ISBN 978-92-64-03131-9
Infrastructure to 2030 – Vol. 2
Mapping Policy for Electricity, Water and Transport

Chapter 5

Key Trends and Implications for Policy Change in Long-Term Rail Freight Traffic and Infrastructure

by
Louis S. Thompson*

Rail infrastructure serves freight and passenger operators. This chapter focuses on rail freight operations and infrastructure needs and examines the underlying economic and demographic forces which are creating growth pressures. What is the future demand for rail freight and how will demand be met by the public and private sectors? As this chapter discusses, management models and government policies vary greatly.

* Thompson, Galenson and Associates, Maryland, US. This chapter was jointly commissioned and financed by the OECD International Futures Programme and the Joint OECD/ECMT Transport Research Centre.

Summary

Studies have shown that the demand for rail services, and the need for the related infrastructure, will grow in the next three decades. Even though the extent of growth is subject to an unusually wide range of uncertainties, the underlying growth pressures and potential for growth are clear.

Rail infrastructure serves two types of operators – freight and passenger – with significant subcategories depending on national or regional conditions. Passenger services can be subdivided by commuters, regional trains, conventional longer-haul intercity trains, and (in some countries) High-Speed Rail (HSR) operating on exclusive rights of way. Freight services can similarly be subdivided by commodity (*e.g.* bulk commodities such as coal by comparison with finished goods), type of service (wagonload, multiple wagon shipment, unit – or block – trains), etc.

The infrastructure needs of freight *versus* passengers cannot be fully distinguished, except where there is an exclusive right of way. There is a complex three-way interaction among the characteristics of the infrastructure, the passenger services and the freight services. This chapter will focus on rail freight operations and infrastructure needs, but the problem of passenger/freight interaction and infrastructure use indistinguishability must always be kept in mind.

Underlying economic and demographic forces will manifestly create a *need* and an *opportunity* for added rail freight infrastructure capacity. This need will be reinforced by, *inter alia*, highway congestion, safety, security, environmental concerns, and deliberate public policies to shift traffic from road to rail.

Though the *need* for added rail freight infrastructure capacity will grow, the responses to this need are less clear. *Responses* by the rail sector and governments will be influenced by government policies, by the business models that the rail sector adopts, and by a number of exogenous factors such as technology.

What will actually happen will be heavily driven by the consensus that emerges (if and where it does) as to the relative roles of the public and private sectors. Where rail freight is provided privately, or at least fully commercially, and where governments do not unduly support highway or water competition, there is reason to believe that the wholly market-driven needs for freight infrastructure and operating investment can be met (one way or the other) from resources generated in the freight sector.

The rail infrastructure challenge lies equally in the willingness of governments to identify social benefits and costs of freight services transparently, and to fund them. Some governments (in the European Union in particular) have identified rail infrastructure public benefits, but have not reached a balanced and fully compensatory support policy among the transport modes. Others (the US and Canada) have still to reach consensus on the public *versus* private benefits of rail freight, and how to pay for them.

In the broadest terms, most rail *freight* services, and their related infrastructure, should be market-driven and, where the market is allowed to function effectively, could be financed and operated without major public involvement. Achieving additional *non-market* freight benefits (reduced highway congestion or air pollution) and minimising non-market costs (passenger-freight interference) will only be achieved with effective public intervention.

In summary, the investment in rail freight infrastructure could be put into two categories: primarily private and primarily public. The *private* investment is likely to be heavily focused in North America and in countries such as Australia and Brazil that have large, export-focused companies in mining and agriculture (where investments may have little benefit for the national system). North American investment is likely to be oriented to increasing capacity, especially on critical port/landside interfaces, on major nodes such as Chicago and, as always, on capacity for major bulk commodity flows such as coal and grains or for the growing internal container flows. There may well eventually be a public sector counterpart for the private investment, but the timing and scope are unclear. The bulk of the primarily *public* investment will clearly be in China and India with a focus on increasing system capacity, either by building new, high-capacity, freight-only lines or by building new passenger lines that will free-up capacity for freight movements. There will also be an EU programme to encourage freight rail flows (and capacity), but the impact of EU programmes on freight, as opposed to passenger, capacity is not clearly defined. There will clearly be a private counterpart for these public investments, especially in operating companies and their assets. The degree of private investment in infrastructure is harder to predict because public policies on freight privatisation are unclear, and because the priorities to be assigned in resolving capacity conflicts between freight and passenger access in open access systems are likely to favour passenger.

1. Introduction

This chapter has two broad themes: the future demand for rail freight infrastructure, and the factors that will influence how that demand is met.

Rail infrastructure is normally multipurpose, serving passengers as well as freight. There are subcategories of each type of service that also will influence the need for operating services on the infrastructure. As a result, it is not possible to clearly disentangle freight as opposed to passenger needs and related investment in infrastructure, except where the infrastructure is dedicated to a single purpose. Single purpose rail freight infrastructure is mostly restricted to the railways of North and South America (though Amtrak does operate over about 25% of the freight infrastructure in the US, and VIA operates over about 25% of the freight infrastructure in Canada), and some specialised railways in South Africa and Australia. Table 5.1 displays the degree to which railways are weighted toward freight or passenger. It *is* possible to disentangle the *operating* performance and investments, though many countries have delayed in doing so.

Table 5.1 shows the location and scale of most of the world's rail infrastructure. Several important points should be noted. First, infrastructure, rail freight traffic and rail passenger traffic are highly concentrated in a limited number of countries. For example, of the 99 countries in the basic dataset used for this chapter, the top 10 account for over 61% of all line-kilometre (km). The top 10 rail passenger carriers account for about 84% of all passenger traffic (passenger-km), and the top 10 freight carriers account for over 92% of all freight traffic (ton-km). This means that a reasonable forecast of the freight demand for infrastructure investment might be accurately based on only a limited number of countries. Note that the set of countries in the top 10 groups are different in each case, but there are only 16 countries that fall in the top 10 in any of the three rankings. These top 16 countries account for about 71% of the world's rail infrastructure. Second, while world rail freight traffic did increase slowly (by 14%) between 1980 and 2003, and passenger traffic increased somewhat more rapidly (40% over the same period), total infrastructure line-km actually *fell* by about 13% (mostly in the OECD countries).

There are a number of explanations for the shrinkage. The US Class I railroads accounted for about 62% of the shrinkage, which rises to 70% when the Canadian National (CN) and Canadian Pacific (CP) in Canada are added. In the US and Canada, many light density lines have become uneconomic in the face of highway competition, and the play of market forces on the private railroads has created intense focus on reducing costs. Another 13% of the shrinkage occurred in Germany, France and Poland, where light density rural tracks have been replaced by more efficient auto and bus services.

This should highlight the fact that rail infrastructure *capacity* (at least as measured by line-km) is not directly related to output. In fact, because there are increasing returns to line density (passenger-km or ton-km per line-km), economic forces have actually delivered a negative relationship between traffic and line-km since 1980 (though this is unlikely to continue). Table 5.1 shows that there is a wide variation among railways in line density. For the most part (India and Japan are exceptions), the highest densities are found on freight-dominant railways because freight trains can be longer and heavier than passenger trains.

Table 5.1. **Data table on worldwide rail infrastructure**

Passenger and freight line density

	Line-km					Pass-km (000 000)				Ton-km (000 000)			
	1980	1990	2003	% growth, 1980 to 2003	Shrinkage (km) 1980 to 2003	1980	1990	2003	% growth, 1980 to 2003	1980	1990	2003	% growth, 1980 to 2003
OECD North America													
Mexico	20 351	20 351	17 576	(13.6)	(2 775.0)	5 295	5 336	n.a.	(100.0)	41 330	36 417	65 260	58
Canada: CP + CN	63 127	52 327	50 551	(19.9)	(12 578.0)	–	–	–	–	185 219	224 751	405 499	119
Canada: VIA	–	–	–	–	–	3 110	1 266	1 350	(56.6)	–	–	–	–
USA: All Class I Railways	287 647	214 475	196 929	(31.5)	(90 718.0)	–	–	–	–	1 393 235	1 530 743	2 267 051	63
USA: Amtrak	1 100	1 100	1 100	0.0	0.0	7 637	9 769	8 862	16.0	–	–	–	–
USA: Suburban carriers	–	–	–	–	–	9 000	11 404	15 993	77.7	–	–	–	–
OECD Asia													
Korea	3 135	3 091	3 140	0.2	5.0	21 640	29 863	28 562	32.0	10 549	13 663	11 057	5
Japan	22 236	20 254	20 067	(9.8)	(2 169.0)	193 143	237 551	241 160	24.9	37 000	26 803	22 600	(39)
New Zealand	4 478	4 029	3 913	(12.6)	(565.0)	370	370	n.a.	(100.0)	3 226	2 744	3 500	8
Australia	40 000	40 000	40 400	1.0	400.0	n.a.	n.a.	11 320	n.a.	63 700	87 920	161 000	153
OECD EU													
Austria	5 857	5 624	5 655	(3.4)	(202.0)	7 380	8 575	8 150	10.4	11 200	12 158	17 852	59
Belgium	3 978	3 479	3 521	(11.5)	(457.0)	6 963	6 539	8 265	18.7	8 037	8 370	8 306	3
Czech Repbulic	9 501	9 501	9 501	–	–	11 728	12 568	6 483	(44.7)	42 705	38 371	17 069	(60)
Denmark	2 015	2 344	2 273	12.8	258.0	3 803	4 855	5 397	41.9	1 619	1 730	1 888	17
Finland	6 075	5 867	5 851	(3.7)	(224.0)	3 216	3 331	3 338	3.8	8 334	8 357	10 047	21
France	34 362	34 070	29 269	(14.8)	(5 093.0)	54 660	63 761	71 937	31.6	68 815	50 667	46 835	(32)
Germany	42 745	40 980	36 044	(15.7)	(6 701.0)	63 637	61 024	69 596	9.4	118 988	101 166	73 951	(38)
Greece	2 461	2 484	2 414	(1.9)	(47.0)	1 464	1 977	1 574	7.5	814	647	456	(44)

Table 5.1. **Data table on worldwide rail infrastructure** *(cont.)*

Passenger and freight line density

	Line-km					Pass-km (000 000)				Ton-km (000 000)			
	1980	1990	2003	% growth, 1980 to 2003	Shrinkage (km) 1980 to 2003	1980	1990	2003	% growth, 1980 to 2003	1980	1990	2003	% growth, 1980 to 2003
Hungary	7 614	7 617	7 730	1.5	116.5	13 550	11 298	7 300	(46.1)	24 041	16 593	7 568	(69)
Ireland	1 987	1 944	1 919	(3.4)	(68.0)	1 032	1 226	1 601	55.1	624	589	398	(36)
Italy	16 138	16 086	15 965	(1.1)	(173.0)	39 587	45 512	45 221	14.2	18 384	19 419	22 457	22
Luxembourg	270	271	274	1.5	4.0	246	208	225	(8.5)	664	615	600	(10)
Netherlands	2 880	2 798	2 811	(2.4)	(69.0)	8 910	11 060	13 848	55.4	3 468	3 070	4 026	16
Poland	27 185	26 228	19 900	(26.8)	(7 285.0)	46 300	50 373	19 643	(57.6)	132 576	83 500	47 394	(64)
Portugal	3 609	3 064	2 818	(21.9)	(791.0)	6 077	5 664	3 339	(45.1)	1 001	1 459	2 442	144
Slovak Republic	3 657	3 657	3 657	–	–	6 315	6 767	2 316	(63.3)	23 505	21 119	10 117	(57)
Spain	13 450	12 560	12 310	(8.5)	(1 140.0)	13 527	15 476	20 608	52.3	10 528	10 742	14 156	34
Sweden	11 377	10 081	9 882	(13.1)	(1 495.0)	6 787	6 076	5 733	(15.5)	15 914	18 441	12 829	(19)
United Kingdom	17 645	16 588	16 660	(5.6)	(985.0)	31 704	33 191	40 400	27.4	17 640	15 986	18 900	7
Non-EU European OECD													
Switzerland	2 943	2 978	2 990	1.6	47.0	9 167	11 049	12 290	34.1	7 220	8 127	9 341	29
Norway	4 242	4 044	4 179	(1.5)	(63.0)	2 394	2 104	2 204	(7.9)	3 014	2 568	2 092	(31)
Turkey	8 193	8 429	8 697	6.2	504.0	6 011	6 410	5 878	(2.2)	5 029	7 894	8 612	71
Total OECD	**670 258**	**576 321**	**537 996**	**(19.7)**	**(132 262.0)**	**584 653**	**664 603**	**662 593**	**13.3**	**2 258 377**	**2 354 629**	**3 273 303**	**45**

Table 5.1. **Data table on worldwide rail infrastructure** *(cont.)*

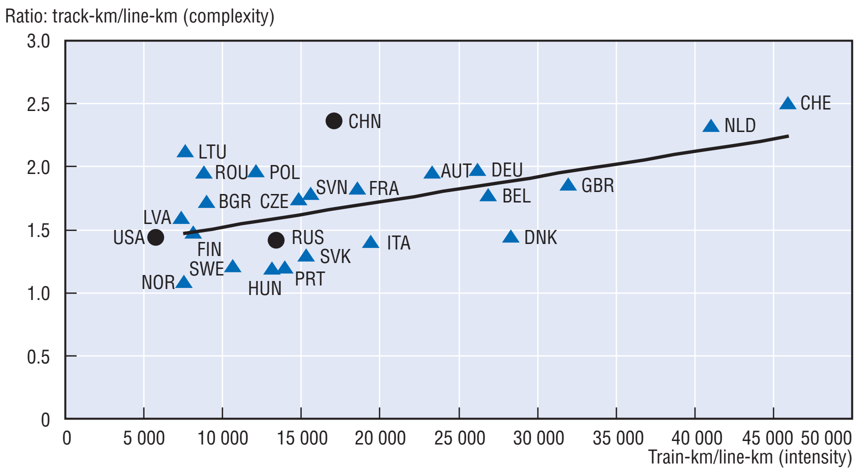
Passenger and freight line density

	Line-km					Pass-km (000 000)				Ton-km (000 000)			
	1980	1990	2003	% growth, 1980 to 2003	Shrinkage (km) 1980 to 2003	1980	1990	2003	% growth, 1980 to 2003	1980	1990	2003	% growth, 1980 to 2003
Europe non-OECD													
Slovenia	1 058	1 196	1 229	16.2	171.0	1 436	1 429	777	(45.9)	3 851	4 196	3 274	(15)
Estonia	993	1 026	959	(3.4)	(34.0)	1 553	1 510	182	(88.3)	6 515	6 977	9 283	42
Latvia	2 384	2 397	2 270	(4.8)	(114.0)	4 774	5 466	762	(84.0)	17 586	18 538	17 604	0
Lithuania	2 008	2 007	1 774	(11.7)	(234.0)	3 258	3 640	432	(86.7)	18 237	19 258	11 457	(37)
Bulgaria	4 341	4 299	4 318	(0.5)	(23.0)	7 055	7 793	2 517	(64.3)	17 491	14 132	5 274	(70)
Romania	11 110	11 348	11 077	(0.3)	(33.0)	23 220	30 582	8 528	(63.3)	78 390	57 253	16 584	(79)
Ukraine	22 600	23 316	22 079	(2.3)	(521.0)	60 160	76 038	52 558	(12.6)	469 643	473 953	225 287	(52)
Belarus	5 512	5 569	5 502	(0.2)	(10.0)	10 922	16 852	13 308	21.8	66 264	75 373	38 402	(42)
Big Five developing countries													
Brazil: all concessions	28 645	26 945	25 895	(9.6)	(2 750.0)	11 867	3 188	2 500	(78.9)	40 640	41 042	67 300	66
Russian Federation	82 600	85 969	85 500	3.5	2 900.0	227 300	274 000	157 100	(30.9)	2 316 000	2 523 000	1 664 300	(28)
China	49 940	53 378	60 446	21.0	10 506.0	138 037	263 530	456 000	230.3	570 732	1 060 100	1 609 000	182
Indonesia	6 458	5 000	5 300	(17.9)	(1 158.0)	5 900	9 290	17 000	188.1	1 000	3 190	5 000	400
India	61 240	62 367	63 122	3.1	(1 882.0)	208 558	295 644	515 044	147.0	158 474	235 785	353 194	123
All other countries	193 384	191 663	167 966	(13.1)	(25 418.0)	146 735	174 219	137 785	(6.1)	656 002	658 847	370 949	(43)
World total	**1 142 531**	**1 052 801**	**995 433**	**(12.9)**	**(147 098.0)**	**1 435 428**	**1 827 784**	**2 027 086**	**41.2**	**6 679 202**	**7 546 272**	**7 670 210**	**14.8**

Source: World Bank Railways Database.

Figure 5.1 shows a somewhat different measure of traffic intensity and freight role, that is, train-km/line-km and the percentage of freight train-km. The point in juxtaposing Table 5.1 and Figure 5.1 is to caution the reader that infrastructure "capacity" and the interactions between passenger and freight traffic and infrastructure operations are complex. This will be discussed in more detail later.

Figure 5.1. **Network complexity *versus* intensity of use (train-km/km of line basis)**



Note: Russian Federation, US and China added manually and do not affect the regression line.
Source: ECMT (2005), *Railway Reform and Charges for the Use of Infrastructure*, OECD, Paris, p. 42.

Stambrook (2006) provides new construction estimates for rail infrastructure between 2000 and 2030 of around USD 1.606 trillion, with the net asset value increasing by USD 711 billion.[1] No attempt was made to attribute amounts to passenger *versus* freight.[2]

Table 5.2 taken from a 2003 IEA study of future energy consumption in transport, provides insight into the relative roles of freight and passenger traffic in the need for added infrastructure. The IEA study is based on projections of a number of factors that influence energy demand, such as population, GDP and efficiency changes. In the rail area, it is also based on an analysis of past trends in rail traffic in relation to demographic changes. It reinforces the fact that most of the freight-driven need for added infrastructure is likely to be in North America and the Big 5. Other areas will be influenced as much by passenger traffic growth as by freight, and the interaction between freight and passenger services will be critical to the outcome.

Table 5.2. **Projected worldwide needs in freight and passenger trail traffic**

	2000	2005	2010	2015	2020	2025	2030	2035	Absolute growth 2005-35	Per cent growth 2005-35
Russian Federation GDP (2000 = 100)	100.0	117.1	134.1	159.1	188.2	216.5	245.6	282.2		
Frt ton-km index	100.0	110.8	122.9	136.2	151.0	167.3	185.5	205.6		
Ton-km projection	*1 197 495*	*1 327 362*	*1 471 314*	*1 630 877*	*1 807 744*	*2 003 792*	*2 221 102*	*2 461 979*	*1 134 617*	*85.5*
Passenger index	100.0	109.6	120.1	131.6	144.3	158.1	173.3	189.9		
Pass-km projection	*167 100*	*183 135*	*200 708*	*219 967*	*241 075*	*264 208*	*289 561*	*317 347*	*134 212*	*73.3*
CIS other than Russian Federation GDP (2000 = 100)	100.0	117.1	134.1	159.1	188.2	216.5	245.6	282.2		
Frt ton-km index	100	109.6	120.1	131.6	144.3	158.1	173.3	189.9		
Ton-km projection	*378 962*	*415 327*	*455 181*	*498 859*	*546 728*	*599 192*	*656 689*	*719 704*	*304 377*	*73.3*
Passenger index	100.0	107.7	116.0	124.9	134.6	144.9	156.1	168.1		
Pass-km projection	*83 953*	*90 419*	*97 382*	*104 882*	*112 960*	*121 659*	*131 029*	*141 120*	*50 702*	*56.1*
Eastern Europe/Turkey GDP (2000 = 100)	100	119.2	140.7	165.7	194.3	226.1	260.5	315.2		
Frt ton-km index	100.0	111.6	124.6	139.0	155.2	173.2	193.3	215.8		
Ton-km projection	*130 277*	*145 405*	*162 290*	*181 136*	*202 170*	*225 647*	*251 850*	*281 095*	*135 690*	*93.3*
Passenger index	100.0	107.2	114.9	123.1	132.0	141.4	151.6	162.5		
Pass-km projection	*65 908*	*70 639*	*75 709*	*81 143*	*86 967*	*93 209*	*99 898*	*107 069*	*36 430*	*51.6*
China GDP (2000 = 100)	100.0	133.7	174.5	223.1	276.2	336.2	406.3	485.7		
Frt ton-km index	100.0	115.9	134.4	155.8	180.6	209.4	242.7	281.4		
Ton-km projection	*1 333 606*	*1 546 015*	*1 792 255*	*2 077 715*	*2 408 641*	*2 792 275*	*3 237 012*	*3 752 584*	*2 206 569*	*142.7*
Passenger index	100.0	115.4	133.1	153.5	177.1	204.4	235.8	272.0		
Pass-km projection	*441 468*	*509 303*	*587 561*	*677 844*	*782 000*	*902 160*	*1 040 784*	*1 200 708*	*691 405*	*135.8*

Table 5.2. **Projected worldwide needs in freight and passenger trail traffic** *(cont.)*

	2000	2005	2010	2015	2020	2025	2030	2035	Absolute growth 2005-35	Per cent growth 2005-35
Other Asia GDP (2000 = 100)	100.0	121.4	149.2	181.5	217.6	258.5	305.2	360.7		
Frt ton-km index	100.0	109.1	119.1	130.0	141.9	154.9	169.1	184.6		
Ton-km projection	*31 032*	*33 871*	*36 970*	*40 353*	*44 045*	*48 075*	*52 473*	*57 274*	*23 403*	*69.1*
Passenger index	100.0	111.6	124.6	139.0	155.2	173.2	193.3	215.8		
Pass-km projection	*87 111*	*97 227*	*108 517*	*121 118*	*135 183*	*150 881*	*168 401*	*187 957*	*90 730*	*93.3*
India GDP (2000 = 100)	100.0	127.4	163.3	207.4	257.7	316.2	385.6	464.3		
Frt ton-km index	100.0	115.9	134.4	155.8	180.6	209.4	242.7	281.4		
Ton-km projection	*305 201*	*353 812*	*410 165*	*475 493*	*551 227*	*639 023*	*740 803*	*858 794*	*504 982*	*142.7*
Passenger index	100.0	113.7	129.3	147.0	167.1	190.0	216.0	245.6		
Pass-km projection	*430 666*	*489 641*	*556 691*	*632 923*	*719 594*	*818 134*	*930 168*	*1 057 543*	*567 903*	*116.0*
Middle East and North Africa GDP (2000 = 100)	100.0	113.7	129.0	146.8	169.1	193.7	217.7	241.6		
Frt ton-km index	100	109.6	120.1	131.6	144.3	158.1	173.3	189.9		
Ton-km projection	*29 892*	*32 760*	*35 904*	*39 349*	*43 125*	*47 263*	*51 799*	*56 769*	*24 009*	*73.3*
Passenger index	100.0	111.6	124.6	139.0	155.2	173.2	193.3	215.8		
Pass-km projection	*79 930*	*89 212*	*99 571*	*111 134*	*124 039*	*138 443*	*154 519*	*172 463*	*83 251*	*93.3*
Europe/OECD GDP (2000 = 100)	100.0	111.5	126.1	140.7	154.4	167.5	180.2	189.2		
Frt ton-km index	100.0	104.1	108.4	112.9	117.6	122.5	127.5	132.8		
Ton-km projection	*247 612*	*257 858*	*268 528*	*279 640*	*291 211*	*303 262*	*315 810*	*328 879*	*71 020*	*27.5*
Passenger index	100.0	106.1	112.5	119.3	126.5	134.2	142.3	150.9		
Pass-km projection	*300 916*	*319 134*	*338 454*	*358 944*	*380 675*	*403 721*	*428 163*	*454 084*	*134 950*	*42.3*

Table 5.2. **Projected worldwide needs in freight and passenger trail traffic** *(cont.)*

	2000	2005	2010	2015	2020	2025	2030	2035	Absolute growth 2005-35	Per cent growth 2005-35
US and Canada GDP (2000 = 100)	100.0	112.6	128.5	142.7	156.9	171.7	187.5	203.9		
Frt ton-km index	100.0	108.4	117.6	127.5	138.3	150.0	162.7	176.4		
Ton-km projection	*2 427 145*	*2 632 171*	*2 854 515*	*3 095 641*	*3 357 135*	*3 640 718*	*3 948 256*	*4 281 772*	*1 649 601*	*62.7*
Passenger index	100.0	104.1	108.4	112.9	117.6	122.5	127.5	132.8		
Pass-km projection	*47 947*	*49 931*	*51 998*	*54 149*	*56 390*	*58 723*	*61 153*	*63 684*	*13 752*	*27.5*
Pacific/OECD GDP (2000 = 100)	100.0	108.8	123.3	137.7	152.1	167.0	182.7	198.3		
Frt ton-km index	100.0	104.8	109.9	115.1	120.7	126.5	132.6	139.0		
Ton-km projection	*156 391*	*163 917*	*171 805*	*180 072*	*188 738*	*197 820*	*207 340*	*217 318*	*53 401*	*32.6*
Passenger index	100.0	107.2	114.9	123.1	132.0	141.4	151.6	162.5		
Pass-km projection	*241 113*	*258 419*	*276 966*	*296 845*	*318 151*	*340 985*	*365 459*	*391 689*	*133 271*	*51.6*
Latin America GDP (2000 = 100)	100	114	134	156	182	210	242	276		
Frt ton-km index	100.0	107.2	114.9	123.1	132.0	141.4	151.6	162.5		
Ton-km projection	*117 903*	*126 365*	*135 435*	*145 155*	*155 574*	*166 740*	*178 707*	*191 534*	*65 169*	*51.6*
Passenger index	100.0	104.1	108.4	112.9	117.6	122.5	127.5	132.8		
Pass-km projection	*13 659*	*14 224*	*14 812*	*15 425*	*16 064*	*16 728*	*17 421*	*18 141*	*3 918*	*27.5*
Africa GDP (2000 = 100)	100	120	145	174	208	247	291	339		
Frt ton-km index	100.0	109.6	120.1	131.6	144.3	158.1	173.3	189.9		
Ton-km projection	*114 609*	*125 607*	*137 660*	*150 869*	*165 346*	*181 213*	*198 602*	*217 659*	*92 052*	*73.3*
Passenger index	100.0	104.1	108.4	112.9	117.6	122.5	127.5	132.8		
Pass-km projection	*17 574*	*18 302*	*19 059*	*19 848*	*20 669*	*21 524*	*22 415*	*23 342*	*5 041*	*27.5*
Total ton-km projection	**6 470 125**	**7 160 469**	**7 932 020**	**8 795 159**	**9 761 684**	**10 845 019**	**12 060 442**	**13 425 359**	**6 264 890**	**87.5**
Total pass-km projection	**1 977 346**	**2 189 583**	**2 427 428**	**2 694 223**	**2 993 766**	**3 330 377**	**3 708 972**	**4 135 147**	**1 945 564**	**88.9**

Note: Frt = freight, pass = passenger.

Source: IEA (2003), ETP Transport Model, Spreadsheet version 1.28.

The probable need for enhanced rail infrastructure in the next 30 years, both in total and specifically for freight, is well established (see TRB, 2002 and TEN-T, 2005, both of which make this point). "Needs" generate different responses, however, depending on the way in which the "market" can balance all of the investment needs it faces. To be very clear, the actual "need" will be for the ability to haul more rail freight *ton-km*. The way in which the need is met (or not met) will be determined by a number of interacting factors, including:

1. The management model in place, which will influence the perception of economic and financial forces that make up the set of incentives the infrastructure provider and freight operators face.
2. Technology (signalling, tractive power, wagon size, axle loads, speeds of freight and passenger trains, energy costs, and a large number of other possible considerations).
3. The high capital cost of rail freight infrastructure by comparison with roads and (in some cases) water navigation combined with the single-purpose nature of rail freight-only infrastructure.
4. Government policies as to the role of the public and private sectors, regulation, modal promotion, rail infrastructure access charges and financial targets for the infrastructure provider, competition objectives (intramodal and intermodal), availability of information, and others.

The outcome of the interaction between "need" on the one hand and "response" on the other will probably differ significantly among countries. Management models will differ as a result of history, culture and political preference. All countries will have access to the same basic technology, but the way in which it is adopted will differ depending on passenger and freight balance, management model and government policy. Government policies will consider the same issues, but will clearly differ as a result of differing national objectives and perceptions.

As a broad generalisation, North American rail infrastructure investment is likely to be driven by the private sector for commercial reasons, and will be concentrated on profitable freight capacity. Government policies in North America are only now beginning to address the issue of public interest in private rail infrastructure (especially as it relates to freight rather than passenger needs), and government involvement in specifically freight infrastructure is only now emerging.

EU rail infrastructure will clearly be largely driven by passenger concerns (economically and politically) and specifically freight infrastructure is likely to receive second priority. Success at promoting rail freight growth and the infrastructure needed to support it will depend on creating commercially driven rail freight companies that can operate Europe-wide with reasonable access to infrastructure: this, in turn, will depend on the *implementation* (as opposed to the formulation) of EU transport policies.

Up to the present, at least, international rail freight operations in Europe have been limited by the higher access priority by passenger rather than freight, by interoperability issues in signalling and electric traction, by access charge regimes that discriminated in favour of the existing, large national freight operator, and by attempts by some countries to use high freight access charges to cross-subsidise passenger train use of the infrastructure. A recent ECMT study analysed the issues for freight use of the infrastructure in the ECMT countries and concluded that access charges applied to freight need to be simplified and that the high freight access charges in the CEE members will need to be reduced to the comparable practices in the original EU15 countries (ECMT, 2005).

Rail infrastructure in Japan has long been almost totally dominated by passenger traffic: this is likely to continue in the future, even though Japan has a significant highway traffic capacity problem for freight as well as passenger. Rail infrastructure in the Russian Federation and China will be heavily influenced by freight capacity needs, though the Chinese government intends to build dedicated passenger lines – partly to improve freight capacity by removing the passenger interference on vital freight lines. Though the Russian Federation has made progress in developing a business model that would permit rail freight to be provided competitively by new, private companies, the implementation of this model is only partially complete, and full implementation is uncertain. The Chinese model relies on a state-owned monolith that might, in the longer run, conflict with the increasing emphasis in China on the "socialist market" economic structure.

The Indian government is currently considering a proposal to construct new freight-only lines in the Mumbai, Delhi, Calcutta and Chennai "Golden Quadrilateral". The business model for financing and operating the new lines is under discussion, though Indian Railways already has a container operating company under separate ownership and management.

Andrieu (2005) argued that the "third conclusion one can draw is that – perhaps with the exception of the telecommunications sector – none of the other sectors have put in place an institutional framework that is up to the challenges of the future, including a regulatory framework which allows for the full and effective participation of private actors". This conclusion could be broadened to argue that there are as yet no countries in which the current public policy and institutional framework will fully suffice to meet the challenges of providing adequate rail infrastructure, specifically rail freight infrastructure, in the next thirty years.

In the US, the federal government is now initiating the process of identifying the specifically public benefits from rail freight (and passenger) infrastructure and services and highlighting those benefits that can only be achieved through public finance. This should also create a focus on locating the public resources required. Canada, with its recently privatised CN, is facing the same issues. In the EU, access to the infrastructure network (at least for freight operators) must be more clearly established and simplified. Some interoperability issues (less serious for freight than for passenger trains) need to be resolved. The structure of the freight operators, both for ownership and for competitive balance, must be defined (though it will likely differ among countries). Financial resources for the freight component of rail infrastructure (freight freeways, and the Betuwe Line, as well as for continued maintenance) need to be located (about EUR 130 billion remain unfunded in the TEN-T programme).

The Russian Federation faces the need for the freight rail infrastructure to recover from a decade of relative neglect during the years of economic transition. This will pose a difficult choice between a need for government support when financial resources are restricted and the need to generate more earnings, particularly on coal, when there will be pressures to hold tariffs down. In addition, operating cross-subsidies from freight to passenger services could seriously undermine the ability of the railway to finance infrastructure for whatever purpose.

China has announced a massive (perhaps grandiose), more than USD 200 billion plan of rail infrastructure investment, between now and 2020. However strong the merits of this plan, the railway (Ministry of Railways of China, MOR) cannot finance this growth from its current earnings or from credible sources of public debt. The institutional framework of MOR will need to adapt to generate new sources of finance and enable the entry of new train operators.

India clearly needs added rail freight capacity. The challenge is that the capacity of the current system is ineffectively managed as a result of social policies that encourage uneconomic passenger services (that rob the system of needed capacity for economic services such as freight and intercity passenger trains) and a policy of cross-subsidy from freight to passenger which absorbs earnings that could more productively finance new freight and intercity capacity.

In all of these cases, traditional approaches (however justified they might have been in the past) are now becoming barriers to meeting the future need for rail freight infrastructure and operating services.

2. Existing models of railways organisation

A "railway" consists in the most general terms of infrastructure (steel rails and sleepers, switches and signals, bridges, buildings and structures, electric traction catenary and associated electrical equipment), and operating assets (locomotives, freight wagons and passenger coaches – some independently powered). The "railway" faces an almost unlimited panoply of economic and social forces which determine demand for passenger and freight services (and thus the need for infrastructure) and set the values for non-market (social) functions that the railway must provide. It is the "business model" that determines how the assets will be deployed in meeting the market and social demands placed on the railway. At the same time, of course, society places restrictions on the business models that the railway can adopt.

Railway business models are broadly defined in two dimensions: structure and ownership. Again in broad terms, there are three structure types: integral, where infrastructure and all operating services are operated under unified control (this is often called "the monolith"); owner-tenant levels, where the owning, dominant operator remains integrated with the infrastructure, and the minority, tenant operators pay for their access to the infrastructure; and "vertically separated" models where (in principle) the infrastructure is separated from the operator or operators. Further variants of the structural model deal with whether or not the "separation" is merely an accounting separation or an actual institutional separation, and with the level of separation among the operators (is there a single, integrated operating company, or are the various passenger and freight operators separated into distinct entities?).

Countries have also varied greatly in the approach to ownership. The US freight railways have generally been owned and operated by private companies. With the privatisation of the largest Canadian railway (CN) in 1996 (CP was already private), and with the concessioning of the Latin American freight and passenger railways in the 1990s, most freight railways in North and South America are now operated privately, while there is a mix of public and private operation of passenger services. Outside the Americas, the traditional model of railway ownership and operation has been public, though the privatisation of British Railways in the mid-1990s and the trend toward franchising of passenger services in some EU countries (Germany, Netherlands, Denmark and Sweden) is enlarging the role of the private sector, at least in operations if not in infrastructure. The break-up of Japanese National Railways (JNR) led to the privatisation of the three largest pieces – East, West and Central Japan railways – creating among the largest passenger operators in the world. Table 5.3 shows the options and gives examples of a number of national examples in both the structural and ownership axes.

These ownership options have emerged over time in response to changing perceptions as to what railways ought to do and how they should do it. The structural options have developed in line with increasing complexity in the markets and purposes served.

Economic efficiency. Most expert analyses of rail economic have agreed that there are no particular benefits of system *size* beyond a relatively small level of a few thousand kilometres. There are, however, increasing returns to traffic density on traffic on a specific line. This has encouraged railways to share the same lines, either through owner-tenant relationships or through vertical separation with

Table 5.3. **The basic business model alternatives: structure and ownership interactions**

Structure	Ownership		
	Public	Partnership	Private
Integral (monolithic)	China, India	Network Rail, India Railway Container Corp., Latin American freight and passenger concessions	Smaller US freight railroads, East Japan, Central Japan and West Japan
Dominant operator Integral, tenant operators separated	Amtrak and VIA, Japan Rail Freight, Russia, Island JRs	US freight and commuter railways in the North-eastern Corridor, CN and CP	US freight railway trackage rights, JB Hunt
Separation	"Standard" EU model	Some UK franchises	Most UK franchises, Railtrack (but not Network Rail), EWS

several operators on the same line, and has been applied both to operators in the same market (for example, two freight operators) and to operators in different markets (for example, passenger operations on freight lines).

Market focus. When railways began, customer options and competition in both the freight and passenger markets were limited, and a monolithic model was possible. As competition has grown in severity and sophistication, it has become harder for a unitary management on the rail side to compete with cars, buses and air in the passenger markets and with trucks and barges (sometimes aided by government support) in the freight markets. The enhanced market focus associated with differentiated (or institutionally separated) management has become more and more important.

Competition. There are a number of countries in which the possibility of rail *versus* rail competition (intra- as opposed to intermodal competition) is seen as a significant weapon in limiting the potential market power of railways, especially in the freight market. In the US, this has taken the form of controls over mergers to protect competition on parallel (integrated) lines and of enforced access rights to retain competition that might otherwise be eliminated through mergers. In addition, private rail freight companies have voluntarily negotiated trackage access agreements ("trackage rights" give one railroad the right to run a specified set of services on the lines of another in return for a trackage use fee), where one railway company wants access to a market exclusively served by another.

Clarity of public involvement and funding. There are many situations in which governments would like to support specific aspects of the rail system or, at least, to support different parts of the system in different ways. This is difficult to do when the only information available is based on more or less arbitrary (and murky) accounting separations and allocations. Institutional separations with transfer prices where necessary give a much more defensible identification of costs and benefits. In the EU, for example, Community law permits public support of infrastructure (so long as access is non-discriminatory) and of social services (primarily suburban or regional passenger traffic), and restricts support to services that are "commercial" (such as freight or intercity passenger).

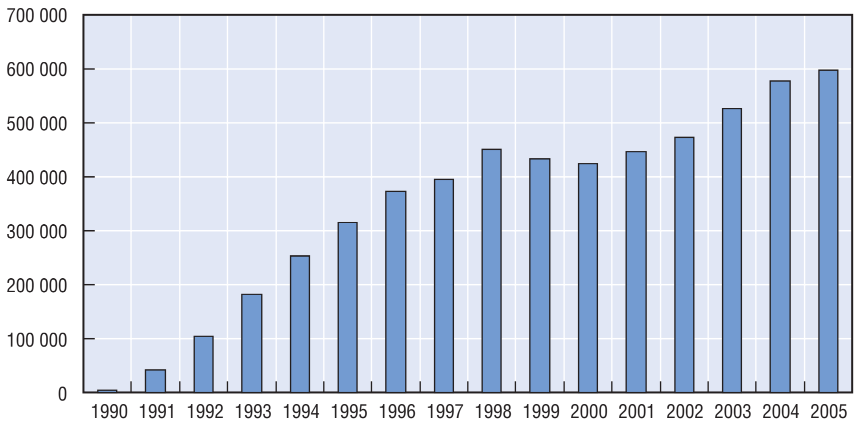
Table 5.4 shows how these objectives interact to influence the choice of the actual business model. There are generally six distinct types of markets being served by railways: infrastructure, freight, HSR, conventional intercity passengers, rural/regional passenger services and suburban services. Each of these has a characteristic commercial or social objective. Because of its high investment costs and the need to serve multiple users in a non-discriminatory way, multiple-use infrastructure is essentially a public utility. Freight, HSR and conventional intercity services compete directly with other private modes such as airlines, buses and cars, and are therefore mostly commercially driven. Rural/regional and suburban services are mostly socially determined because they serve lower income needs, or are provided to reach social goals such as reduced noise and air pollution or reduction of urban congestion (though these weights can change with location and will change over time, especially as alternative modes become more congested and less competitive). Each of the six has a distinct competitive implication, where some (especially freight, possibly conventional intercity or HSR) may justify competition *in* the market (*i.e.* rail *versus* rail competition) whereas most of the others are subject to competition *for* the market (that is, competitively awarded, exclusive franchises).

Table 5.4. **Markets and models: interactions**

Type of market	Purpose: commercial or social	Type of competition (if any)	Public and private roles
Infrastructure	Utility or commercial	None/FOR	Mostly public, though private ownership and/or contract operation is possible
Freight services	Commercial	IN	Currently often public, moving towards private ownership and operation
Passenger services			
HSR	Commercial	FOR	Currently public, could be privatised or franchised
Conventional Intercity	Commercial (social?)	IN	Currently public, could be franchised
Rural/regional	Social	FOR	Currently public, could be franchised
Suburban	Social	FOR	Currently public, could be franchised

The categories in Tables 5.3 and 5.4 are sometimes less distinct than they appear. A good example is the J.B. Hunt Company in the US. J.B. Hunt is actually one of the largest US truckload freight carriers. In the early 1990s, Hunt became convinced that problems of driver availability (at that time Hunt had more than 200% driver turnover each year) and of highway congestion would mandate a better combination of the short haul, pick-up and delivery capabilities of trucking and the long haul, high volume capabilities of rail. Hunt developed and negotiated with railways an arrangement in which Hunt provides all marketing, pick up and delivery and customer relations, while the railways handle only full trainload shipments of Hunt containers between Hunt terminals. This is in effect a wholesaler/retailer relationship in which each part plays to its strengths. The Hunt system is now nationwide and has grown from about 6 000 containers (then 48 foot standard) in 1990 to 600 000 containers (present 53 foot standard) in 2005 (Figure 5.2).

Figure 5.2. **JB Hunt intermodel traffic**



Note: Growth is slightly understated because container size has grown from 48 feet in 1990 to 53 feet in 2006.

Source: J.B Hunt.

Hunt's intermodal traffic has benefited from economic growth and increasing international trade, as well as from highway congestion and driver shortages in the US. The Hunt intermodal approach has been limited by rail capacity problems, particularly in terminal areas, and from less than optimum on-time performance that was partly caused by rail capacity problems and partly caused by the fact that US freight railroads normally do not operate freight trains on fixed schedules. The Hunt intermodal system is a good example of the interaction between market forces and enterprise structure – new business models do indeed arise and develop if they are permitted to do so.

The distinction between intercity passenger services and regional or long haul suburban services can also be blurred. In these cases, separation of commercial from social roles can be difficult.

The power of a change in business model is illustrated by the shift in Latin America. At the beginning of the 1990s, all Latin American railways were monolithic state agencies ("enterprises" has too favourable a connotation). By the end of the decade, essentially every freight railway was operated by private concessions (as well as the suburban passenger services and metros in Buenos Aires and Rio de Janeiro). Table 5.5 shows the dramatic results: traffic that had been shrinking or stagnant began growing rapidly, and labour and infrastructure productivity exploded. After successful concessioning with the resulting increases in efficiency and customer focus, freight rail services in Latin America are now poised for continuing growth, so long as the political environment continues to be supportive and the export economies in these countries continue to thrive as the have in the recent past.

Table 5.5. **Concessioned freight railways in Latin America**

		Km of line	Ton-km	Ton-km/employee	Ton-km/km
Mexico (old FNM)	1996	26 000	41 959	850	1 614
	2004	16 000	61 051	3 550	3 816
Brazil (old RFFSA)	1995	22 095	39 195	1 000	1 774
	2004	21 659	59 700	4 700	2 756
Brazil (old FEPASA)	1998	4 183	4 995	450	1 194
	2004	4 236	9 400	4 420	2 219
Argentina	1992	18 000	2 523	240	140
	2004	11 000	9 878	2 530	898

Source: World Bank Concessioned Railways Database.

3. Key economic and social trends affecting rail freight traffic and infrastructure

3.1. Drivers of growth

The basic drivers of growth in the potential demand for rail freight are well described by Stambrook (2006). Freight traffic, in particular, is a derived demand, that is, freight movement (whether by air, truck, rail or water) is not consumed for its own sake, but is, instead, generated by the need to move the goods and services being produced by the economy. Passenger travel is also, for the most part, a derived demand in that only a small part of personal travel is generated purely for the travel experience. Even for leisure purposes, most travel is to get there, not to look out the window. The most powerful driver of freight demand is, of course, underlying economic development.

Predicting economic growth is always difficult, and the results of predictions are always riddled with questionable assumptions and a large range of uncertainty. The basic data source for this OECD Futures Project seems to be the World Bank's "Global Economic Prospects 2005" (World Bank, 2005). Table 5.6 shows the GDP/capita forecasts in the World Bank 2005 report. Table 5.6 only extends through 2015, not long enough for the scope of this study. Table 5.7

Table 5.6. **Forecast growth of world GDP per capita**

Compound annual percentage

	1980s	1990s	2000 to 2006	2006 to 2015
World total	**1.3**	**1.2**	**1.5**	**2.1**
High-income countries	2.5	1.8	1.6	2.4
OECD	2.5	1.8	1.6	2.4
US	2.3	2	1.8	2.5
Japan	3.4	1.1	1.1	1.9
EU	2.1	1.8	1.4	2.3
Non-OECD countries	3.5	4	2	3.5
Developing countries	0.7	1.5	3.7	3.5
East Asia and the Pacific	5.8	6.3	6.4	5.3
Europe and Central Asia	0.9	–1.8	5	3.5
Latin America and the Caribbean	–0.9	1.6	1.2	2.3
Middle East and North Africa	–1.1	1	2.5	2.6
South Asia	3.3	3.2	4.5	4.2
Sub-Saharan Africa	–1.1	–0.5	1.8	1.6

Source: World Bank (2006), Global Economic Prospects 2006, p. 8.

shows population, GDP and GDP/capita estimates taken from an international energy study (based on the *IMF World Economic Outlook* 2002). Neither the categorisations nor the estimates from the two sources match up precisely; in fact, it would be a surprise if they did. The significant point is that both show significant GDP and GDP/capita growth, although they differ somewhat by countries and regions. This means that the underlying economic forces will encourage growth in freight traffic: no matter which source is used, this will be true.

Within the broader umbrella of economic growth, there are a large number of considerations that could act to restrain or accelerate the growth of freight traffic overall, and of the share of rail in the freight sector in particular.

Globalisation. "Globalisation" conjures up visions of worldwide trade, with emphasis on waterborne and long-haul air movements. While these are important, globalisation is also having a significant and positive impact on rail freight traffic. This can be seen in two ways: reduction of trade barriers generated by regional free trade agreements, and in the traffic to and from the ports involved in global trade.

Both the North American Free Trade Agreement (NAFTA) and the increasing size of the EU have created opportunities for increased rail traffic. NAFTA is a free trade agreement among the US, Canada and Mexico, signed in 1990, which began having an impact in 1992. Trade has grown rapidly by all modes, but rail freight traffic from 1992 to 2004 slightly more than tripled in value between the US and Mexico, and significantly more than doubled between the US and Canada

Table 5.7. **Growth rates in population, GDP and GDP/capita**

Compound annual

	2000	2005	2015	2025	2035	2000 to 2005	2005 to 2015	2015 to 2025	2025 to 2035
	Population (millions)								
OECD North America	405	426	466	504	537	1.02	0.90	0.79	0.64
OECD Europe	514	520	525	526	509	0.23	0.10	0.02	–0.33
OECD Pacific	197	201	205	204	200	0.40	0.20	–0.05	–0.20
Former Soviet Union	254	252	251	248	247	–0.16	–0.04	–0.12	–0.04
Eastern Europe	100	96	91	85	82	–0.81	–0.53	–0.68	–0.36
China	1 272	1 318	1 406	1 467	1 479	0.71	0.65	0.43	0.08
Other Asia	891	967	1 119	1 265	1 401	1.65	1.47	1.23	1.03
India	1 014	1 089	1 230	1 352	1 450	1.44	1.22	0.95	0.70
Middle East	168	192	245	300	353	2.71	2.47	2.05	1.64
Latin America	415	446	506	560	603	1.45	1.27	1.02	0.74
Africa	794	892	1 110	1 358	1 617	2.35	2.21	2.04	1.76
Total	**6 023**	**6 399**	**7 154**	**7 869**	**8 477**	**1.22**	**1.12**	**0.96**	**0.75**

Table 5.7. **Growth rates in population, GDP and GDP/capita** *(cont.)*

Compound annual

	2000	2005	2015	2025	2035	2000 to 2005	2005 to 2015	2015 to 2025	2025 to 2035
	GDP (USD billions)								
OECD North America	10 556	11 884	15 059	18 126	21 528	2.40	2.40	1.87	1.73
OECD Europe	9 637	10 744	13 555	16 145	18 237	2.20	2.35	1.76	1.23
OECD Pacific	4 366	4 749	6 011	7 293	8 657	1.70	2.38	1.95	1.73
Former Soviet Union	1 414	1 655	2 250	3 061	3 989	3.20	3.12	3.13	2.68
Eastern Europe	453	540	751	1 025	1 429	3.58	3.35	3.16	3.38
China	4 861	6 499	10 845	16 345	23 611	5.98	5.25	4.19	3.75
Other Asia	2 955	3 587	5 363	7 639	10 657	3.95	4.10	3.60	3.39
India	2 279	2 903	4 727	7 205	10 579	4.96	5.00	4.30	3.92
Middle East	952	1 083	1 398	1 845	2 301	2.61	2.59	2.81	2.23
Latin America	2 605	2 965	4 072	5 466	7 181	2.62	3.22	2.99	2.77
Africa	1 530	1 830	2 670	3 773	5 191	3.65	3.85	3.52	3.24
Total	**41 609**	**48 439**	**66 700**	**87 923**	**113 362**	**3.09**	**3.25**	**2.80**	**2.57**

Table 5.7. **Growth rates in population, GDP and GDP/capita** *(cont.)*

Compound annual

	2000	2005	2015	2025	2035	2000 to 2005	2005 to 2015	2015 to 2025	2025 to 2035
	GDP per capita (USD thousands)								
OECD North America	26.0	27.9	32.3	35.9	40.1	1.42	1.48	1.06	1.11
OECD Europe	18.8	20.7	25.8	30.7	35.8	1.94	2.23	1.75	1.55
OECD Pacific	22.1	23.7	29.4	35.7	43.3	1.41	2.18	1.96	1.95
Former Soviet Union	5.6	6.6	9.0	12.3	16.2	3.34	3.15	3.17	2.79
Eastern Europe	4.6	5.6	8.3	12.1	17.4	4.01	4.01	3.84	3.70
China	3.8	4.9	7.7	11.1	16.0	5.22	4.62	3.72	3.72
Other Asia	3.3	3.7	4.8	6.0	7.6	2.31	2.64	2.26	2.39
India	2.2	2.7	3.8	5.3	7.3	4.18	3.48	3.38	3.25
Middle East	5.7	5.6	5.7	6.2	6.5	–0.35	0.18	0.84	0.47
Latin America	6.3	6.6	8.0	9.8	11.9	0.93	1.94	2.05	1.96
Africa	1.9	2.1	2.4	2.8	3.2	2.02	1.34	1.55	1.34
World average	**6.9**	**7.6**	**9.3**	**11.2**	**13.4**	**1.95**	**2.04**	**1.88**	**1.81**

Source: IMF (2002), *World Economic Outlook*.

(especially in car parts as well as in basic goods). The basic reason for the rail participation is that the length of haul advantage of rail has been increased. This has been enhanced by cross-border ownership of railways both between the US and Canada (CN and CP both own significant railroad companies in the US and Norfolk Southern owns track in Canada) and between the US and Mexico (one major Mexican railway connecting the US to Mexico – TFM – is owned by a US railway, KCS, and the other major Mexican connector – FerroMex – has a significant US partner, UP). In addition, the government of Canada has created a Pacific Gateway, which is a multimodal network of transportation infrastructure focused on trade with Asia, mostly via the Port of Vancouver. This programme has included nearly CAD 590 million in investment in both public and privately owed infrastructure assets in the seaports, airports, railroads and road systems aimed at improving Canada's connectivity with Asian trade.

The EU may be an equally significant example of the opportunity that increasing lengths of haul can offer the rail sector. One of the underlying reasons that the Commission issued Directive 91/440 was the expectation that open access to rail infrastructure would eventually create rail freight companies operating more seamlessly and competitively across borders. Prior to Directive 91/440, the balkanisation of the EU railways meant that, in effect, the longest seamless rail freight trips were restricted by the boundary of each country, whereas the trucking competition has always been able to operate seamlessly across borders. If rail freight companies could easily operate across national borders, then the seamless haul for rail freight could in principle extend from the north of Sweden to the French/Spanish border (or beyond, if the effects of the gauge change can be overcome) and from Liverpool to Bratislava (or on to the eastern border of Turkey someday).

Evidence from the US and Canada (the largest truly single markets for which good data exist) and from China and the Russian Federation (also large single markets) gives an idea of the likely point at which rail gains more and more advantage over truck (see Table 5.8). The average rail length of haul in the US, Canada and the Russian Federation is about 1 400 km, and around 800 for China (and nearly 1 000 for Mexico) – all of which are in the range where rail has a cost advantage. By comparison, the EU countries typically have a freight length of haul from 130 to 400 km, which is clearly in the range at which rail does not have a natural advantage. To an extent, the actual length of haul by rail in the EU is probably underestimated, since each country reports the ton-km on its territory, but may well be double (or more) counting the tonnage handled. In any event, the creation of EU-wide freight rail operating companies will clearly offer the opportunity to increase the length of haul by rail. Expansion of the EU from 15 to 25 countries will also increase rail's length of haul and thus its competitive position.

Table 5.8. **Average lead for railway freight over truck**

In kilometres

	1980	2004	Per cent change
Brazil – FEPASA	367	468	27.5
Brazil – RFFSA	470	436[1]	–7.2
Mexico	682	935	37.1
Czechoslovakia	254	–	–
Czech Republic	–	185	–27.2
Slovak Republic	–	194	–23.4
Hungary	186	183	–2.0
Poland	284	293	3.2
Russian Federation	1 131	1 434[1]	26.8
China	526	743	41.3
Korea	224	235[1]	4.7
India	720	671[1]	–6.8
Austria	219	208	–4.7
Belgium	112	131	16.9
Denmark	250	260	4.2
Finland	283	237	–16.4
France	314	384	22.5
Italy	326	279	–14.6
Japan	303	597[1]	96.8
Netherlands	157	168	7.2
Portugal	270	235	–13.1
Spain	303	442	46.2
Sweden	297	300[1]	1.0
Switzerland	161	161	–0.1
United Kingdom	114	219	92.3
West Germany	201	–	–
Germany	–	288	43.4
Canada: Canadian National	1 093	1 440	31.7
Canada: Canadian Pacific	1 037	1 495	44.2
US: All Class I railways	1 029	1 452	41.1
Australia (bulk)	–	245	–
Australia (non-bulk)	–	1 636	–

Note: Average lead is defined as ton-km per tons originated.

1. Indicates data are from 2003.

Source: World Bank Railways Database.

Congestion in ports and in the port/landside interface is another facet of globalisation that could affect rail freight traffic, and truck or inland water traffic as well. Port side congestion is already occurring in a number of the world's ports (see UNCTAD, 2005). There are a number of ports in which rail access has become a significant determinant of the amount of traffic that rail ultimately receives (or ports in which highway access is sufficiently congested that improved rail access would have a significant impact on rail traffic). A good example of this is the Port of Rotterdam, where the Betuwe Line has been constructed to ease the flow of port traffic onto the EU rail freight network. (See Betuwe Line case study in Box 5.1. Betuwe Line data are also in the TEN-T case study in Box 5.3.)

Another example is the Alameda Project, a PPP project to improve rail access to the Port of Los Angeles and Long Beach, California (see Chapter 1, Box 1.4 on the Alameda Corridor Project).

The US ports of Los Angeles, Long Beach and New York/New Jersey are particular pressure points in world trade flows. These three are the primary West Coast and East Coast points of entry of containerised traffic, an area in which world growth was 23% between 2001 and 2004, and which is expected at least to double between 2005 and 2020 (assuming there is capacity to handle it – see US DOT, 2005). A less obvious, but equally significant container capacity issue for the US is the rail hub in Chicago, the nodal point for over one-third of all rail flows in the country (see Box 5.2 on the CREATE Program), and a potential pinch point for container traffic in the US. Beyond these cases, the US DOT (2005) has concluded that the US container movement network is rapidly approaching its capacity limits, and shows port capacity shortfalls of around 30% on the West Coast and about 25% on major East Coast ports. A major factor in the capacity issue is the landside connections to the ports, of which rail is a large actor, especially for container traffic that is travelling a significant distance inland.

It is clear that the US ports will not be alone in facing capacity issues due to growth in container traffic. Table 5.9 shows what has been happening in the top 20 world container ports in the early 1990s. This table has a number of critical aspects. First, on average, container movements grew by over 30% in only two years (2002 through 2004). Though this rate of growth would clearly be unsustainable for long, it does presage rapid growth – and strained landside capacity – nearly everywhere. Second, China accounts for three of the four largest container ports, accounting for 30% of the movements in the top 20 ports (and, in fact, Chinese ports in total account for 44% of the traffic in the top 20 ports). Next, the two major EU container ports, Rotterdam and Hamburg, experienced growth rates of nearly 30%, though growth has recently slowed. Los Angeles (19.8%), Long Beach (27.9%) and New York/New Jersey (17.3%) are also growing rapidly. Since rail access is critical to most of these ports (and all have highway congestion as well), it is clear that there will be a strong demand on the railway infrastructure to handle more traffic.

Table 5.10 shows that the port capacity issue, and the related land links, is likely to be go beyond solely the issues of container movement. "Dry cargo" in this table includes not only containers, but also all other bulk cargos such as iron ore, coal, and grains, among others (unfortunately it is not possible to separate the container tonnage from the rest of the dry cargo category).

Box 5.1. **The Betuwe Line, Netherlands**

International trade has always been especially important to the Netherlands: 20% of the Dutch GDP is attributed to activities in the Port of Rotterdam and the Schiphol Airport (US DOT FHWA, 2005). As a result, port access issues have taken a high priority in transport planning in the country, and landside port capacity issues are critical in a country that has among the highest population densities in the world.

Rotterdam, in addition to being one of the world's larger general cargo ports, is the largest *container* port outside Asia (Table 5.9). The Rotterdam container traffic, at over 8 million TEU (twenty-foot equivalent units), would amount to around 11 000 trucks/day – a serious challenge to the Dutch highway system, and a potentially significant creator of noise and pollution. It is important that as much of the container traffic as possible be shifted to rail and water (Rhine river) for inland movement.

The efficiency of the port is not just important to the Netherlands, because Rotterdam, along with Hamburg, is a major interface point in world trade. For example, 57% of all European distribution centers for US companies are located in the Netherlands, making Rotterdam a key link in transatlantic trade.

In 1990, the Dutch government announced its intention to proceed with a project to construct a new rail link from the Rotterdam area to a connection with the German railway network in order to speed up the connection of Rotterdam with inland, rail-based trade, to relieve the congestion on the existing railway (NS) lines that were already carrying large volumes of passenger trains (as Tables 5.1 and 5.15 show, the Dutch rail system has higher traffic density and a higher percentage of passenger traffic than any other EU15 railway), and to relieve congestion on the Dutch highways. This decision was apparently based on a "strategic" belief, but was not based on detailed analysis (see Netherlands Court of Audit, 2000). Subsequent planning studies led to a commitment to upgrade an existing 40-km rail line in the port area (from Maasvlakte to Kijfhoek, near Rotterdam), and to connect it with a new, 120-km line to Zevenaar where it connects with the German network. The overall project is called the Betuwe Line. The upgraded section has been used as an internal railway to integrate the Port of Rotterdam and to improve the existing linkages. The second section, which is now expected to be completed in early 2007, will complete the high capacity (up to 10 trains per hour each way), all-freight link with the German network.

The project has had a troubled history in a number of ways. The completion date has stretched from 2004 to 2007, and the cost in constant terms has doubled, from EUR 2.3 billion to around EUR 4.6 billion (about 60% of the escalation is due to scope additions, and 40% is due to cost escalation). The early traffic estimates (and the financial and economic viability of the project) have been called into question because the downward trend in overall rail freight traffic in the Netherlands has continued and official estimates of Betuwe Line traffic have been stretched out in time. At the same time, rail freight traffic to Germany has increased since 1994, so the future demand picture specifically for the Betuwe Line is not fully defined.

Box 5.1. **The Betuwe Line, Netherlands** *(cont.)*

The government's plans for the institutional management of the Betuwe Line have also evolved, partly in line with the evolution of the structure of the national railway. Originally planned to be part of the national rail infrastructure, the government gave serious consideration in the mid to late 1990s to setting the project up as a PPP. This has now been abandoned on grounds of "risk", which (the Netherlands Court of Audit suggests) apparently means that the cost of the project is too high to be recovered within the limits of the potential demand expected and the infrastructure access charges that the government is willing to allow to be charged.

The government has instead asked the national infrastructure agency (ProRail) to manage the facility for the first few years after completion until the actual traffic flows and operating costs can be determined. Current estimates are that the line will need public support of about EUR 20 million annually, over and above the funds generated from access charges (set at marginal cost), through 2011, after which no further government support to operations is expected. ProRail has announced the proposed 2007 access charges for the line, which include a discount from the national charge structure in order to promote traffic on the line.

It is interesting also that the predominant freight operator on the line is Railion, a subsidiary of the Deutsche Bahn holding company, though there are seven other licensed operators, including Rail4Chem. Railion is the only significant rail freight carrier serving both of the two largest EU container ports – Hamburg and Rotterdam – putting much of the traffic on the Betuwe Line under the control of a company that might feel conflicting pressures between promoters of traffic through the two ports.

The analysis of the project by the Court of Audit highlights the similarity of the Betuwe Line with a number of other major public rail infrastructure projects. On the positive side, the Dutch government has been quite aggressive in determining the public objectives in improved access to the Port of Rotterdam, and has been willing to make a clear distinction between commercial and public objectives, accompanied by public support for the public goals. On the negative side, the essential scope of the project appears to have been committed before any conclusive analysis was available, and not much re-examination has been done since. Because the real performance and structure of the line were not pinned down until recently, the institutional structure – especially the role of the private sector – could not be committed. In addition, the goal of keeping the access charges low in order to promote traffic conflicted with the stated goal of promoting private sector investment. Finally, because of the enormous size of the project (it is the second largest public works project in Holland's history after the Delta Works), the management team was not initially up to the challenge. Several years, and several reorganisations, were necessary before the project was brought under control.

It is not at all uncommon for projects like this to be over budget and over schedule. Flyvbjerg, Bruzelius and Rothengatter (2003) argue that these kinds of short falls are endemic in public megaprojects. Only the future years will tell whether the demand estimates, on which the benefits are based, were also too high (all too typical).

Box 5.2. **The CREATE Program**

The Chicago area is the nerve centre in the US railroad network, acting as the main connecting point for six of the seven Class I railroads (which includes the two largest Canadian rail companies). The Chicago rail infrastructure includes 78 switching yards, 4 500 km of tracks, and covers a total of 6 400 hectares. Approximately 1 200 trains (of which 500 are freight trains) handling 37 500 rail freight wagons are processed daily. The Chicago hub also handles 20 000 intermodal rail/truck operations daily. In total, the Chicago rail hub handles roughly one-third of all rail freight traffic in the US. Significantly, the states most affected by rail traffic movements through Chicago (aside from Illinois) are California, New Jersey, Texas and Ohio. This linkage with seemingly remote states is driven by the fact that Chicago actually handles much of the containerised rail traffic that originates or terminates in the ports of California (Los Angeles and Long Beach) and New Jersey (the Port of New York and New Jersey) as well as the petroleum cargoes originating in Texas (Houston, Beaumont and Corpus Christi). Ohio is a major consumer of containerised cargo from Asia via Pacific ports as well.

The Chicago Region Environmental and Transportation Efficiency (CREATE) Program has been under joint development since the concept was initiated in 1990. On the private sector side, the project involves the Association of American Railroads (AAR) along with six railroad members (BNSF, UP, CP, CN, NS, and CSX), plus three smaller railway switching companies (Belt Railway of Chicago, B&O Chicago terminal and Indiana Harbor Belt) that form the contact point among the line haul railways. Public authorities include the commuter rail section of the Chicago Metropolitan Area Transportation Authority (Metra), along with the Chicago Department of Transportation, the Illinois Department of Transportation and the Federal Highway Administration (part of the US Department of Transport). Amtrak is also a party to the planning.

The project originated through the recognition that highway and rail congestion in the Chicago hub area was reaching serious proportions. By the mid-1990s, congestion levels had grown to a point where congestion was costing the area about USD 400 per capita (the LA/Long Beach area was much higher). With all projections indicating that rail traffic would continue to increase, the objectives of the project were to (in the order listed in the project documents): reduce accidents at level crossings; eliminate rail and highway conflicts that caused highway congestion by constructing 25 rail/highway over grade bridges; eliminate conflicts in rail traffic and reduce rail/rail congestion (freight and passenger) by constructing better connecting points and building 6 rail/rail flyovers; reduce fuel consumption and emissions on rail and highway; reduce highway traffic congestion; re-route rail freight traffic more efficiently; modernise and increase rail capacity to meet future needs; and improve rail connections through the hub area to improve the flows of rail traffic, including international traffic.

Box 5.2. **The CREATE Program** *(cont.)*

The project developers recognised that there is a split between private and public benefits. Project estimates show that the private rail benefits should be worth USD 232 million out of the total project cost of USD 1.534 billion. The railroads have agreed to finance their share, with public funding from Chicago and Illinois making up the balance. Federal funding under the federal highway programme would ultimately finance a significant share of the Illinois share: for example, level crossing elimination would be largely financed with federal funds.

As with the ACTA, CREATE is an *ad hoc* response to a problem that appeared most serious at the local and railroad level. As the project has developed, however, the potential national significance has become clearer. Because of Chicago's role as the critical hub for rail interchanges among the major railways, the pressures for a larger and more direct federal role have grown. Unlike ACTA, however, the railroads are funding their share upfront, rather than trying to develop a payment per wagonload over time (six railroads cannot agree on the charge per wagonload).

Thus far, though the railroad and local shares are relatively secure, the need for federal funding through the state has not been satisfied (FHWA funding for level crossing elimination would be stretched and other states would have to be denied if the Illinois amounts were paid), nor have the proponents been able to generate a more direct federal grant role. At present, only about USD 300 million in funding is firmly committed to the project, roughly equally divided among the railroads, local government and state/federal sources. Despite the difficulties, the criticality of the project is likely eventually to support gradually increased funding along with a more balanced role that would permit the project to proceed in a planned, rather than piecemeal, way.

Though the growth rates of containers were clearly faster than the rest of the dry cargoes, because the bulk cargo demand is driven by underlying economic growth, dry cargo growth in and out of the EU, Australia/New Zealand, and the Asian developing economies is strong. The worldwide rate of tonnage growth of 4.8% between 1990 and 2004, which shows every sign of continuing into the future, would lead to a further doubling of tonnage by 2020. More significantly, it is likely that a higher percentage of the bulk cargo needs rail for port access than do containers, indicating that rail systems and port access facilities will be challenged in many ports that are not critical container facilities. Since many bulk cargo ports are related to specific commodity flows (iron ore in Brazil, coal and iron ore in Australia) this will have implications for private investors as well as public sector finance.

Table 5.9. **Top 20 world container terminals**

Throughput in TEU millions

	2004	2002	Per cent growth 2002-04
1. Hong Kong, China	21.93	19.14	14.6
2. Singapore	20.60	16.94	21.6
3. Shanghai[1]	14.57	8.81	65.4
4. Shenzen[1]	13.65	7.61	79.4
5. Busan (Korea)[1]	11.43	9.45	21.0
6. Kaoshiung	9.71	8.49	14.4
7. Rotterdam[1]	8.30	6.52	27.3
8. Los Angeles[1]	7.32	6.11	19.8
9. Hamburg[1]	7.03	5.37	30.9
10. Dubai	6.43	4.19	53.5
11. Antwerp[1]	6.06	4.78	26.8
12. Long Beach[1]	5.78	4.52	27.9
13. Port Klang	5.24	4.50	16.4
14. Qingdao[1]	5.14	3.41	50.7
15. New York/New Jersey[1]	4.40	3.75	17.3
16. Tanjung Pelepas	4.02	2.67	50.6
17. Ningbo[1]	4.00	n.a.	n.a.
18. Tianjiin[1]	3.81	n.a.	n.a.
19. Laem Chabang	3.62	2.66	36.1
20. Tokyo	3.58	2.71	32.1
Total for top 20	**166.62**	**121.63**	**37.0**

Note: If the flows in Ningbo and Tianjiin are estimated at 3 million TEU in 2002, the growth rate for the Top 20 would be about 31%.

n.a.: not available.

1. Indicates significant dependence on rail access.

Source: UNCTAD (2005), p. 76.

Security issues are becoming more important, especially in the port/landside interface, but also at land borders where rail traffic is significant. The NAFTA borders are facing greatly increased inspections as a result, and the same may be true of the EU borders with CIS and Balkan countries. To the extent that the issue is related to the control of the contents of containers as they are loaded, this is a common problem for all modes, and will not favour or disadvantage any particular mode. To a probably marginal extent, the ability of railways to stack and load containers in a way that retards illegal entry, and to keep containers moving on a defined and controllable path, may act to promote use of railways, especially for potentially hazardous cargo.

Congestion on highways as an opportunity for rail. Highway congestion is an increasingly serious problem in the US and in the EU. Highway congestion in the US was originally an urban phenomenon and is increasingly serious in the major urban *areas* (many of which have ports). Highway congestion is now spreading into the rural parts of the Interstate Highway System (the major network of

Table 5.10. **Exports and imports by world region**

Millions of tons

	1990	2004	Per cent of compound growth
North America			
Petroleum	355.6	725.6	5.2
Dry cargo	742.7	842.3	0.9
Europe			
Petroleum	905.9	642.4	–2.4
Dry cargo	1 245.4	2 536.4	5.2
Japan			
Petroleum	284.4	254.3	–0.8
Dry cargo	668.7	745.4	0.8
Australia and New Zealand			
Petroleum	26.5	53.3	5.1
Dry cargo	284.4	627.5	5.8
South America: Eastern Seaboard			
Petroleum	129.0	247.8	4.8
Dry cargo	349.7	462.7	2.0
Developing countries in Asia			
Petroleum	920.4	1 645.2	4.2
Dry cargo	753.4	2 243.3	8.1
World total			
Petroleum	3 515.7	4 634.0	2.0
Dry cargo	4 618.0	8 911.1	4.8

Note: All dry cargo figures include containers.
Source: UNCTAD (2005), pp. 119-122.

limited access highways commenced in 1956 and essentially completed by the end of the 1980s). Table 5.11 gives a stark picture of the problem, showing that highway traffic density (vehicle miles travelled/lane mile) has increased by 65% since 1980 on the urban parts of the Interstate Highway System, and by 102% on the rural parts of the Interstate System. Of the 19 major port-related urban areas, 14 are officially considered "congested", and most of those are "highly congested".

Highway congestion may, if anything, be worse in many EU countries.[3] For example, the strategy paper of the Association of Train Operating Companies (ATOC) in the UK includes "congestion on the roads" as one of the main factors that will affect growth of rail traffic (freight and passenger) in the future (ATOC, 2005). Unfortunately, ATOC also concludes that congestion at peak times on the *railway* will act to retard rail growth as well. The entire transport system faces capacity issues, and the UK may have to enhance *both* rail and highway infrastructure capacity.

Table 5.11. **US roadway vehicle-miles travelled (VMT) per lane/mile**

By class of highway

	1980	1985	1990	1995	2000	2001	2002	2003	2004
Urban VMT per lane-mile, total (thousands)	613	677	764	810	869	852	861	856	860
Interstate	3 327	3 773	4 483	4 784	5 323	5 370	5 440	5 436	5 479
Other arterials	1 451	1 556	1 751	1 829	1 974	1 997	2 025	2 012	2 019
Collector	572	552	634	686	718	728	743	741	745
Local	146	168	184	181	196	181	188	183	184
Rural VMT per lane-mile, total (thousands)	103	113	136	148	172	176	179	175	174
Interstate	1 031	1 170	1 473	1 693	1 993	2 035	2 080	2 070	2 088
Other arterials	518	555	640	695	778	787	797	780	771
Collector	132	141	164	167	189	192	195	190	189
Local	19	20	23	25	30	32	33	33	32
Index 1980 = 100									
Urban VMT per lane-mile, total (thousands)	100	110	125	132	142	139	140	140	140
Interstate	100	113	135	144	160	161	164	163	165
Other arterials	100	107	121	126	136	138	140	139	139
Collector	100	96	111	120	125	127	130	130	130
Local	100	115	126	124	134	124	128	125	126
Rural VMT per lane-mile, total (thousands)	100	110	132	143	167	171	174	170	169
Interstate	100	113	143	164	193	197	202	201	202
Other arterials	100	107	123	134	150	152	154	150	149
Collector	100	106	124	126	143	145	147	143	143
Local	100	105	120	131	159	167	175	171	170

Source: 1980-94: US Department of Transportation, Federal Highway Administration, *Highway Statistics Summary to 1995*, FHWA-PL-97-009 (Washington DC, July 1997), Table VM-202.

1995-2004: US Department of Transportation, Federal Highway Administration, *Highway Statistics* (Washington DC, Annual issues), Table VM-2; Internet site *www.fhwa.dot.gov/policy/ohpi* as of 18 January 2006.

Lane-miles:

1980-95: US Department of Transportation, Federal Highway Administration, Office of Highway Information Management, unpublished data, 1997, Table HM-260.

1996-2004: US Department of Transportation, Federal Highway Administration, *Highway Statistics* (Washington DC, Annual issues), Table HM-60. Internet site *www.fhwa.dot.gov/policy/ohpi* as of 18 January 2006.

Urbanisation is also impeding metropolitan rail freight flows in a number of major urban areas. A good example is the Chicago area, where rail freight flows through the city are slowed by level crossings with high amounts of highway traffic, awkward connections among the various railroads (Chicago is a major interchange point between the two major western railroads – UP and BNSF – and the two major eastern railroads, NS and CSX), and a lack of sufficient space to develop adequate marshalling yards in the urban areas. The response, the so-called CREATE Program (see case study in Box 5.1) is a proposed federal, state, local and private railroad project which will improve rail to rail connections, eliminate level crossings, and decongest the interactions among the local suburban rail agency (RTA), Amtrak passenger trains and the freight trains of the five or more freight rail companies in the Chicago area.

Rising energy costs. Rail freight consumes less energy per ton-km than trucking (a balance that varies from area to area, depending on both railway and trucking efficiency and technology). In general, then, rail's competitive position in freight markets will be enhanced *vis-à-vis* trucking, and rail traffic should increase if the costs of petroleum fuels remain high. The significance of the impact of rising fuel prices is not entirely clear, though, given the fact that trucking has a competitive advantage in markets where service quality is a factor. The effect will be to raise the value of cargo for which rail becomes competitive, but the actual effect on rail revenues and traffic is difficult to judge.

Government efforts to shift traffic from road to rail. Many countries within the EU, as well as the EC, have an explicit policy to shift freight and passenger traffic from highway to rail in order to reduce highway congestion and to achieve a number of desired social benefits such as reduced pollution and CO_2 emissions (freight railways consume less than one-third the energy per ton-km than do trucks),[4] improved safety (US fatalities per ton-km for rail freight are one-tenth the rate for heavy trucks),[5] and changes in urban design (both the Alameda Corridor and the CREATE projects are aimed at consolidating urban facilities and releasing land for better use), etc. In fact, the EC has set an explicit goal of raising the rail market share in freight from 8% of ton-km to 15% of ton-km. The tools for doing so in the rail sector appear to be to:

1. Encourage that rail access charges be set at incremental cost.
2. Foster adequate investment and maintenance of the EU rail infrastructure.
3. Separate the accounts of freight and passenger operators in order to ensure that freight operators are not asked to cross-subsidise passenger losses from freight profits (a policy that is clearly in operation in most of the eastern European railways, and the Russian Federation).

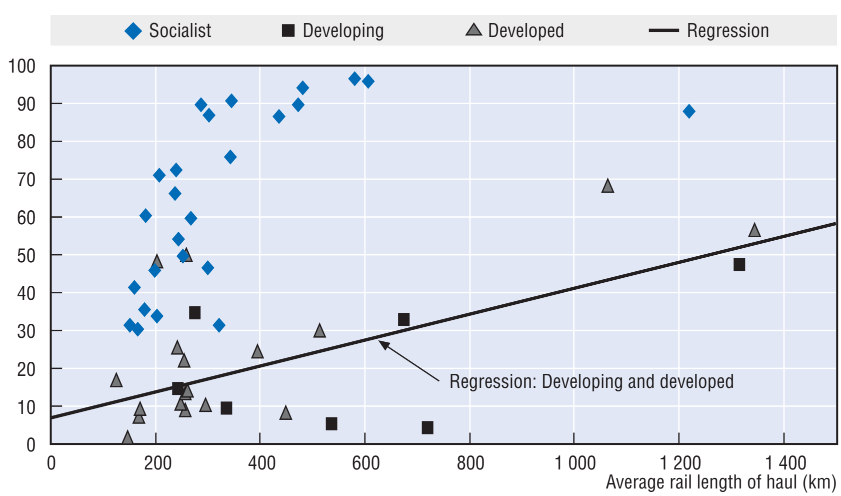
There are few other countries or country groups that have an explicit strategy to promote a shift to rail from highway. In fact, though US freight regulatory policy is now nominally "balanced", the actual financial role of the US government heavily supports large trucks and barges (prior to the rail and trucking deregulation, US regulatory policy also heavily favoured trucks and barges, because of a deeply rooted political perception of railways as "public be damned" monopolists). Fortunately, both the US and Canada have eliminated cross-subsidy from freight to passenger through creation of nationally funded rail passenger companies (Amtrak and VIA) that receive government support to cover operating losses and that pay access charges for use of private freight tracks. Current policies favouring rapid construction of highways in China may also have the effect of shifting the modal balance toward highways: but, given the trends in the Chinese economy toward higher valued products, especially for export, some shift away from overdependence on rail may well be rational. Indeed, the rail freight market share in China has been falling for many years: from 72.3% in 1971 to 47% in 1981 to 39.2% in 1991 to 30.6% in 2001 (ton-km share).

Figure 5.3 illustrates the same problem in many of the eastern European countries and the Russian Federation. Prior to the transition from socialism, many of these countries probably had *too much* rail freight traffic, partly because of over-industrialisation that produced too much bulk traffic, and partly because socialist planners, lacking a full appreciation for logistics costs (as opposed to transport costs alone), tended to overemphasise dependence on rail in the transport sector. As a result, the formerly socialist countries had a rail freight share that was inefficiently *high*. As these countries make the shift to market economies (some are further along than others, but none have completed the shift), rail freight market shares will inevitably need to fall – and *should* fall. The major limitation on this trend will be the availability of alternative modes, primarily trucking.

Despite the EC's desire to shift some freight traffic from highways back toward rail, the actual trend has been in the opposite direction, from about 21% in 1970 to 8.4% in 1998 (EC, 2001). As Figure 5.3 suggests, rail freight market shares will be under strong pressure to fall in the central and eastern countries that are EU members (and prospective members). This raises the question as to whether the EC can actually do anything that will achieve its objective.

Figure 5.3. **Rail share of rail + truck traffic (%) *versus* average rail length of haul**

1998



Source: ECMT (2001), "What Role for the Railways in Eastern Europe?", Round Table 120, OECD, Paris, p. 59.

The US example appears positive. As a result of years of unbalanced and intrusive tariff and entry/exit regulation, the market share (ton-km) of the US freight railroads had fallen from 56.2% in 1950 (just before the start of the Interstate Highway System construction) to a low of 37.5% in 1980, just before deregulation. In 1981, the transport regulatory system for trucks and railways was fundamentally changed, removing most tariff and entry/exit regulation from railways and trucks. As a result, railways were essentially free to set tariffs in accord with demand. They are free to sign confidential contract tariffs with shippers in which shippers can invest in unloading facilities and specialised freight rolling stock in return for tariff consideration. Since 1980, the US rail freight market share has increased to over 42%, and is at least stable if not climbing slowly. It deserves emphasis, however, that the change was only *regulatory*: there was no change in the fundamentally unbalanced federal and state financial support for heavy trucks.

A recent study analysed the question of increasing rail freight market share in the EU (see Vassallo and Fagan, 2005). Vassallo and Fagan argue that it would be unrealistic to expect that the eight per cent existing market share of the EU rail freight railways could ever be lifted to the North American levels, for several reasons:

1. The role of water transport is inherently higher in the EU than in North America.
2. Distances are greater in North America than in Europe (though this disparity can be reduced by further reducing the boundary effects of the existing infrastructure and operating companies).
3. The commodity mix in North America (high percentage of coal and grains) is more conducive to rail than the merchandise-dominated commodity mix that prevails in most EU railways.

After accounting for these differences, they do argue that the market share in the EU could be doubled – from eight to fifteen per cent (reaching the Commission's goal) if several policy goals are implemented:

1. Increased interoperability and training.
2. Balancing the need for passenger and freight train access to the network (essentially upgrading the priority that freight should have).
3. Enhancing infrastructure (added track and signalling) to make more capacity available to freight.
4. Promoting competition for freight (through encouragement of more effective access to the network by competing rail freight companies).

It is fundamental to emphasise that market forces acting upon private (or, at least, commercial) enterprises are the main driver of the demand for freight transport, and for the rail mode within the freight transport sector. As a result, the main battle for rail market share will be fought where it should be fought, in the transport market place. Governments can and will influence this market, but for the most part this influence should be aimed at providing a reasonably level playing field, without distorted support or hindrance to any mode. Second, governments can also influence market share by clearer identification of social needs that the market cannot or will not provide – congestion, safety and environmental impacts.

3.2. Where and how will rail freight infrastructure grow?

Rail infrastructure will "grow", but the definition of the term needs careful discussion. As discussed above, freight "capacity" does not directly relate to kilometre of rail lines. As Figure 5.1 showed, a kilometre of rail line can produce vastly different amounts of freight traffic. In fact, as will be discussed below, there is a nearly unlimited list of influences on the output of rail lines, each of which has a cost and an impact, and many of which interact or even conflict. For this reason, it is probably better to ask where the *investment* in rail infrastructure for the purposes of increasing the ability handle rail freight traffic will be. In this approach, "investment" will include not only kilometres of new line, but also all sorts of measures to increase freight throughput, including adding new track to existing lines (double- or triple-tracking, new signals, electrification, freight depots and yards, interoperability measures, and a host of productivity measures to be discussed below.)

Table 5.12 summarises the data from Table 5.2 to show, for the countries and groups developed, what the growth in rail ton-km and passenger-km will be between 2005 and 2035. The table also shows the percentage of freight and passenger traffic growth that can be attributed to each country or regional groupings, and it shows the percentage of the growth in each country that is freight traffic as opposed to passenger traffic (assuming that Traffic Units – the sum of passenger-km and ton-km is a useful measure of total traffic).

Table 5.13 restates the value of investment in railways presented in Stambrook (2006). Unfortunately, the country groupings are not the same in the IEA report (2003), and the data do not exist to make them entirely consistent. That said, at least some of the groupings (and individual countries) are the same, and some significant comparisons can be drawn. The calculations and amounts in both tables must be taken with a distinct "grain of salt", and quantitative inferences are probably impossible to draw. Nevertheless, it is intriguing to note, for example, that 76% of China's traffic unit (TU) growth will be in freight, and that China will be the fastest growing railway in the world in absolute terms (freight *and* passenger).The top four groupings (China, US/Canada, the Russian Federation and India) account for 88% of the freight traffic growth and 72% of the passenger traffic growth in the world. Adding Japan and the EU OECD countries to the passenger category brings the passenger percentage to 86%, and the freight

Table 5.12. **Growth in rail traffic from 2005 to 2035**

	Absolute growth 2005-35		Per cent growth 2005-35		Per cent absolute freight traffic growth	Per cent absolute passenger traffic growth	Per cent absolute growth as freight
	Ton-km	Pass-km	Ton-km	Pass-km			
China	2 206 569	691 405	142.7	135.8	35.2	35.5	76.1
US and Canada	1 649 601	13 752	62.7	27.5	26.3	0.7	99.2
Russian Federation	1 134 617	134 212	85.5	73.3	18.1	6.9	89.4
India	504 982	567 903	142.7	116.0	8.1	29.2	47.1
Non-Russia CIS	304 377	50 702	73.3	56.1	4.9	2.6	85.7
Eastern Europe, Turkey	135 690	36 430	93.3	51.6	2.2	1.9	78.8
Africa	92 052	5 041	73.3	27.5	1.5	0.3	94.8
European OECD countries	71 020	134 950	27.5	42.3	1.1	6.9	34.5
Latin America	65 169	3 918	51.6	27.5	1.0	0.2	94.3
Pacific OECD countries	53 401	133 271	32.6	51.6	0.9	6.8	28.6
Middle East, North Africa	24 009	83 251	73.3	93.3	0.4	4.3	22.4
Other non-OECD Asia	23 403	90 730	69.1	93.3	0.4	4.7	20.5
Total world	**6 264 890**	**1 945 564**	**87.5**	**88.9**	**100.0**	**100.0**	**76.3**

Source: IEA (2003), ETP Transport Model, Spreadsheet version 1.28.

grouping to 90%. Overall, Table 5.12 suggests that about 76% of the growth in railway TUs will be in freight. Though it would almost certainly be inaccurate simply to multiply the traffic growth percentages in Table 5.12 by the investment percentages in Table 5.13, it seems reasonable to argue that at least half, and maybe more, of the investment predicted in rail construction over the 2000 to 2030 period will be for addition of *freight* infrastructure capacity.

Of course, we know more than just these general percentages. Some countries have announced significant initiatives for investment that furnish more specific values.

China, for example, has announced a USD 220 billion programme between 2005 and 2020. This will include increasing the size of the network from 70 000 km to 100 000 km, increasing electrification and double tracking to at least 50% of the network, and construction of around 7 000 km of new, dedicated passenger lines. Of these, at least one (Beijing to Shanghai) will be designed for 300-plus km/hour speeds, and one is said to be a candidate for magnetic levitation. There is little doubt that the current traffic density of the Chinese network would support such a network. The challenge will be so see how to finance the additions, since the earnings of the railway alone will not support the required investment.

The Indian government has announced a proposal to construct all new, high axle load, dedicated freight lines to link Mumbai with New Delhi and Calcutta. The total cost of the project is currently estimated at EUR 3.6 billion.

Table 5.13. **Rail construction forecast**

USD billions

	2000 asset value	Construction value 2000-30	2030 asset value
High income industrialised	468.5	1 069	900.8
G7	329.7	679	583.2
United States	93.4	203	180.8
Japan	78.5	103	97.8
Germany	43.8	120	95.9
United Kingdom	24.8	54	44.9
France	28.0	78	61.6
Italy	46.3	83	72.0
Canada	14.9	37	30.2
Other – OECD	111.4	310	248.8
Europe and central Asia	84.0	246	194.1
East Asia and Pacific	22.0	46	39.4
North America (Mexico)	5.4	18	15.3
OECD industrialised	441.1	988	832.0
Non-OECD	27.4	82	68.8
East Asia and Pacific	1.6	15	12.5
Europe and central Asia	5.8	10	8.7
Latin America and the Caribbean	10.8	33	26.8
Middle East and North Africa	0.7	8	6.9
South Asia	–	–	–
Sub-Saharan Africa	8.6	16	13.6
Big Five	100.3	405	322.3
China	28.8	231	171.9
India	19.0	62	52.9
Brazil	7.4	30	24.3
Russian Federation	43.6	70	64.1
Indonesia	1.6	11	9.0
Developing	62.6	132	119.7
East Asia and Pacific	3.5	22	18.3
Europe and central Asia	30.5	43	39.8
Latin America and Caribbean	5.3	15	12.6
Middle East and North Africa	9.0	26	23.4
South Asia	4.1	14	13.0
Sub-Saharan Africa	10.3	13	12.6
World	**631.4**	**1 606**	**1 342.8**

Source: Stambrook (2006).

These lines are justified based the congestion on the existing lines, mainly caused by interactions between freight and passenger trains. The question here will be to see whether a more rational policy might be simply to raise the prices on the existing regional passenger services (which cause the congestion on the passenger/freight lines), and thus free up freight capacity.

The EC has announced a EUR 200 billion plan for upgrading the main passenger and freight lines in the EU (see case study on the TEN-T network in Box 5.3). The freight share of this amount is not clear, but is at most only a part of the EUR 105 billion allocated for conventional speed projects. The relative priority of passenger services *versus* freight services on the upgraded system is also not at all clear.

The US freight network is approaching an unacceptable level of congestion, primarily because freight traffic growth has, for the past 30 years, been matched by a determined effort to reduce unnecessary investment in rail trackage. Figures 5.4, 5.5 and 5.6 show the result of increasing rail traffic combined with shrinking network size: freight traffic density has more than tripled since the Staggers Act deregulation in 1981, and has more than quadrupled since the creation of Amtrak in 1971.

Figure 5.7 shows the impact: the freight railroads were able to manage the increases in density until about 1990. Since then, there has been a 20% deterioration in train speeds. Increased output since 1990 has been achieved in the face of increasing congestion and at the cost of decreased productivity of rolling stock and increased labour costs.

Coal flows out of the Power River Basin in Wyoming are of great significance; but, the high density flows from the Los Angeles/Long Beach area through Chicago and onward to the East Coast reflect the importance that rail container flows play in the output of the network. In terms of container traffic, West Coast to East Coast connections via Chicago are of great importance, as previously noted. These container flows are not balanced, however, so there is a net flow of empty containers from east to west that balances the predominantly loaded flows from west to east.

The issue in the Russian Federation is not specifically capacity, since the railway carried more traffic in 1988 than it is likely to carry anytime in the reasonable future and there are no present indications of line congestion. Instead, the issue is rehabilitation of a network that has operated for years without investment. The new Russian railway company (OAO RZhD) has reasonably healthy earnings, and has plans to rectify the infrastructure deficits either from earnings or from targeted government assistance. Significantly, the approach to obtaining new freight wagons is heavily dependent on ownership of new wagons by shippers or operators[6] rather than by OAO RZhD. As of now, over 30% of the Russian freight wagon fleet is privately owned, and the railway expects this percentage to rise to over 50% within the next few years.

None of the plans discussed above can be entirely financed from internal funds generation (though the US, Canada and the Russian Federation may come close on the infrastructure side). In all cases, outside financing (government, or other private investors in the case of freight wagons) will be

Box 5.3. **TEN-T rail programme**

The European Commission has long recognised that transport is critical to economic development and to the geographic integration of the members of the EU. The issues and problems of transport co-ordination have increased with additions of new countries to the EU, with a quantum jump when the EU increased its membership from 15 to 25 in 2005. In addition, the Commission is also concerned with promoting better connections between the EU and the countries adjoining it, and beyond.

The trans-European transport network (TEN-T) was developed in order to identify and alleviate problems limiting the free flow of passengers and freight within the Union. TEN-T covers highways (89 500 km), railways (in total 94 000 km of which about 20 000 km are to be higher-speed passenger lines operating at 200 km/hour and above), inland waterways (11 250 km) and 366 airports. The target for completing the TEN-T network improvements is 2020, although the approach contains a large number of specific corridors and investment components, some of which are already underway or completed.

The challenge is to meet demand for rail freight transport that is expected to grow by two-thirds by 2020 within the old EU15, and to double within the new member states. There will be a corresponding increase in passenger flows as well. The TEN-T programme in total is expected to reduce road congestion by 14% and to improve rail flows, a benefit that is estimated at EUR 8 billion annually. The Commission found that without TEN-T, the rate of growth in the EU would be slowed, and CO_2 emissions would increase. The total investment remaining to complete the TEN-T projects is estimated at EUR 252 billion (the total cost of all projects, including the non-priority axes, would total more than EUR 600 billion). The sources of finance for these projects could include direct funding from member states, EIB loans, ISPA, ERDF and Cohesion funding, as well as the TEN-T budget. As a supplement, the TEN-T programme looks to PPP projects, but recognises that these can never be more than about 20% of the total funding, and that making PPPs feasible will require new legislation to create a better investment climate for the private sector.

The specifically rail part of the TEN-T programme will include projects covering 19 271 km of line, and could cost about EUR 200 billion by current estimates (see Table 5.14 below). The entire panoply of rail projects will take until 2020 to complete although, as noted, some of the projects are already finished or are underway. As the table below shows, EUR 83.9 billion are to be used for solely passenger projects, EUR 10.7 billion are to be allocated for solely freight projects, and the remainder (EUR 105.6 billion) will be spend on projects that are at least nominally to benefit both freight and passenger services. Of the joint projects, it is difficult to allocate money as between freight and passenger; but, it seems safe to assume that a predominant share of the EUR 105.6 billion would benefit rail freight only peripherally, by way of moving some passenger traffic off combined lines and thus hypothetically creating more capacity for freight.

Box 5.3. **TEN-T rail programme** *(cont.)*

Table 5.14. **The TEN-T rail programme**

Priority axis	Description	Completion	Km line	Total cost EUR million	Spent to Dec. 2004 EUR million	Passenger or freight use
1.	Berlin-Vienna/Milan-Bologna-Naples-Messina-Palmermo	2007-15	1 798	45 611	13 232	Both
2.	Paris-Brussels-Cologne-Amsterdam-London	1993-2007	510	17 457	14 777	Passenger
3.	High Speed Rail Axis – France/Spain/Portugal	1998-2015	2 956	39 730	7 352	Passenger[1]
4.	High Speed Rail Axis East Luxembourg-Paris-Mannheim	2002-07	510	4 373	1 534	Passenger[1]
5.	Betuwe Line	2004-06	160	4 685	4 130	Freight[2]
9.	Cork-Dublin-Belfast-Stranraer	2001-05	502	357	357	Both
11.	Øresund fixed link	2000	53	4 158	4 158	Both
12.	Nordic Triangle rail/road axis	1995-2015	1 998	10 905	3 222	Both
14.	UK West Coast Main Line	1994-2008	850	10 866	9 680	Both[3]
16.	Freight rail axis Sines-Algeciras-Madrid-Paris	2006-20	526	6 060	0	Freight
17.	Railway axis Paris-Stuttgart-Vienna-Bratislava	1990-2015	882	10 077	2 396	Both
19.	High-Speed Interoperability Iberian Peninsula	2001-20	4 687	22 313	2 485	Passenger[1]
20.	Fehmarn belt railway axis (Hannover-København)	2006-15	448	7 051	4	Both
22.	Rail axis Athens-Sofia-Budapest-Vienna-Prague-Nuremburg-Dresden	2005-16	2 100	11 125	0	Both
23.	Rail axis Gdansk-Warsaw-Bratislava-Vienna	2005-15	1 291	5 488	852	Both
Total			**19 271**	**200 256**	**63 179**	

1. Also may release conventional line capacity for freight.
2. Specifically intended to serve the port of Rotterdam for distribution into the EU. Capacity: 74 million tons.
3. Mostly passenger objectives.

A later effort has been made to develop an analogous programme for improving the rail connections between the EU25 (Cyprus and Malta have no railways) and the 26 adjoining countries of the CIS, Middle East and North Africa. Traffic volumes between the EU and these countries are expected to double by 2020, with rail playing a major role because of the huge distances and inferior highway network in many of the CIS countries (and the Russian Federation in particular). This programme would have the added benefit of improving the longer-range connections with Asia. The total cost of this programme has been estimated at EUR 45 billion spread over five corridors, though this must be considered at most a rough estimate of such a massive programme extending over 20 years or longer, and hypothecated on improved relations and co-operation among a large number of countries. There is no separation of the programme as between rail and other modes.

Box 5.3. **TEN-T rail programme** *(cont.)*

Significantly, the extension programme puts a major emphasis on technical and institutional issues. Technical issues (interoperability and communications) are likely to be easier (though more costly) to resolve than the institutional issues (border formalities, common legal regimes for freight, etc.).

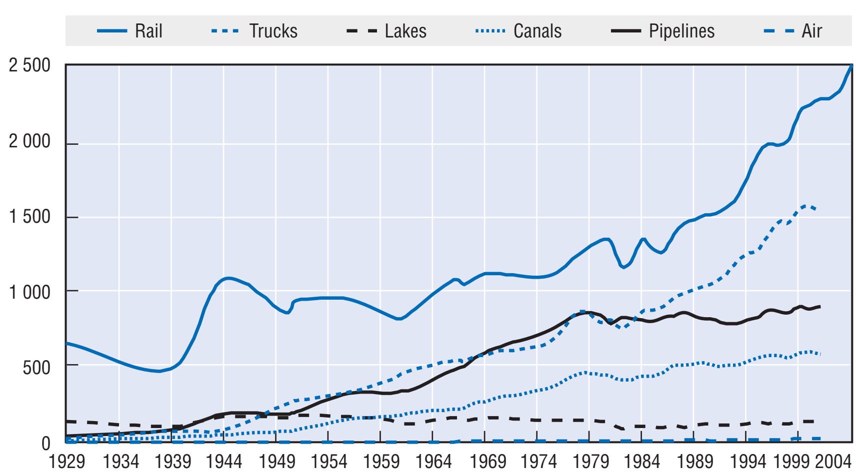
Overall, and in contrast with the US cases, national and EU government inputs dominate the TEN-T programme, with little direct participation by local governments or the private sector. A specific problem that has long accompanied the rail freight planning is that the networks to be improved are being planned by state-owned entities that are far more interested in infrastructure investment and passenger service than they are in freight services. This poses the clear risk that the "freight" investment may well go to the wrong place and for the wrong reasons, especially if the private sector eventually takes a larger role in the EU in operating freight services.

Also by contrast with the US cases, the TEN-T programme is heavily oriented to long range, comprehensive planning with a very limited role for *ad hoc* approaches. High-level planning has the advantage of ensuring coherence at the system level, but it often suffers for lack of direct contact with the actual users of the facilities.

It is unlikely that the full, ambitious TEN-T programme can be financed as planned, because the member governments may well not agree to support the EC's plans fully. For this reason, the EC is now focusing its effort on high priority and bottleneck segments of the proposal. It seems likely that actual financing will run 50-70% of plans. The effect of cutbacks on the specific modal plans is hard to predict though we might speculate that the brunt of rail sector reductions would fall more heavily on freight than on passenger investments.

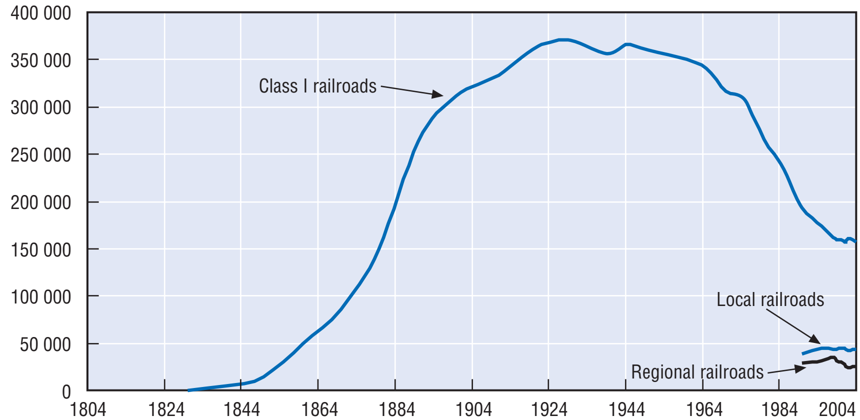
Figure 5.4. **Ton-km in the US by mode**

In millions of ton-km



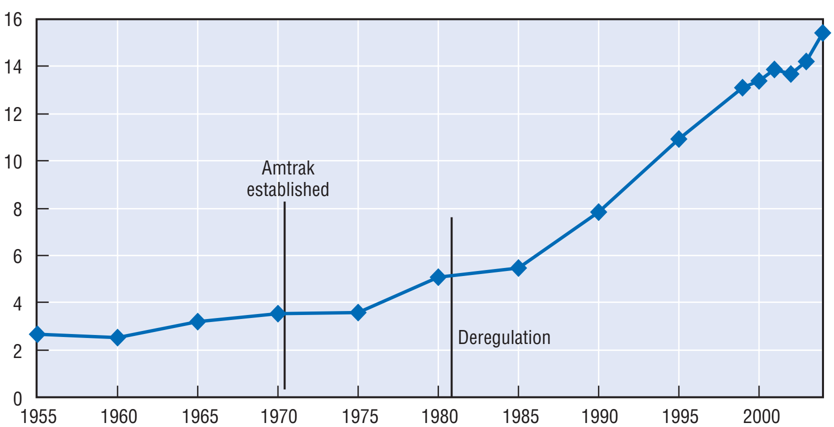
Source: AAR (2005), *Handbook of Railway Facts 2005*.

Figure 5.5. **Km of rail line in the US**



Source: Author based on AAR (2005) and US STB (various years).

Figure 5.6. **Ton-km/km on US Class I Railroads**



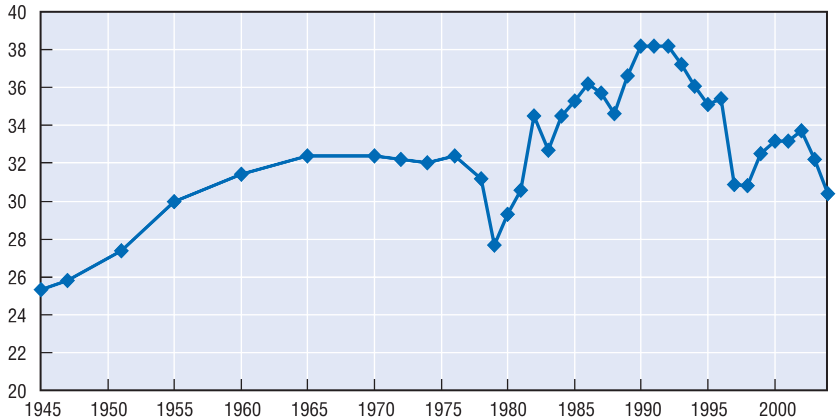
Source: US STB (various years).

critical. Finding and developing these outside sources will require a rebalancing of the railway and public finance roles (with the public sector including both national and local/regional governments).

Though there is no way to reach a fully quantitative estimate of the splits of the above rail freight infrastructure investment estimates as to geography and to type of facility, some speculation is at least possible. First, if the Chinese and Indian expansion programmes proceed, and if the TEN-T programme is actually funded, then the largest part of *public* investment benefiting rail freight infrastructure is likely to be made in China, India and the EU member states. There will clearly be private freight rail infrastructure investment in North

Figure 5.7. **Average US freight train speed**

Km/hour



Source: US STB (various years).

America, but (without dramatic changes) there is not likely to be more than a 20-30% increase in the USD 7 billion average capital investment programme of the Class I railroads over the past 10 years. There are no significant prospects for major rail freight infrastructure programmes in Latin America, Africa, the Middle East and Asia (aside from China and India), though Brazil may be an exception if iron ore and soy export markets remain strong. Second, again with the possible exception of China and India, most of the foreseeable investment in rail freight infrastructure capacity will not be in new lines, *per se*. Instead, most investment will be in adding capacity to existing lines through double tracking, signalling, and electrification. Information management techniques for signalling and train controls as well as machine-aided dispatching will also be important.

Though not actually part of infrastructure, significant increases in line capacity will also be realised through enhancing the capability of locomotives and freight wagons (higher horsepower, improved tractive effort, higher net-to-tare ratios, etc.) and more effective management of capacity (unit trains, greater length of haul, reduced changes of locomotives, etc.). Finally, it is clear that port/inland transport network interfaces (port access from/to the land side) are going to be an increasing challenge, especially on the West and East Coast of the US (and in Chicago), the ports of Rotterdam and Hamburg, and the major ports of Asia (particularly China). Whether the port access issues are treated as a port problem or a rail (and highway) problem is harder to predict; but, it is clear that a significant amount of investment will be needed to reduce the impedance at the interface.

It is also possible that the Trans-Siberian route across Russia will develop into a significant actor in container transport from Asia to Europe. Whether this will actually happen or not depends on the management model that the Russian Railway eventually adopts and on the availability of capacity on the Trans-Siberian route for containers in competition with the enormous volumes of coal that the Russian government also expects to move from Siberian mines to eastern and western destinations. It is less likely that the other Asia to Europe rail "Silk" routes (via China-Kazakhstan-Russia, or China-Kazakhstan, Kyrgyzstan, Uzbekistan, Turkmenistan, Iran, and/or Turkey) will ever develop significant traffic, partly because of distance and gauge changes, and partly because of managerial and political complexity.

3.3. How can productivity be improved?

In general, productivity improvements rest on two factors: technology and economics.

Technological factors to improve freight rail productivity. There are many ways in which the "productivity" of freight rail infrastructure and operations can be enhanced, and there are a number of examples of freight railways in the world that illustrate these opportunities.

Increasing freight wagon (the North American term for freight wagon is freight car) cargo capacity is an important alternative because line capacity goes up directly with wagon size. For example, the maximum freight wagon loading in the US increased from 63.5 tons in the 1970s, to 90.7 tons in the 1990s. On selected lines, the maximum wagon loading can now rise as high as 113.4 tons. Since 1970, the *average* wagon load has risen from 54.9 tons to as high as 67.7 tons (in 1985) but has declined slightly since due to an increase in merchandise (as opposed to bulk) traffic. Table 5.15 shows the range of average wagon loadings in a number of railways for which the data are available.

Increasing freight train loading is another important option, at least up to the point that the length of the train might exceed the length of the passing sidings to be used (and assuming that the tractive effort assigned to the train, and the braking distance, are within the design plans of the signal system). Table 5.15 also shows the range of variation in train loading for a number of selected countries. To be precise, train loading is related to both the train length and the maximum load per wagon.

When wagon weights go up, then the maximum axle load goes up as well. It is the axle load that ultimately determines the strength needed in the infrastructure (rail, track structure and bridges), and increased axle loads cause increased track maintenance, with greatly increasing effect on mixed freight and passenger lines. At the same time, improvements in rail metallurgy have significantly reduced rail wear even when axle loads have risen. Maximum axle

Table 5.15. **Average wagon loading and train loading for selected railways, 2004**

In tons

	Railway	Wagons loaded	Tons loaded	Average wagon load	Average train load
AUT	ÖBB	2 356 630	90 569	38	357
BEL	SNCB/NMBS	1 529 358	69 040	45	408
CZE	CD	2 018 994	86 816	43	418
DEU	DB AG	6 839 397	269 884	39	343
FIN	VR	1 055 630	42 700	40	578
FRA	SNCF	2 991 561	117 415	39	348
HUN	MAV	1 346 342	45 270	34	419
ITA	FS	2 214 005	83 087	38	360
LTU	LG	802 411	45 555	57	1 334
LVA	LDZ	865 438	51 058	59	1 600
POL	PKP	3 495 452	163 488	47	615
PRT	CP	263 723	11 151	42	296
SVN	SZ	273 157	17 856	65	359
SVK	ZSSK	1 145 838	49 756	43	575
CHE	SBB CFF FFS	2 035 122	57 940	28	322
BGR	BDZ	429 310	20 387	47	401
ROU	CFR	2 758 919	62 771	23	485
TUR	TCDD	475 541	17 708	37	n.a.
IRL	RAI	516 586	29 453	57	n.a.
MAR	ONCFM	580 525	32 901	57	n.a.
CAN	Total Canada	5 359 972	251 746	47	n.a.
USA	AAR Class I	30 094 796	1 673 023	56	2 716
CHN	CR	n.a.	2 178 160	n.a.	2 565
IND	IR	n.a.	557 390	n.a.	1 288
JPN	JR	9 122 000	37 056	4	n.a.
RUS	RZhD	n.a.	1 229 000	n.a.	2 041

Source: International Union of Railways (UIC), *International Railway Statistics*.

loads can rise as high as 35.7 tons in the US, compared with 25 tons in the Russian Federation and 22.5 tons in most of the EU. On HSR lines, the maximum axle load is often restricted to 17 tons.

Enhanced signalling increases productivity by increasing traffic density (more train-km/line-km). Conventional methods of enhanced signalling are closer signal spacing, multiple-aspects (allowable speeds), centralised traffic control, and others. More recent innovations include versions of positive train control (PTC or ERTMS) and even "moving block" signalling in which train speed and spacing are determined by the schedule and by the characteristics of each train.[7] These types of signalling are dependent on methods of position determination (GPS, Galileo or other), clear and totally reliable digital communications, and computer-based control systems. The economic benefits of these newer systems also include other significant productivity gains and cost reductions such as better energy management, improved equipment condition reporting (reducing maintenance cost and improving reliability and availability), reduced energy consumption through better train speed management, and reduced crew costs (potentially through enabling a reduction in crew levels). All of these systems will improve the safety of operations significantly beyond the already safe levels of today.

Modern locomotive designs, including traction slip/slide controls (especially the switch from DC to AC traction), are reducing energy consumption significantly and improving output per locomotive. As an example, ton-km per litre of fuel has improved by 75% between 1980 and 2004 in the US. Class I railroads (AAR, 2005) and ton-km per installed locomotive horsepower increased by 53% over the same period (US STB, various years).

There are a number of operating techniques that yield improved freight productivity. The use of unit or block trains, for example, significantly improves the productivity of wagons, locomotives and labour. As a result, many EU railways have simply abandoned single wagonload traffic in favour of block trains (or, at least, multiple wagonload shipments). Dedicated unit trains offer another level of improvement because the rolling stock can be specialised for the service, and is often owned by the shipper rather than the railway. Dedicated, shipper-owned wagon fleets have long been the norm in tank wagons, but are now becoming common in many bulk commodities (such as coal for utility power plants) and specialised commodities (automobiles, finished steel, etc.) in North America, the EU and the Russian Federation.

A good example of a consolidated shopping list to enhance capacity is found in ATOC, 2005. Although this list is heavily passenger influenced, it does involve freight, and has most of the same elements to be found in any capacity enhancement programme. It includes:

- De-bottlenecking.
- Lengthening trains.
- Squeezing more train paths by better scheduling and control.
- Increasing equipment reliability.
- Increasing track capacity.
- Avoiding removing track or scrapping of rolling stock.
- Reducing the number of unproductive trains.
- Analyzing and employing world wide best practices.

Data on trends in improved productivity. Calculating and comparing railway freight productivity is notoriously difficult. Most important, the balance between passenger service and freight service affects all comparisons. The traditional approach – using the linear sum of passenger-km and ton-km to represent output – is at best an approximation (Transport Reviews, 2003, pp. 7-13). Analyses have suggested, for example, that passenger-km are far more labour intensive than ton-km. With this caveat in mind, Table 5.16 shows selected measures of railway productivity and its growth between 1980 and 2003. This table leaves no doubt that railways have worked hard to improve productivity, both of labour, infrastructure and freight wagons. Locomotive and coach productivity is not calculated because the use by some railways of independently powered coaches (called diesel or electric multiple unit equipment) makes passenger locomotive productivity calculations questionable.

The case of the US freight railways is particularly instructive because passenger service plays an insignificant role in the network and because the railway accounts make a complete separation between passenger and freight. It is therefore possible to look directly at freight railway productivity without confusing the impact of passenger service. In addition, the US case holds special interest because the railways were deregulated in 1981 and thus furnish a particularly interesting "before and after" illustration of the impact to a change in incentives and the management model. Moreover, the data are good enough to permit calculation of output trends per ton of wagon capacity (and not just per wagon, which is distorted because wagons were getting larger) and per installed horsepower in the locomotive fleet (locomotives were getting larger also).

Figure 5.8 shows the results of deregulation in the US – dramatic improvements in the productivity of all aspects of the industry. Figure 5.9 shows the results of the improvement from the point of the user of the system – equally dramatic reductions in the cost of rail freight and of the prices charged to the shipper. Table 5.5 showed a similar improvement after the concessioning of the Latin American railways.

Management models will also have a significant effect on productivity, both on determining how technology is employed to improve productivity and on how the required investment in infrastructure capacity will be financed. The US Class I railroads and the Canadian railroads have shown what the private sector can do in meeting commercial demand if the government policy framework is not impossibly biased. But the limits to this model are becoming clearer as the congestion throughout the US transport network (caused, in part, by flaws in the federal financing approach) grows. The role of the public sector in financing private rail freight capacity improvements seems certain to grow, and the Alameda and CREATE projects are one possible model for a more general approach.

The railway in China shows what a purely publicly owned railway can do with adequate financing within a socialist, planning context: this model, too, is showing signs of strain in the face of a need for rapid growth in the socially-driven parts of the system combined with a tariff policy that holds tariffs too

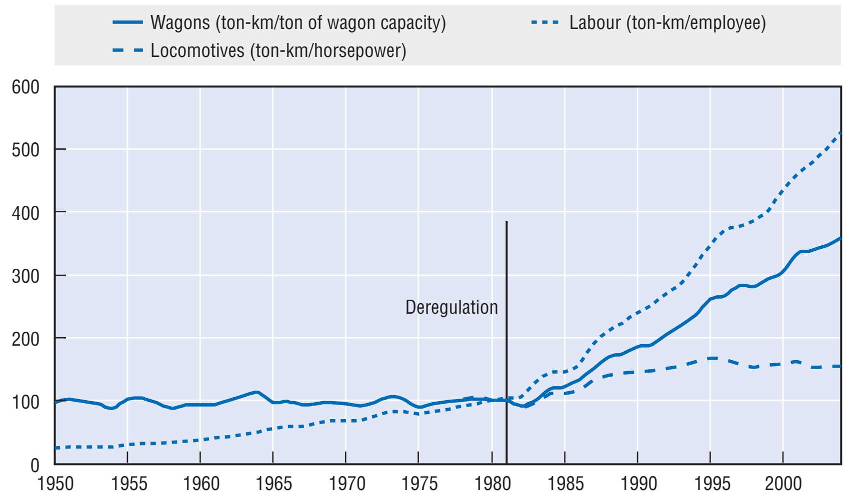
Table 5.16. **Railway productivity trends, 1980 to 2003**

	Traffic units (TU)/employee)			TU/km of line			Ton-km/wagon		
	1980	1990	2003	1980	1990	2003	1980	1990	2003
Argentina	227	211	2 530	643	537	420	213	233	430
Bolivia	158	129	1 060	327	251	300	283	265	310
Brazil	500	550	5 400	1 900	1 600	2 680	600	700	1 380
Mexico	591	501	2 500	3 278	2 052	2 800	948	781	2 070
South Africa	430	989	3 906	4 219	5 333	5 325	522	649	926
Bulgaria	335	342	226	5 654	5 100	1 804	n.a.	333	306
Czech Repbulic	n.a.	300	306	n.a.	n.a.	2 479	n.a.	n.a.	375
Slovak Republic	n.a.	300	337	n.a.	n.a.	3 400	n.a.	n.a.	422
Hungary	276	219	348	4 937	3 662	1 923	352	267	353
Poland	516	398	490	6 580	5 104	3 369	n.a.	650	427
Romania	537	355	339	9 146	7 740	2 267	620	397	256
Turkey	190	290	602	1 348	1 697	1 666	217	386	511
FYROM	210	186	127	1 537	1 614	665	n.a.	316	153
Serbia	247	246	121	3 741	3 633	800	554	445	n.a.
Croatia	283	253	299	4 613	4 102	1 435	n.a.	n.a.	536
Slovenia	366	358	536	4 997	4 703	3 296	n.a.	483	686
Russian Federation	1 700	1 751	1 400	30 791	32 535	21 303	2 624	2 983	2 800
Ukraine	1 075	1 236	740	23 443	23 589	8 000	n.a.	2 120	950
Kazakhstan	n.a.	2 152	1 500	n.a.	29 498	11 500	n.a.	3 818	1 664
Belarus	911	1 046	675	14 003	16 560	9 398	n.a.	2 529	1 748
Estonia	n.a.	947	2 446	8 125	8 272	9 870	n.a.	500	532
Georgia	n.a.	817	341	n.a.	11 021	3 762	n.a.	979	478
Latvia	1 006	1 011	1 318	9 379	10 014	8 091	n.a.	1 300	2 214
Lithuania	n.a.	1 219	1 020	10 705	11 409	6 702	n.a.	900	946
China	319	391	937	14 192	24 797	34 163	2 143	2 905	3 202
Indonesia	134	309	n.a.	1 068	n.a.	n.a.	n.a.	272	n.a.
Korea	840	1 151	1 449	10 268	14 082	12 618	623	876	765
India	233	323	590	5 993	8 521	13 755	395	681	1 730
Pakistan	187	196	250	2 757	2 926	3 300	218	164	n.a.
Austria	256	326	610	3 172	3 687	4 598	n.a.	354	792
Belgium	245	330	454	3 771	4 285	4 706	187	276	413
Denmark	257	324	664	2 691	2 809	3 205	235	373	n.a.
Finland	472	578	1 221	1 901	1 992	2 288	388	550	887
France	505	566	716	3 593	3 359	4 058	287	342	451
Greece	178	197	271	925	1 056	841	75	59	131
Ireland	92	154	400	834	934	1 042	141	322	247
Israel	538	911	1 532	n.a.	2 099	3 907	n.a.	1 141	927
Italy	263	324	720	3 592	4 036	4 239	n.a.	195	400
Japan	605	1 364	2 568	10 350	13 052	13 144	350	888	1 523
Netherlands	441	540	838	4 298	5 050	6 359	305	458	2 228
Portugal	289	322	644	1 961	2 325	2 051	171	319	614
Spain	360	527	1 127	1 788	2 087	2 416	258	285	557
Sweden	693	862	1 418	1 995	2 432	1 878	347	671	1 509
Switzerland	427	509	842	5 568	6 439	7 234	n.a.	n.a.	484
Germany	210	210	842	2 783	2 468	3 983	n.a.	350	463
New Zealand	154	326	n.a.	720	681	n.a.	115	213	n.a.
Canada: Canadian National	2 000	3 715	10 814	n.a.	3 955	8 426	n.a.	1 963	n.a.
Canada: Canadian Pacific	2 494	4 370	10 384	3 030	n.a.	7 509	1 288	2 291	n.a.
USA: All Class I Railways	3 040	7 073	14 659	5 241	7 925	14 250	814	1 263	1 757

Note: n.a. signifies not applicable or not available.
Source: World Bank Railway Database.

Figure 5.8. **Productivity in US railroads**

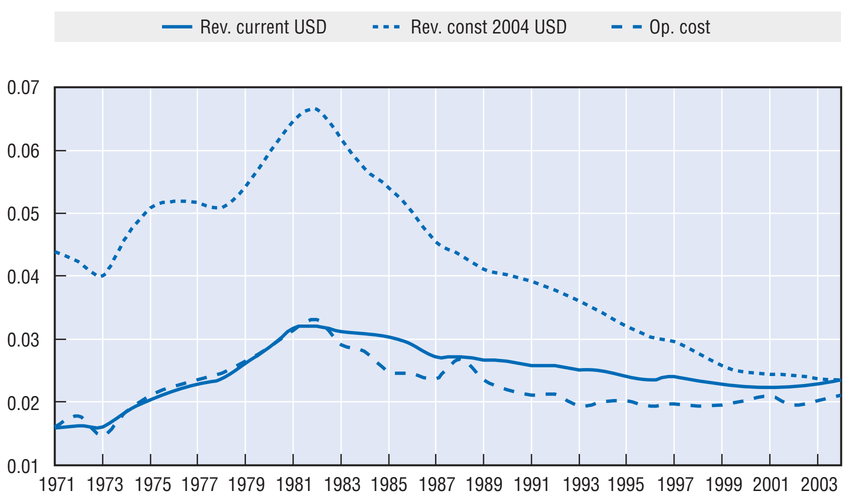
Index: 1980 = 100



Source: US STB (various years).

Figure 5.9. **US Class I revenue per ton-mile**

Statistics of Class I railroads



Source: US STB (various years).

low and effectively removes pricing flexibility from the railway. China will obviously need both an infusion of private investment in a number of areas along with a thorough re-thinking of government oversight policy. The Russian Federation illustrates the damage that can be done when the railway is still "planned", but the economy shifts to a market-driven approach: the result was a decade of underinvestment. The current attempts to reform the management model are reasonably comprehensive, but implementation has proven difficult, partly because of the politics of cross-subsidy from freight to passenger, and partly because of a mismatch between the powers that the planners and regulators want to retain, and the forces of a competitive transport sector.

The net result is a simple conclusion: the three parts of the management model must be consistent with each other. That is, the competition objectives and the competitive realities in the economy must be clear and accepted. Then, the structure and ownership of the railway (and the rest of the transport sector) must yield the desired type and degree of intramodal (rail *versus* rail) and intermodal competition: a monolithic railway is rarely a competitive railway. Next, the approach to regulation must make the right balance between the competition that the market develops and whatever degree of market power the railway might maintain; only that which really needs regulation should be regulated (a principle that former planners find hard to accept). If the right balances are struck, then the railway will probably do an effective job of finding the right technology and generating the financial resources needed to provide the right capacity. Finally, government promotional and financial policy must focus on defining, and paying for, whatever social rail services the economy requires.

4. Implications for policy change

There are a very large number of possible policy and public finance innovations that could have an effect on whether the needed rail freight infrastructure is actually provided, and by whom.

4.1. Ownership of infrastructure

The prevailing world model is based on public authority ownership and management of infrastructure. This is partly for historical reasons, partly for reasons of cultural values concerning ownership of "critical" infrastructure, partly because the public authorities want to control the quality of infrastructure and access priorities (to favour passenger over freight), and partly because public intervention to keep rail passenger fares low means that the operators do not generate enough money to fully finance infrastructure.

Private ownership and management of rail infrastructure is, of course, possible. The North American example is clear (in fact, the largest Canadian railroad – CN – was privatised in 1996 after years as a Crown Corporation). Among the largest passenger railways – the three large Japanese companies – are entirely private (though there is public investment in the infrastructure in cases where the private companies think the investment is unprofitable). In addition, about 30% of the line-km in Japan has always been owned by private companies operating commuter services. The infrastructure of British Railways (BR) was privatised to become Railtrack. For a number of reasons, this privatisation failed, and a new company (Network Rail) was formed that occupies a middle position between public and private (there are reports that Network Rail is considering issuing new equity, which would further blur the distinction between public and private). The Latin American countries all retained ownership of their rail freight infrastructure, though they concessioned operations.

Though governments have often insisted on owning rail infrastructure, they are somewhat less than insistent on meeting their obligations to fund the needed maintenance and investment. To an extent, this is due to a perennial problem with government budgeting (people want services but do not want to be taxed to pay for them – the reason why cross-subsidies from freight to passenger services are popular) and partly one of political priorities – what Andrieu (2007) calls "short-termism". This is a problem that has become public and serious in France, for example, where the SNCF (non-TGV) infrastructure has suffered from underfunding. A general conclusion is that the private sector has and will adequately fund the amount of rail freight infrastructure it needs for commercial purposes, if the regulatory and competitive environment are appropriate. Only the public can, and should, fund rail infrastructure that serves social or public needs.

Prognosis: With the exception of North America, the three large Japanese railways, and a few integrated bulk freight railways, there is little enthusiasm for private ownership of railway infrastructure. It is possible that some governments may view sale of their railway infrastructure as a source of cash for a strapped treasury (this was part of the motivation for the Railtrack privatisation and the sale of the Estonian Railway – both of which have subsequently faced significant challenges). For the most part, however, there will not be significant infrastructure privatisations or additions to private line-km because of a general perception that rail infrastructure is a nationally strategic asset. On the other hand, there may well be significant prospects for contracted maintenance or even award of concessions to *manage* public infrastructure, including freight infrastructure.

4.2. Ownership of the freight operating company

As with infrastructure, the traditional model in most of the world is for the freight operator (and passenger operators) to be owned and managed by government "enterprises". The only long-standing exceptions were in the US and the CP in Canada, and several mining railroads around the world (CVRD in Brazil, or Pilbara in Australia) that had railroads as part of the overall mining and transport function. This model is changing. The CN was privatised in 1996 – perhaps the largest railroad freight privatisation ever (with the possible exception of the privatisation of Conrail in the US in 1987). Essentially all of the operators of rail freight in Latin America (Argentina, Chile, Bolivia, Peru, Brazil, Guatemala and Mexico) were shifted to private concessions in the 1990s and no significant public rail freight operators remain. The BR freight operator (EWS) was entirely privatised in 1996 (it is *not* a franchise). The open access regimes in the EU and the Russian Federation have engendered the rise of new, private, usually own-account rail freight operators (such as Rail4Chem and Ikea) that operate paying access charges. New open access rail freight operators have arisen to compete with EWS in the UK, and UK operators are now negotiating to run trains through the Channel Tunnel and into the continental networks. Though not actually a privatisation, Railion (the freight arm of Deutsche Bahn) has bought the formerly national freight operators in the Netherlands and Denmark, and has offered to buy other freight operators in Sweden and Poland. The German government is now considering "privatising" DB, though in what format is still unclear. A privately owned freight rail operator (Connex) has recently commenced running trains on the public national infrastructure (RFF) in France. The paradox of government ownership of rail freight companies is that the trucking and water operators have always been private. Private companies are inevitably closer to the market and the customer. In addition, trucking companies do not suffer from the border effects that railways face in the EU, and trucking companies inherently offer better service than rail (albeit at higher prices) because their shipment sizes are smaller.

Prognosis: The trend toward private ownership and management of operators may well be the best hope for rail freight growth. It is entirely possible that the EU freight rail operators will be mostly privatised in the next decade, and it is even more likely that new, private, open access operators and carriers will be a significant competitive force in the EU and Russia.

4.3. Competition policy

Government competition policies towards railways hinge first on the degree of intermodal competition that exists in the transport market. In countries where ample intermodal competition prevails – generally the case in the EU, North America and Latin America, and increasingly the case in China – governments can be less concerned about the competitive structure of the railway sector. Where ample competition does not exist – as is the case in the Russian Federation, where over 80% of the surface transport goes by rail because the highway system is so limited – a structure fostering intrarail competition can be a significant tool. The US has, for example, seen a constant trend toward railway mergers, to the point that rail *versus* rail competition on parallel lines has been significantly reduced. In 1970, there were 71 Class I railroads; today there are nine, of which only four are significantly competitive. Of these, two (UP and BNSF) compete in the west, and two (CSX and NS) compete in the east.

The Russian Federation government is considering (but seems unlikely to adopt) plans to create parallel line competitive companies in the Third Phase of its railway restructuring. Even though intermodal competition is pervasive in most of the EU, the EC has fostered open access to infrastructure in order to create at least some cross-border competition among railway freight companies. In this regard, a situation in which one company (for example Railion) buys up a large number of formerly national rail freight operators might pose significant structural competition issues.

Prognosis: For the most part (except for some bulk traffic in the Russian Federation and China), regulation of rail freight tariffs will be effectively eliminated and replaced by enhanced intermodal competition or, in some cases, with intramodal competition as well.

4.4. Regulation

Regulation must be consistent with competition. In situations where competition is pervasive (high-valued cargoes that trucks can carry effectively, or low-valued cargos where barges operate, or between two market areas that are served by two railroad companies), there may be little need for regulation of railway tariffs and services. This was, for example, the rationale behind the trucking and rail deregulation in the US in the early 1980s. Even where the general level of competition is adequate, though there may still exist areas where the railways can exercise market power. For this reason, the Surface Transportation Board (STB) in the US retains power to regulate rail tariffs where three tests are met: railways have market dominance *and* railway earnings are inadequate *and* the proposed railway tariffs appear to be too high (there are numerical standards for all three tests). For the most part (including Latin America and Africa and most of Asia) there is little reason to expect that rail freight tariff regulation will be needed. There are, however, three significant exceptions: China, the Russian Federation and India.

China has already witnessed a rapid growth of trucking, and the rail share of intercity ton-km has already fallen below that of North America (and continues to fall, primarily because the rail system is congested with bulk traffic and because the railway is not commercially oriented and tariffs are overregulated). At the same time, the railway freight traffic in China does include a number of vital commodities, especially coal, on which the economy is heavily dependent and for which there is little effective competition. China will clearly need to retain control over railway pricing of coal, and possibly some other bulk commodities. Because of its geography and weather, Russia will always have a higher rail market share than in other countries, especially for long haul traffic from European Russia to Asian Russia. To some extent, this traffic can be subjected to open access competition: where this is infeasible, regulatory power over tariffs must be retained (albeit rationalised). India exhibits a distinct set of regulatory issues, partly because of an inadequate road network (though intracoastal shipping does furnish a competitor in some cases), and partly because of a distorted rate structure in which rail freight rates are held artificially high in order to cross-subsidise politically mandated passenger services. So long as this cross-subsidisation continues, both freight and passenger tariffs will have to be regulated, as will truck tariffs, if the system is not to collapse under its contradictions (as effectively happened in the US immediately prior to deregulation).

Prognosis: Cross-subsidies in railways from freight to passenger services are remarkably difficult to eliminate because policy makers find it easier to tax freight shippers than the public at large. The EC has thus far been unable to enforce its requirement for separate accounting of social from commercial services, and has been mostly unable to enforce the stricture against cross-subsidies. Given the current lack of information to support regulatory intervention (ECMT, 2006), and given that the new EU members are supporters of cross-subsidies, there is little reason to believe that the EC will be successful in improving its regulatory enforcement in the next decade. The Russian Federation government has proposed (but has so far not implemented) a reduction in cross-subsidies. India has weakened its rail network by cross-subsidies, but has been unable to change policy because of political interference. Fortunately, China has thus far avoided losses on passenger services, and the passenger services in Japan are profitable, or are supported directly from public funds. Both the US and Canada have successfully eliminated cross-subsidies by institutional separation of Amtrak and VIA and by direct public funding.

4.5. Regulatory/investment interactions

As suggested in the case of India, there is a direct linkage between tariff regulation and investment generation, especially for freight operations and infrastructure. If the regulator's actions are restricted to alleged abuse of market power and to political attempts to cross-subsidise passenger from freight, and if the regulator does not adequately consider the earnings need of the railway, then internally generated investment will be inadequate. Unfortunately, this is the rule in many of the world's railways, and will be a major source of weakening of the link between the rail freight infrastructure that is needed, and that which is actually provided.

Prognosis: Regulatory constraints on development of rail investment have been, or will be, removed in North and South America and the EU. Such constraints will remain serious in the Russian Federation (due to the policy of making coal exports appear more economic by forcing down long haul coal tariffs), India and China, all of which are pursuing explicitly social goals at the expense of adequate freight earnings for their railways.

4.6. Cross-subsidies and PSOs

Imposed cross-subsidies from freight to passenger services have a significant and adverse impact on the ability of the freight side of the railway to generate earnings and finance investment in infrastructure. This is not only a problem in India. In fact, most of the central and eastern European countries (including those that are new EU members) have traditionally used cross-subsidies to hold down passenger tariffs while also minimising government budget contributions. This is true not only of operating support, but also of infrastructure, where many of these countries charge high infrastructure access charges to freight in order to reduce the access charges to passenger operators (ECMT, 2005). The same problem can be seen in different guises (Japan Rail Freight Company, and Amtrak and VIA in North America) where the tenant operator is supposed to pay only "marginal cost" for track access. EC directives oppose cross-subsidies, and require that social services only be provided under a fully compensatory Public Service Obligation (PSO) contract. The question is whether, and how soon, the Commission will succeed in enforcing its directives in this respect.

Prognosis: Transparent PSO systems are usually more popular with economists and public managers than they are with politicians. The problems in the CEE countries with creating more transparent PSO regimes are a good example. It is clear that more and more PSO systems for supporting social services by railways will be developed. Unfortunately, the development will be slow, and full compensation (if it can ever be properly defined and measured) will be slow in coming.

4.7. Infrastructure access charges

The EU is the only multicountry regime in which infrastructure access charges are legally required and in which the rules for setting the access charges are formally developed. In most other countries (US, Canada, the Russian Federation, Japan, Argentina, Mexico), access charges apply to minority, tenant operators, and are set at an approximation of marginal or variable cost. Marginal cost is, unfortunately, a more useful concept in theory than in practice (see discussion on information below), and is subject to abuse if the tenant operator is politically powerful. In most of these countries, the owning railway argues that the tenant is not even paying marginal cost, especially when the lines over which the tenant operates are congested. The EU rules for access charges are by now well established: access to the infrastructure must be non-discriminatory; no user should pay below marginal cost; all users should optimally pay marginal cost with government making up the difference between economic marginal cost and the financial costs of the infrastructure provider; governments are permitted to require the infrastructure provider to pursue recovery of some (or all) of financial costs through imposed mark-ups, but the mark-ups must be levied in an economically efficient manner and must not be discriminatory; and, the infrastructure provider must, through the sum of user access charges and government support, collect enough to be financially stable from year to year (ECMT, 2005). These rules would be beneficial to infrastructure in general, and to freight operations in particular, if they were fully enforced. Unfortunately, they are not enforced, partly because of a lack of information, partly because of lingering political interference that favours priority access for passenger services, and because the new CEE members have been reluctant to deal with the cross-subsidy/PSO issue. The result has been a patchwork of inconsistent access charge regimes that almost certainly act to hinder the flow of rail freight traffic across national boundaries and, in the CEE countries, clearly are encouraging rail freight traffic to shift to trucks.

Prognosis: There is emerging support within the EU for adopting simple access charges for rail freight (that is, basing freight access charges on simple measures of use, such as net ton-km or gross ton-km or train-km). There is less support for complete harmonisation of the charge levels, both because of different cost circumstances and financial objectives among countries, and because harmonisation of freight access charges would expose internal cross-subsidies from freight to passenger services. In addition, some countries (*e.g.* Germany) argue that some aspects of rail freight access charging decisions are commercially sensitive and should be confidential.

4.8. Inadequate information

A fundamental challenge of access charge regimes (which are necessary for successful operation of either the owner/tenant models or the vertical separation regimes) is the ability to set access charges that bear some relationship to marginal cost and that can be shown to relate in an appropriate way to the cost of different types of users. In addition, all users and government need to know that the condition of the infrastructure is appropriate and stable from year to year. As discussed in a recent ECMT report (2006), the access to, and validity of, information about EU railways is inadequate to the task. Though the EC requires it, few EU railways actually separate their costs and revenues as between infrastructure, passenger operations and freight operations. It is thus difficult, if not impossible, to say that passenger losses are being adequately compensated or that the costs of infrastructure are being fully covered as required. Few railways maintain, and none report publicly, the data required to calculate the marginal cost of infrastructure as applied to each user. Equally important, there is no agreed or common method for calculating marginal cost anyway. Though the EC requires an annual Network Statement – and most countries comply (or will nominally comply shortly) – the Network Statements are too general to ensure that the condition of the infrastructure is actually appropriate or stable from year to year.

Prognosis: Developing better information will be a critical aspect of improved railway management and regulation in the EU. The EC is likely to push for improved information. Indeed, EC directives already require that most required information be developed. The issue is one of enforcement (always slow) and of development of improved and harmonised accounting systems (also slow). It could be decades before the required information is actually developed and reported in a fully useful way.

4.9. *Interoperability*

Interoperability at national boundaries is a significant issue in the EU. The need to change electric power voltage and frequency, signal systems and crew has made it difficult for any operator to provide service in more than one country. This is somewhat less serious for freight than for passenger services, since diesel locomotives could haul freight across boundaries with ease, but the signalling systems are still disparate and crews are rarely qualified to operate across boundaries. Given the slow progress in the access charge issues above, it may in the end be easier to resolve technical interoperability problems than the political ones.

Prognosis: Although the technical solutions to interoperability issues are reasonably easy to define, getting railways (and their governments) to agree on common solutions has not been simple. Moreover, the money involved is so large that a process of evolution as old systems are replaced seems to be the best approach. Despite a generally positive outlook, it will be decades before full interoperability is achieved, if ever.

4.10. *Priority access for passenger services* versus *freight*

Countries generally support passenger services (preferably through an explicit PSO system), while they do not usually provide significant support to freight: for example, NERA estimated that only 2.8% of EU rail funding went to support freight (NERA, 2004). Passenger services (especially commuter services in the major cities) tend to enjoy high political visibility. As a result, infrastructure providers are often under clear (usually non-verbal) orders to give access slot priority to passenger operators and let freight take what is left over. This obviously has an effect on the ability of the freight operator to compete and to finance any needed freight capacity.

Prognosis: The problem of non-discriminatory access to the EU rail infrastructure for freight services cannot be fully resolved because of the very high levels of passenger services on the networks. The concept of dedicated freight lines (or the Freight Freeways) has promise, but the costs of implementation may be so high as to make most dedicated freight lines uneconomic.

4.11. Broader government policies influencing intermodal market shares

There are at least three areas in which non-rail government policies will affect rail freight traffic and infrastructure.

First, as in the US, many governments have policies that include financial assistance to the various modes of transport. The US government (and state governments), for example, provides massive assistance to the construction of the national highway system. The revenue sources to finance the highways (principally a tax on fuel, but also on lubricating oils and tires and tubes, and on truck licenses) are roughly sufficient. However, within user categories, the car and bus users pay for their financial share of construction and maintenance whereas the heavy trucks pay 50-80% of what they should pay (FHWA, 2000) to recover financial costs. Second, neither trucks nor cars cover their marginal social costs (adding safety, congestion, environmental impacts).[8] Heavy truck subsidies are a significant determinant of the market share currently enjoyed by trucks. Third, the federal government in the US pays essentially the entire cost of constructing and maintaining the inland waterway system. The net result is that railways lose high revenue traffic to trucks and low revenue traffic to barges (where barge competition is possible).

Prognosis: It is unlikely that this problem will be resolved, at least in the US or Canada, due to the political power of the trucking and barge lobbies, though there is some indication of a growing awareness of transport congestion issues in the US. Railways will have to find a way to live with the problem. One potentially promising idea, though, is congestion tolling on the highways. At present, there is little political enthusiasm or understanding of tolling: if that changes, then railway freight traffic should definitely benefit.

Much the same situation prevails in Latin America where trucks do not pay their way in highway construction and maintenance costs. This has had the result of weakening the performance of the rail freight concessions. **Prognosis:** No significant change.

Even where trucks pay their way in a rough financial sense (as may be the case in the EU where fuel taxes are very high), they do not necessarily pay their way when externalities, especially congestion, are included. The problem is that there has been strong political resistance to highway use tolling, partly because of tolling administration costs and traveller delays, and partly because many people object to "paying twice" for their access to highways (they don't think that paying both fuel taxes and use tolls would be fair). This resistance has been compounded when users are asked to pay congestion-related tolls, such as time-of day and directional tolls (inbound in the morning, outbound in the afternoon). Many European countries, as highway congestion has mounted, are beginning to implement various types of congestion tolls in major urban conurbations. Advances in tolling technology that, at least in principle, will eventually permit congestion tolling whenever and wherever it occurs have aided this movement. It seems quite possible that the most important single advance in technology aiding the growth of railway freight traffic could be in highway tolling. It is an open question whether trucking demand will suffer more from low tolls and congested throughput or higher tolls and free flowing traffic.

Prognosis: Highway tolling is likely to increase. It will benefit EU rail freight traffic only if the management model for rail freight is changed to promote private ownership and operation of rail freight carriers. It would definitely benefit North American railways, but by how much is uncertain, since much of the competitive equation is driven by quality rather than cost considerations.

The form of financing can sometimes be as important as the level. For example, fuel taxes are purely variable with use. If the traffic does not move, the operator does not pay. By comparison, the fixed costs of private railways must be paid whether or not the business cycle is positive. Access charges for freight railways can have a very different effect if they are purely variable with use as compared with having a significant fixed component. For example, the Alameda Corridor Project was financed mostly with public funds, with the railways paying the money back through a charge per container hauled. The project might not have been feasible if the railway had been required to borrow all of the money up front.

Prognosis: As the Alameda Corridor Project shows (see Chapter 1, Box 1.4), the use of public money to convert a fixed charge into a variable charge has real promise. The actual use of the approach in the US depends on development of broader policies to support it, rather than the past reliance on *ad hoc* groupings of federal and local authorities with the private railroads. In cases where the user charges can reliably pay the expected share of public investment, this approach will probably grow. The Alameda Corridor Project also highlights a dilemma: if the user charges cannot be passed on the shippers, the enthusiasm of the railways is likely to be limited.

Government policies toward the method of promoting private involvement are also important. When facilities such as rail infrastructure are being privatised, governments have the choice of trying to value assets at book value or allowing them to be sold for going concern value (usually much less). In addition, assets can be sold for upfront cash (hard to finance) or for a stream of payments over time. Concessions or franchises can be either positive (payments to government for use of the infrastructure) or negative (payments from government to cover operating losses and maintenance of assets). Franchises can either be gross cost (in which the franchisee takes no demand or revenue risk, but only bids minimum cost to provide services) and "commercial" (in which the franchisee takes the demand revenue risk as well). Gross cost franchises (actually contracts) tend to be more appropriate for socially supported services whereas commercial franchises are more appropriate for services where market forces are fully at work. In all of these cases, government policy and expertise will determine whether the approach works.

Prognosis: The understanding of this set of issues has advanced, as a recent ECMT conference on franchising of railway services demonstrated. If the current EU trends toward franchising remain positive, then private involvement in both infrastructure and operations of freight (and passenger) rail will develop.

5. Conclusion

This chapter argues that a significant portion of future rail freight infrastructure investment will need to be approached as a *joint effort* between the public and private sectors because there are both public and private benefits of rail freight services. This suggests the use of PPP vehicles, for which there is an accumulated store of experience, some successful and some not (see the Australia case study in Box 5.4 for a discussion of the Darwin extension). A particular lesson that has emerged – the effect of the "megaproject" – needs to be emphasised. It is almost inevitable that the new PPPs for transport infrastructure, including rail freight, will be megaprojects, with impacts that reach virtually all areas in the society, and with resulting political challenges (poverty reduction, regional development, environmental and cultural preservation, etc.) that reach far beyond easy planning and management, especially for the private partner. As Flyvbjerg *et al.* (2003) discuss, the complexity of such projects, along with the irresistible tendency on the public side to overpromise benefits and underestimate costs, almost always leads to results that are delayed, over budget and under performing.

Prognosis: Most PPPs will be troubled ones, with optimistic schedules and inadequate budgets. In addition, political challenges from special interest groups will further aggravate budget and schedule problems.

Box 5.4. **Australian rail restructuring**

The details of railway ownership and operation in Australia, and the process by which they have evolved in the past 30 years, are far too complex to be covered in depth in this chapter.[1] It is useful, though, to summarise in a broad way what has happened as it illustrates and elaborates a number of the structural issues presented in Tables 5.3 and 5.4.

Australia has around 40 000 km of rail line, making it one of the world's larger freight networks (see Table 5.1). In total, in 2003/04 the Australian railways carried almost 600 million tons of freight (see below), of which about 580 million tons were bulk commodities (mostly coal, ores, and grains). Only two per cent of the total tonnage crossed a state line; 98% of the tonnage was short haul (238 km average), bulk moves for processing or export, and 42% was carried on private railways having no significant connections to the rest of the network.

Prior to the mid-1970s, railways in Australia had either been developed as private, dedicated railways, or they had been owned and developed to serve the needs of a single state. With no significant interconnections, the various rail systems used different gauges (see map below), with slightly over 4 000 km of broad gauge lines (1 600 mm), around 19 000 km or narrow gauge lines (1 067 mm) and the remaining 17 400 km of standard gauge lines (1 435 mm). Except for the private, dedicated railways, all common carriage railways were publicly owned and operated by state governments as vertically integrated systems.

Beginning in 1975, the process of development of a freight *system* began. Although the steps in the evolution are very complex, the end result is shown in the tables and map below. The common carriage network is now, for the most part, vertically separated, offering competitive access using published and regulated access charges (the private railways were, and remain, integrated without competition, and the Tasmanian Railway has no competitive operators at present). On the Queensland Railway Group (QRG) narrow gauge infrastructure, which is publicly owned by the state government of Queensland, the infrastructure provider is part of the group but is "ring fenced" from the remainder of the group and offers access to others. The Australian Rail Track Corporation (ARTC), owned by the Commonwealth government, owns, leases or has contracted access to a national network of standard gauge lines spanning the continent from Perth to Brisbane (via Adelaide, Melbourne and Sydney) and from the North (Darwin) to a connection with the transcontinental line at Tarcoola). The ARTC standard gauge line connects with a series of state-owned standard gauge lines, offering competitive access through a significant part of the country. The narrow gauge lines in Western Australia were privatised but have now been acquired by the QRG (and offer open access as in Queensland). The broad gauge system of the Victoria Railway is now managed by ARTC, and offers open access.

Box 5.4. **Australian rail restructuring** *(cont.)*

The freight operators have been separated from infrastructure. Most have been privatised, with the exception of the QRG freight operator (that recently bought the Western Australia freight operation). There are now four major privately owned freight operators: Pacific National, Asia Pacific Transport Consortium, Genessee and Wyoming of Australia, and NRG (Flinders Power). There are also a number of smaller, private, tenant operators, including SCT Logistics, P&O, Grain Corp, Southern and Silverton Rail, Patrick Portlink, Lachlan Valley and Southern Shorthaul R.R. Table 5.19 below has a description of the territories and operating conditions of the freight operators.

Vertical separation for freight also led to the creation of a national, long haul passenger operator, the Great Southern Railway (GRS). GRS is a private corporation providing overnight, tourist-based passenger services from Sydney to Perth and from Melbourne and Adelaide to Darwin. GRS operates on a "hook and haul" basis in which GRS provides the coaches and all passenger services and the operating freight carrier provides locomotives and drivers. Most of the suburban and local passenger services are operated on a vertically integrated basis by local authorities (Perth, Adelaide, Sydney and Brisbane) whereas the commuter services in Melbourne are provided by a private franchisee (Connex).[2]

Australia also furnishes an interesting example of a PPP project – the 1 420 km Alice Springs to Darwin Railway. This link had been a century-long dream of the Northern Territory, furnishing a direct rail connection with the rest of the country and, it was hoped, providing a "land-bridge" for containers between southern Australia and Asian markets via the Port of Darwin.

Construction of the link commenced in 2001, and was completed in January 2004. In addition, the 820 km link from Alice Springs to the East-West line at Tarcoola was acquired under lease. The AUD 1.86 billion cost of the link was financed through an AUD 191.4 million grant from the Commonwealth government, AUD 367.8 million from the State governments of South Australia and Northern Territory, and AUD 1.3 billion financed by the private sector. The project was overseen by a public company jointly owned by South Australia and Northern Territory (AustralAsia Railway Corporation), which awarded a BOOT concession to the Asia Pacific Transport Consortium. Freight operation on the line is provided by Freightlink (a partner of AustralAsia) and by the Australian Rail Group (now owned by QRG) under open access provisions for the infrastructure.

After only two years, it is not yet clear whether the project is financially "successful". Thus far, the land-bridge traffic has not developed as expected, but the potential for bulk freight may turn out to be greater than forecast, and the line appears to have gained about 85% of the entire surface freight transport traffic from the South to Darwin. Freightlink reportedly lost money in its first two years, and is now trying to sell part of its equity for AUD 350 million to obtain new financing (*source*: "The Australian Financial Review", 3 May 2006). The performance of the concession owner is not public, so its success cannot easily be assessed.

Box 5.4. **Australian rail restructuring** *(cont.)*

The Australian experience offers a number of potential conclusions bearing on the availability of infrastructure for rail freight:

- The completely market driven, private freight railways, carrying 42% of Australia's rail freight traffic, were able to finance their infrastructure needs without significant public intervention. Since these companies are serving a booming world commodities market and have low production costs, there is no reason to think that they will be unable to provide the capacity they need in future.
- The privatization of the freight operators has largely been successful (Williams, 2005, p. ix), offering better services at lower rates, and generating sufficient internal financing for operating needs.
- The primary interstate infrastructure provider, ARTC, seems to be an effective conduit for reaching a balance between public and private funding for rail infrastructure. For the fiscal year ended 30 June 2005, ARTC generated AUD 239 million in access revenues, AUD 88 million in services to regional and local governments, and another AUD 62 million in other non-operating revenues. To this was combined AUD 100 million in special Commonwealth government grants for improving the system. The total (AUD 489 million) comfortably exceeded the total costs for the year of AUD 342 million. In total, ARTC has received AUD 550 million in grants, and expects to receive AUD 550 million in grants for financing of specific infrastructure projects through the Auslink programme that deals with the national transport infrastructure (see ARTC Annual Report, 2005, pages 2 and 44). An additional AUD 820 million has been provided via Auslink to ARTC to upgrade the high density Melbourne-Sydney-Brisbane corridor in order to upgrade capacity and reduce trip times for freight as well as passenger trains. Overall, through ownership of ARTC and through funding in the rail activities of the Auslink programme, the government has clearly defined the public interest needs for rail infrastructure capacity, and has moved to ensure that these needs are financed.
- The separation of passenger operations has been effective in ensuring that the freight operators do not have to cross-subsidise passenger services. In particular, GRS has upgraded the quality of the service and is profitable on an operating cost basis. It is not yet clear whether GRS will be able to finance new equipment if that is needed.
- Under an acceptable balance of public and private finance, as the Alice Springs to Darwin project shows, PPPs can readily add capacity to the national rail freight infrastructure.

1. See Williams (2005) for a more detailed discussion of the overall organisation of the Australian rail sector, and Kain (2006) for a detailed discussion of the experience with passenger franchising in Australia.
2. Franchising of passenger services in Melbourne has been a troubled process that may still be evolving. See Kain (2006) for a detailed discussion. See also Williams, Greig and Wallis (2005).

Table 5.17. **Australian rail freight traffic, 2003/04**

Top bulk commodities	For hire carriage		Private carriage	Total
	Intrastate	Interstate		
	Million tons			
Coal	239.1	0	0	239.1
Ores	12.7	0	207.0	219.7
Grain	17.6	0.1	0	17.7
Other bulk commodities	55.2	3.0	44.0	102.2
Total bulk	**324.5**	**3.1**	**251.0**	**578.6**
Non-bulk traffic	**6.6**	**9.4**	**0**	**16.1**
Total traffic	**331.2**	**12.6**	**251.0**	**594.7**
	Billion ton-km			
Coal	45.5	0	0	45.5
Ores	3.5	0	69.1	72.5
Grain	5.5	0.1	0	5.6
Other bulk commodities	12.2	4.8	1.2	18.2
Total bulk	**66.7**	**4.9**	**70.2**	**141.8**
Non-bulk traffic	**4.0**	**22.3**	**0**	**26.3**
Total traffic	**70.7**	**27.2**	**70.2**	**168.1**
	Average length of haul (km)			
Coal	190.5	0	0	190.5
Ores	273.4	0	333.6	330.1
Grain	312.1	571.4	0	314.2
Other bulk commodities	221.5	1 605.4	26.6	178.1
Total bulk	**205.6**	**1 559.1**	**279.8**	**245.1**
Non-bulk traffic	**600.9**	**2 366.2**	**0**	**1 636.4**
Total traffic	**213.5**	**2 164.9**	**279.8**	**282.7**

Source: Australasian Railway Association (2006), Tables 3 and 4.

Table 5.18. **Australian railway structure, mid-2006**

	Infrastructure	Suburban and regional passenger operations	Intercity passenger operations	Intrastate freight	Interstate freight
South Australia	ARTC owns interstate freight line. State owns local passenger lines.	Trans Adelaide state operated.	Privately operated by Great Southern ("hook and pull").	PN.	PN, AP, G&W, NRG, SS, S&S, PP, P&O, Onesteel.
Tasmania	Privatised: Pacific National Tasmania.	–	–	Privatised: PN Tasmania.	Privatised: PN Tasmania.
Western Australia	WestNet (private), but ARTC has access to Perth.	Transperth publicly operated suburban; Transwa public regional.	Privately operated by Great Southern ("hook and pull").	PN, QR National, S&S, Pilbara, BHP Iron Ore.	QR National, S&S.
Queensland	QR Network Access (QRG).	Brisbane operated by QRG.	QRG.	QRG, Comalco.	QRG, PN.
Victoria	State, with interstate lines leased to ARTC.	Suburban franchised to Connex; V/Line passenger for regional.	Privately operated by Great Southern ("hook and pull").	PN, QR National, SS, S&S, PP, P&O	Pacific National.
New South Wales	State, with interstate line leased to ARTC.	Public "Railcorp".	Privately operated by Great Southern ("hook and pull").	PN, QR National, GC, SS, S&S, PP, LV.	QR National, PN.
Northern Territory (Alice Springs to Darwin)	50-year BOT concession, incl. lease of Alice Springs to Tarcoola line.	–	Privately operated by Great Southern ("hook and pull").	FreightLink (AP).	FreightLink (AP).
ACT	ARTC.	–	–	–	PN

Note: PN = Pacific National. AP = Asia Pacific. G&W Aus = Genessee and Wyoming of Australia. NRG = NRG Energy. QRG = Queensland Rail Group. GC = Grain Corp. SS = Southern Shorthaul. S&S = Southern and Silverton. PP = Pacific Portlink. LV = Lachlan Valley.
Source: ARA (2006).

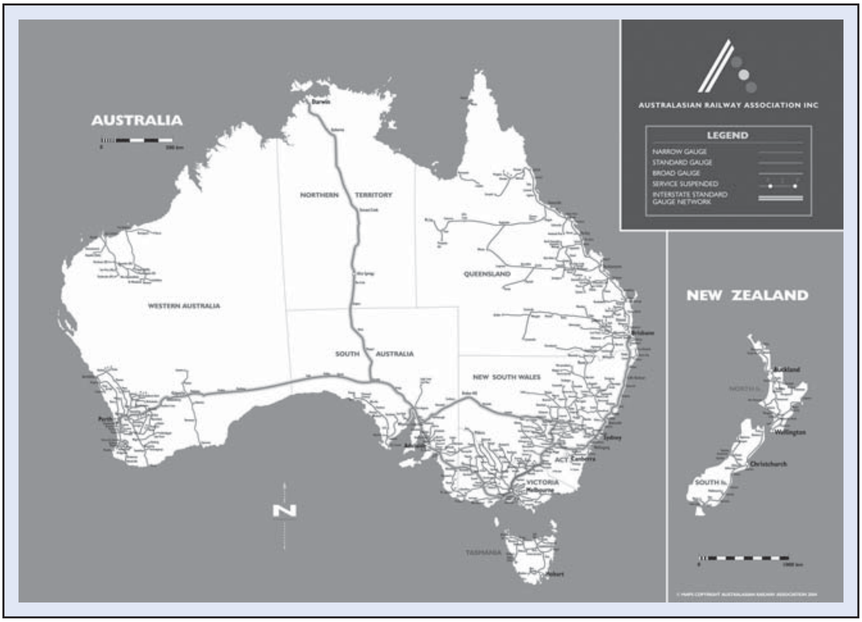
Table 5.19. **Freight railway operators in Australia**

State	Private integrated				Pub integ	Public tenant	Private tenant						
	PN	AP	G&W Aus	NRG	QRG	QR Nat	PN	GC	SS	S&S	PP	P&O	LV
SA		X	X	X		X	X		X	X	X	X	
Tas	X												
WA						X	X			X			
QL					X		X						
Vic	X					X	X		X	X	X	X	
NSW						X	X	X	X	X	X		X
NT		X											
ACT							X						

State	Wholly privately and vertically integrated			
	Pilbara	BHP Iron Ore	Comalco	Onesteel
SA				X
Tas				
WA	X	X		
QL			X	
Vic				
NSW				
NT				
ACT				
State				

Source: ARA (2006).

Figure 5.10. **Australasian Railway Association map**



Note: Used by permission of the Australian Railway Association.

Notes

1. The definition of “new construction” is not precise. The amount given includes not only new construction, but also rehabilitation and, in some cases, major maintenance.
2. Correspondence with David Stambrook of Virtuosity Consulting, Canada, dated 11 April 2006.
3. The definition of “congestion” in the US may be different than in the EU, so common conclusions are always approximate.
4. See ORNL 2006, pp. 2-17. Conservatively assumes average load/truck of 20 tons.
5. See US Department of Transportation, Bureau of Transportation Statistics, “National Transportation Statistics”, Tables 2-4 and Tables 1-46b.
6. In Russian practice, an “operator” is a company that owns freight wagons and asks the main carrier to haul trains with a discount reflecting wagons ownership costs.
7. “Moving block” signals, in which computers automatically calculate the position of each train and regulate the speeds of all trains, have so far been restricted to the controlled conditions of mass transit. They have not been proven yet on regular rail lines. If moving block signals can be proven safe and effective, they could have a significantly positive impact on line capacity.
8. Calculations of social marginal costs are difficult. Work done at Leeds University (see Sansom, *et al.* 2001, p. 49) suggested that Heavy Goods Vehicles impose social costs (the largest component of which is congestion) that fall far short of charges

paid. In fact, the same was true of all highway users. Comparable studies in the US (see, *e.g.* TRB 1996, p. 98) concluded similarly that marginal costs of heavy trucks far exceeded the charges imposed on them, and that the major components of social marginal costs were congestion and accidents. The report studied the specific case of containers moving by truck from Los Angeles to Chicago and found that congestion accounted for almost half of total social marginal costs. Though a direct comparison is harder to make, the US DOT/FHWA study (US DOT 2000, p. 17) found that congestion is the largest social marginal cost imposed by heavy trucks.

Bibliography

Alameda Corridor website (2006), various documents including fact sheets on history, governance and project description; news releases; briefing charts, *www.acta.org*.

American Association of State Highway and Transportation Officials (AASHTO) (2002), *Transportation: Invest in America*, Washington DC.

Andrieu, Michel (2007), "A Cross-Sectoral Synthesis on the Long-Term Outlook for Infrastructure Business Models", in *Infrastructure to 2030 (Volume 2): Mapping Policy for Electricity, Water and Transport,* OECD, Paris.

Andrieu, Michel (2005), "The Long-Term Global Outlook for Investment in Infrastructures", paper prepared for the OECD IFP project on Infrastructure to 2030, Paris, 12 December 2005.

Association of American Railroads (AAR) (2005), *Handbook of Railroad Facts 2005*, Washington DC.

Assocation of Train Operating Companies (ATOC) (2005), *Looking Forward: Contribution to Railway Strategy*, London.

Australasian Railway Association, Inc. (ARA) (2006), *Australian Rail 2004: The 2004 Productivity Report*, Kingston, ACT, Australia.

Australian Rail Track Corporation Ltd. (ARTC) (2005), *Annual Report 2004-2005*, *www.artc.com.au/company/annual.htm*.

Bureau of Transport and Regional Economics (2006), "Freight Measurement and Modelling in Australia", Report 112, government of Australia, Canberra.

Chicago Region Environmental and Transportation Efficiency Program (CREATE) (2005), *Final Feasibility Plan*, August, *www.createprogram.org*.

Dewey Shipping Consultants Ltd. (2005), *Annual Review of Global Container Terminal Operators – 2005*.

European Council of Ministers of Transport (ECMT) (2005), *Railway Reform and Charges for the Use of Infrastructure*, OECD, Paris.

ECMT (2006), "Public Accounting and Asset Quality Data: Reporting Requirements for Effective Regulation of Rail Infrastructure", CEMT/CS/CF(2006)2, OECD, Paris.

European Commission (EC) (2001), "White Paper, European Transport Policy for 2010: Time to Decide", Luxemburg.

EC (2005), "Networks for Peace and Development: Extension of the Major Trans-European Transport Axes to the Neighboring Countries and Regions", November, Luxembourg.

EC (2005), "Trans-European Transport Network: TEN-T Priority Axes and Projects 2005", Luxembourg.

Flyvbjerg, Bent, Nils Bruzelius and Werner Rothengatter (2003), *Megaprojects and Risk*, Cambridge University Press, Cambridge.

IEA (2003), ETP Transport Model, Spreadsheet version 1.28.

International Union of Railways (UIC), *International Railway Statistics*.

Kain, Peter (2006), "The Pitfalls in Competitive Tendering: Addressing the Risks Revealed by Experience in Australia and Britain", paper for 12 January ECMT workshop on competitive tendering of rail services.

McClellan, James (2006), "Railroad Capacity Issues", paper for TRB Conference in Railroad R&D Needs for the Future, Washington DC.

McCullough, Gerard (2005), "US Railroad Efficiency: A Brief Economic Overview", Department of Applied Economics, University of Minnesota, Minneapolis.

National Economic Research Associates (NERA) (2004), *Study of the Financing of and Public Budget Contribution to Railways*, London.

Netherlands Court of Audit (Algemene Rekenkamer) (2000), *Policy Information on the Betuwe Line*, *www.rekenkamer.nl/9282200/v/indexdom.htm*.

Penfold, Andrew (undated), "The Future of Seaborne Trade – Supply, Demand and Innovation", PIANC 2020 (Permanent International Association of Navigation Congresses) meeting briefing charts.

Prorail (2006), Network Statement 2006, Netherlands, *www.prorail.nl*.

Prorail (2007), Network Statement 2007, Netherlands, *www.prorail.nl*.

Quinlan, Howard G. (revised 2005), "Route-Kilometer Statistics Tracing the Evolution of Australian Public Railways to 20 June 1997", Australian Railway Historical Society (ACT Division), Canberra.

Sansom, Tom, Chris Nash, Peter Mackie, Jeremy Shires and Paul Watkins (2001), "Surface Transport Costs and Charges", Institute for Transport Studies, University of Leeds, United Kingdom.

Schrank, David and Tim Lomax (2005), "The 2005 Urban Mobility Report", Texas Transportation Institute, College Station.

Stambrook, David (2006), "Key Factors Driving the Future Demand for Surface Transport Infrastructure and Services", in *Infrastructure to 2030: Telecom, Land Transport, Water and Electricity*, OECD, Paris.

Thompson, Louis S. (2003), "Changing Railway Structure and Ownership: Is Anything Working", *Transport Reviews*, Vol. 23, No. 3.

Transportation Research Board (TRB) (1996), "Paying Our Way: Estimating Marginal Social Costs of Freight Transportation", Special Report 246, Washington DC.

TRB (2002), "Freight Capacity for the 21st Century", Special Report No. 271, Washington DC.

United Nations Conference on Trade and Development (UNCTAD) (2005), "Review of Maritime Transport, 2005", United Nations, New York and Geneva.

US Congressional Budget Office (CBO) (2006), "Freight Rail Transportation: Long-Term Issues", January, Washington DC.

US Department of Energy, Oak Ridge National Laboratory (ORNL) (2006), *Transportation Energy Data Book*, 25th Edition.

US Department of Transportation (DOT), Bureau of Transportation Statistics (2003), National Transportation Statistics.

US DOT, Federal Highway Administration (FHWA) (2000), *Addendum to the 1997 Federal Highway Cost Allocation Study*, May, Washington DC.

US DOT FHWA (2005), *International Freight Studies: Summary Report on Europe*, performed late 2000, updated June 2005, *http://ops.fhwa.dot.gov/freight/freight_analysis/euro_scan/index.htm*.

US DOT, Federal Maritime Commission (2005), *Report to Congress on the Performance of Ports and the Intermodal System*, June, Washington DC.

US Surface Transportation Board (STB) (1978 to present), *Statistics of Class I Railroads*, various issues, Washington DC.

Vassallo, Jose Manuel and Mark Fagan (2005), "Nature or Nurture: Why Do Railroads Carry Greater Freight Share in the United States Than in Europe", WP05-15, Harvard University, Kennedy School of Government, Cambridge.

Waterfront Coalition (2005), "National Marine Container Transportation: A Call to Action", May, Washington DC.

Williams, Robert, David Greig and Ian Wallis (2005), "Results of Railway Privatization in Australia and New Zealand", World Bank Transport Paper TP-7, September.

World Bank (2005), *Global Economic Prospects 2005*, Washington DC.

World Bank (2006), *Global Economic Prospects 2006*, Washington DC.

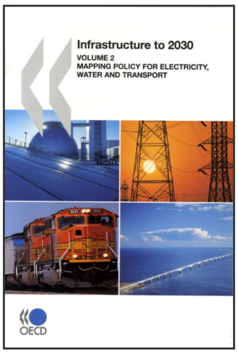
World Bank (undated), Railways Database, data covering 1980 to 2003/4, *www.worldbank.org/transport/rail/rdb.htm*.

Table of Contents

List of boxes

List of tables

List of figures


Infrastructure to 2030
VOLUME 2
MAPPING POLICY FOR ELECTRICITY, WATER AND TRANSPORT
OECD