not be necessary for successful privatization when there is at least one other vertically integrated competitor. Indeed, Pittman (2005) argues vertically separated freight railroads tend towards bilateral monopoly, which has significant costs and only limited benefits. The Canadian experience suggests that having a vertically integrated duopoly is often a superior arrangement. Of course, these lessons pertain to freight privatization and may not apply to passenger privatization.

A single, detailed study such as this one, in conjunction with other research findings, should provide some guidance to government policy makers in helping improve railroad privatization outcomes. There are some areas where additional research would provide further guidance. First, the performance and welfare effects of existing privatizations should be tracked over longer time periods (a large percentage of our estimated welfare gains are due to the assumed perpetual benefits that arise beyond the end of our data period). Second, it would be helpful if the welfare impacts of rail privatization could be further disaggregated by markets. This kind of analysis would shed light on the extent to which any measured gains from privatization flow from the presence of inter-modal or intra-modal competition. It may be that those routes on which CN faced no effective competition did not produce the same cost savings as on those where it had to compete directly against CP or where trucking or shipping were close substitutes. Third, more systematic evidence is needed to determine the conditions under which share issue privatization is superior to direct private sale. Along the same lines, more research is needed to substantiate our tentative conclusion

Please cite this article as: Boardman, A.E., et al., Efficiency, profitability and welfare gains from the Canadian National Railway privatization, *Research in Transportation Business & Management* (2012), http://dx.doi.org/10.1016/j.rtbm.2012.11.011

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that freight rail privatizations have been more successful than passenger rail privatizations. Finally, in order to control as much as possible for confounding effects, performance and welfare analyses of privatizations should compare actual post-privatization results to those that would have occurred in an explicit counterfactual situation of continued government ownership. Simple before-and-after comparisons cannot truly confirm that a privatization produced better results than state ownership.

It is now widely accepted that privatization improves performance in competitive markets in developed countries. But there have been a number of reservations and caveats around this broadly positive conclusion. Do these improvements persist over time? Can these improvements occur in more oligopolistic markets? Although based on a single case study, this analysis suggests a positive answer to both questions.

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Please cite this article as: Boardman, A.E., et al., Efficiency, profitability and welfare gains from the Canadian National Railway privatization, *Research in Transportation Business & Management* (2012), http://dx.doi.org/10.1016/j.rtbm.2012.11.011