Interstate Freight on States' Roads

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1 Introduction

Australia's land transport infrastructure is a valuable asset that makes a significant contribution towards the nation's economic performance and its international competitiveness. It is also well documented that freight movements on the road and rail networks play an important part in the Australian economy.

Road transport represents a vital link in various logistics chains, providing access for freight to ports and terminals and urban freight distribution between warehouses and retail outlets. It is also the dominant mode for moving freight over relatively short distances and where alternatives are not readily available. Most non-bulk goods carried by other modes also use road transport for part of their journey. Approximately 80 per cent of road freight is transported over distances of less than 100 kilometers. However, road transport (together with air) has captured from rail and coastal shipping a major part of the market for priority delivery of non-bulk freight over longer distances, especially in the interstate (IS) freight sector.

The Survey of Motor Vehicle Use (SMVU) conducted by the Australian Bureau of Statistics is the primary data source for road freight task estimates. But its definition of interstate road freight is limited to 'freight carried by trucks registered in other states on a state's roads'. Included in this definition is intrastate freight carried mostly within, say NSW, by trucks registered in Victoria. Excluded from this definition is that portion of interstate tonne-kilometres performed by NSW trucks within NSW as they head to, say Victoria. On both counts, the SMVU task estimates of interstate freight for NSW do not measure what road authorities wish measured – which is interstate freight carried by all trucks on a state's roads. This paper derives estimates of this concept of interstate freight and presents a methodology for continually updating the estimates from future SMVUs.

The estimation of interstate road freight tasks within States in this paper is based on origin–destination (O–D) matrices. The study also presents a time-series analysis of interstate road freight task on States' roads between 1971 and 2004.

2 The problem

Since the introduction of the SMVU by the ABS in early 1970s, the ABS has used a limited concept of the interstate road freight task. This interstate road freight task is defined as the amount of tonne-kilometres done by other States' trucks on a State's road.

From 1971 to 1995, the survey (SMVU) was conducted every three to five years. Since 1998, it has been conducted annually. However, because there is no overlap between the samples selected in consecutive years, it has not been specifically designed to measure the change between years. Moreover, this major methodological adjustment in 1998 complicates the use of the data in computing growth rates in road freight. Thus the ABS warns that 'Caution must be used when using the SMVU to measure change'.

Given the importance of growth in Australian road freight, and to overcome the problem of methodological adjustment that complicates the use of the data in computing growth rates, the BTRE has recently completed a major exercise in adjusting past SMVU freight data to make it comparable to the current SMVU methodology (BTRE, 2006). This

exercise detailed the adjustments for road freight time-series for Australia for constructing a standardised time series out of the disjointed and non-comparable data from different years' surveys. The method of standardisation is termed 'disaggregation correction'. It was first used in an earlier paper by BTRE authors (e.g. Cosgrove & Mitchell 2001). Details of the disaggregation correction can be found in BTRE (2006).

In addition, a methodology for estimating road freight over the period 1971 to 2003 for each State and Territory in Australia was proposed, based on adjusted national aggregates from the ABS SMVU (Gargett and Cregan, 2005).

To overcome the problem of the ABS definition of interstate road freight task, it is necessary to derive a more logical and acceptable definition. The amount of freight task (in terms of tonne-kilometres) by all States' trucks on a State's road is essentially linked to origin–destination (O–D) matrices.

3 Four Past Origin-Destination Road Freight Matrices

Four past estimates of interstate road freight movements in Australia based on origin–destination (O–D) are available. These are included in the following Bureau of Transport Economics (BTE) and the Australian Bureau of Statistics (ABS) publications, which were based on various freight movement surveys. These publications are:

(1) BTE Estimates of Australian interregional freight movements, 1971–72 (Commonwealth of Australia, 1976).
(2) Interstate Freight Movement, Australia; 1980–81, based on the 1980–81 Interstate Freight Movement Survey (IFMS) (ABS, 1982).
(3) Experimental Estimates of Freight Movements, based on the 1994–95 Freight Movements Survey (FMS 1994–95) (ABS, 1996).
(4) Freight Movements, Australia, based on the 2000–01 Freight Movements Survey (FMS 2000–01) (ABS, 2002).

3.1 BTE Estimates of Australian interregional freight movements, 1971–72

This publication sets out BTE estimates of the directions and magnitudes of the longer–distance freight movements undertaken in Australia by the various transport modes. Interregional freight estimates were made for 1971–72. These estimates were the first of their kind ever compiled on an Australia-wide basis. However, road freight estimates were subject to more error than for other modes (i.e. rail, sea and air modes).

During the estimation of interregional freight movements based on interregional freight estimates for 1971–72, an experimental method was used to derive interstate road freight matrix. This might have overestimated road freight flows, but the data have not been adjusted.

3.2 ABS Interstate Freight Movement, Australia, 1980-81

This publication presents statistics on interstate freight movements by road, rail, sea and air within Australia which is based on the Interstate Freight Movement Survey (IFMS) for the year ended June 1981 (i.e. financial year). The survey was 'business-based' (i.e. statistics were compiled from data provided by a sample of transport operators and other private and government-owned organisations involved in moving freight by road within Australia).

Interstate road freight movements were collected by means of a census of approximately 16 000 enterprises. The scope of the IFMS included enterprise units undertaking 20 000 tonnes or more of interstate road freight movements in a year, either by hire and reward

under prime contract arrangements or on own account. Freight moved under sub-contract arrangements was excluded.

Data produced by the IFMS included tonnage data for capital cities and some more specific areas by origin and destination.

Interstate Freight Movement Survey was one of the best and most reliable ABS surveys of interstate freight movement. Therefore no adjustment has been made to the estimates.

3.3 ABS Experimental Estimates of Freight Movements, 1994–95

This publication provided statistics on tonnes of freight moved in Australia based on the Freight Movements Survey conducted by ABS (FMS 1994–95). This FMS was carried out quarterly, collecting freight movements by commodity group, mode (including road, rail, sea, and air), weight and origin–destination. Estimates from this survey were labelled experimental because initial results raised concerns over their quality and the underlying methodology of the road component.

Prime contract movements undertaken by businesses which were the registered owners of rigid and articulated trucks with a gross vehicle mass or gross combination mass of 3.5 tonnes or more, respectively, were included in the survey.

Freight moved under sub-contractual arrangements was attempted to be excluded, as it was covered under the prime contract. However, some freight moved under these arrangements was included, although sub-contractors were not supposed to report it. To overcome this potential source of overestimating, estimates of freight movements were adjusted downwards using a factor of 0.87.

3.4 ABS Freight Movements, Australia, 2001

This publication presents results from the Freight Movements Survey (FMS 2000–01). It provides estimates of freight moved by road, rail, sea and air for the period 1 April 2000 to 31 March 2001. A sample of approximately 14 000 articulated vehicles (almost a quarter of the Australian total) was selected to report over 26 fortnightly periods within the reference year.

The statistics for the road component of the collection were based on a sample survey of articulated vehicles (with gross vehicle/combination mass of 4.5 tonnes or more) that were registered with a motor vehicle registry (i.e. the road component of the survey is ‘vehicle-based’). Rigid trucks and other commercial vehicles were excluded from the scope of the survey.

Estimates on freight moved by road have been adjusted to compensate for under-reporting by respondents and for the non-inclusion of rigid trucks (minor for interstate). The final adjustment figure settled on was 1.15.

The estimated tonne–kilometres of road freight for an interstate O–D matrix for 1972, 1980–81, 1994–95 and 2001 are presented in Table 1.

Table 1 Estimated interstate road freight task (million tkm), 1972, 1980–81, 1994–95 and 2001.

Origin	Destination								IS Total
	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	
					1972				
NSW		1 070	730	325	41	0	23	251	2 440
VIC	1 080		354	219	96	0	0	86	1 836
QLD	809	107		101	14	0	113	0	1 143
SA	378	227	165		33	0	142	0	945
WA	48	25	13	47		0	22	0	155
TAS	0	0	0	0	0		0	0	0
NT	14	2	111	27	13	0		0	167
ACT	24	5	0	0	0	0	0		29
IS Total	2 352	1 435	1 373	719	197	0	300	338	6 715
					1980-81				
NSW		1 581	1 002	458	349	0	157	70	3 616
VIC	1 967		1 170	480	428	0	0	51	4 096
QLD	794	508		144	62	0	99	4	1 610
SA	500	356	284		51	0	180	4	1 375
WA	124	120	31	59		0	13	0	346
TAS	0	0	0	0	0		0	0	0
NT	9	4	0	7	1	0		0	22
ACT	30	19	14	2	0	0	0		64
IS Total	3 423	2 587	2 501	1 150	890	0	448	129	11 128
					1994-95[a]				
NSW+ACT[b]		4 217	3 558	1 543	0	0	0		9 318
VIC	4 380		4 245	2 066	0	0	0		10 690
QLD	3 059	2 523		447	784	0	55		6 869
SA	1 390	1 419	594		344	0	253		4 000
WA	0	0	0	0		0	0		0
TAS	0	0	0	0	0		0		0
NT	0	0	0	0	0	0			0
ACT	0	0	0	0	0	0	0		0
IS Total	8 828	8 160	8 397	4 055	1128	0	308	0	30 877
					2001[c]				
NSW		7 119	5 522	2 171	501	0	238	518	16 068
VIC	6 757		2 773	2 507	480	0	0	65	12 581
QLD	5 153	2 332		588	333	0	662	37	9 105
SA	2 029	2 694	800		1 082	0	928	57	7 590
WA	579	374	350	1 051		0	292	0	2 645
TAS	0	0	0	0	0		0	0	0
NT	36	19	240	455	200	0		0	951
ACT	163	30	22	17	0	0	0		233
IS Total	14 717	12 569	9 707	6 789	2 595	0	2 119	678	49 174

[a] Data adjusted for overestimation using a factor of 0.87.
[b] NSW and ACT combined.
[c] Data adjusted for underestimation for using a factor of 1.15.
Source: BTRE estimates.

4 Adapting ABS Survey of Motor Vehicle Data to an O–D Matrix Basis

Similar to the above origin-destination (O–D) matrices, ABS data for road freight task for the years 1982, 1985, 1998, 1999, 2000, 2001, 2002, 2003 and 2004 are estimated. These estimates are presented in Table 2.

The protocol for calculating these O–D matrices is as follows:

(1) We take a three year average of SMVU 2000, 2001 and 2002 (Table 18 of the data cube, which is 'State/Territory of Registration' by 'State/Territory of Operation'), centred at 2001.
(2) We then calculate a cell factor for scaling, equal to the 2001 Freight Measurement Survey (FMS) cell tonne-kilometres divided by the average 2000–2002 SMVU cell tonne-kilometres.
(3) Then we use this scaling factor on that O–D cell in each of the SMVU matrices of 1998, 1999, 2000, 2001, 2002, 2003 and 2004.
(4) We do a similar operation to derive the 1982 and 1985 matrices based on using the 1981 O–D matrix in the scaling factor.

Table 2 Estimated interstate road freight task (million tkm) on an O–D matrix basis, 1982, 1985 and 1998 to 2004.

Origin	Destination								IS Total
	NSW	VIC	Qld	SA	WA	TAS	NT	ACT	
				1982					
NSW		1 867	1 041	467	114	0	211	51	3 750
VIC	2 403		1 319	547	765	0	0	58	5 091
QLD	719	403		152	72	0	120	6	1 472
SA	435	389	364		12	0	72	5	1 277
WA	68	155	42	59		0	7	0	331
TAS	0	0	0	0	0		0	0	0
NT	7	2	0	12	2	0		0	22
ACT	51	27	26	4	0	0	0		108
IS Total	3 683	2 843	2 791	1 241	964	0	410	119	12 051
				1985					
NSW		2 045	1 482	688	840	0	169	132	5 356
VIC	2 440		1 595	647	214	0	0	70	4 967
QLD	1 312	915		210	83	0	124	2	2 645
SA	851	501	331		128	0	415	5	2 231
WA	262	137	33	91		0	27	0	550
TAS	0	0	0	0	0		0	0	0
NT	16	9	0	6	2	0		0	32
ACT	18	17	6	1	0	0	0		41
IS Total	4 899	3 624	3 447	1 642	1 267	0	735	209	15 823
				1 998					
NSW		5 562	3 926	770	1 012	0	7	385	11 663
VIC	5 188		1 038	2 154	673	0	0	62	9 115
QLD	4 017	2 276		566	277	0	135	111	7 382
SA	917	2 513	249		2 950	0	367	2	6 998
WA	282	180	212	974		0	242	0	1 889
TAS	0	0	0	0	0		0	0	0
NT	44	87	664	419	84	0		0	1 298
ACT	166	14	9	16	0	0	0		205
IS Total	10 614	10 631	6 098	4 899	4 996	0	751	562	38 550
				1999					
NSW		6 594	6 791	1 356	1 862	0	156	403	17 163
VIC	5 696		2 222	2 502	599	0	0	62	11 081
QLD	4 168	2 082		753	531	0	817	223	8 574
SA	1 375	3 049	723		2 552	0	272	2	7 974
WA	300	67	250	401		0	989	0	2 007
TAS	0	0	0	0	0		0	0	0
NT	37	202	734	503	145	0		0	1 621
ACT	173	23	27	8	0	0	0		232
IS Total	11 750	12 018	10 747	5 523	5 688	0	2 235	691	48 652

(continued)

Table 2 Estimated interstate road freight task (million tkm) on an O–D matrix basis, 1982, 1985 and 1998 to 2004 (continued).

	Destination								IS Total
Origin	NSW	VIC	Qld	SA	WA	TAS	NT	ACT	
				2000					
NSW		7 708	5 810	1 801	605	0	7	571	16 502
VIC	7 167		3 556	2 794	541	0	0	31	14 089
QLD	4 674	1 764		1 129	638	0	515	0	8 720
SA	1 703	2 301	814		769	0	1 537	142	7 265
WA	294	135	166	668		0	408	0	1 671
TAS	0	0	0	0	0		0	0	0
NT	67	0	363	453	123	0		0	1 005
ACT	189	27	31	26	0	0	0		272
IS Total	14 094	11 935	10 740	6 870	2 675	0	2 466	745	49 524
				2001					
NSW		7 139	5 081	2 740	7	0	27	526	15 520
VIC	6 522		1 925	2 442	616	0	0	105	11 610
QLD	5 846	2 394		355	120	0	409	56	9 180
SA	1 588	2 366	613		1 280	0	598	20	6 465
WA	837	710	577	1 440		0	263	0	3 827
TAS	0	0	0	0	0		0	0	0
NT	30	29	151	494	317	0		0	1 021
ACT	113	16	11	6	0	0	0		147
IS Total	14 935	12 654	8 357	7 478	2 340	0	1 298	707	47 770
				2002					
NSW		6 509	5 674	1 973	890	0	679	458	16 184
VIC	6 581		2 837	2 284	282	0	0	59	12 044
QLD	4 939	2 837		280	241	0	1 062	56	9 414
SA	2 796	3 415	974		1 197	0	649	10	9 040
WA	605	279	307	1 043		0	204	0	2 438
TAS	0	0	0	0	0		0	0	0
NT	12	29	208	419	160	0		0	828
ACT	188	49	25	18	0	0	0		280
IS Total	15 121	13 117	10 024	6 018	2 770	0	2 595	583	50 228
				2003					
NSW		9 249	5 719	2 683	1 271	0	197	911	20 031
VIC	6 450		3 446	2 346	74	0	0	25	12 341
QLD	6 702	3 834		526	156	0	199	56	11 474
SA	4 139	3 025	753		1 404	0	119	2	9 442
WA	659	930	453	1 428		0	1 010	0	4 481
TAS	0	0	0	0	0		0	0	0
NT	107	29	253	395	327	0		0	1 111
ACT	132	45	28	16	0	0	0		222
IS Total	18 189	17 113	10 653	7 395	3 232	0	1 526	995	59 102
				2004					
NSW		6 217	6 697	2 387	61	0	0	662	16 024
VIC	7 707		2 572	2 475	217	0	0	18	12 989
QLD	6 029	4 103		2 152	90	0	3 006	502	15 882
SA	1 993	2 317	525		696	0	479	52	6 063
WA	675	72	453	1 031		0	272	0	2 504
TAS	0	0	0	0	0		0	0	0
NT	77	895	212	213	419	0		0	1 816
ACT	165	40	22	3	0	0	0		231
IS Total	16 647	13 645	10 481	8 261	1 483	0	3 757	1 234	55 508

Source: BTRE estimates.

5 Cell-by-Cell O–D Matrix Modelling

Cell-by-cell O–D matrix modelling was done by interpolating road freight task data from 1970 to 2005 between isolated O–D pairs by means of the most representative trucking time–series around — the number of trucks passing through Marulan. This was multiplied by a load per truck series from BTRE (2006) to give a series on tonnages through Marulan. For the regressions between the road freight task and the tonnages passing through Marulan, 'Log' transformation was used. In many cases, a time trend was included, depending on the nature of data.

Actual and predicted road freight tasks (million tonne–kilometres) between 1972 and 2004 for NSW–VIC and QLD–NSW are presented in Figure 1 as examples, while the coefficients of regression analysis for various routes are given in Table 3. However, some of the years' data for some routes were omitted from the regression due to large variability in the data set. These are highlighted in the footnotes of Table 3.

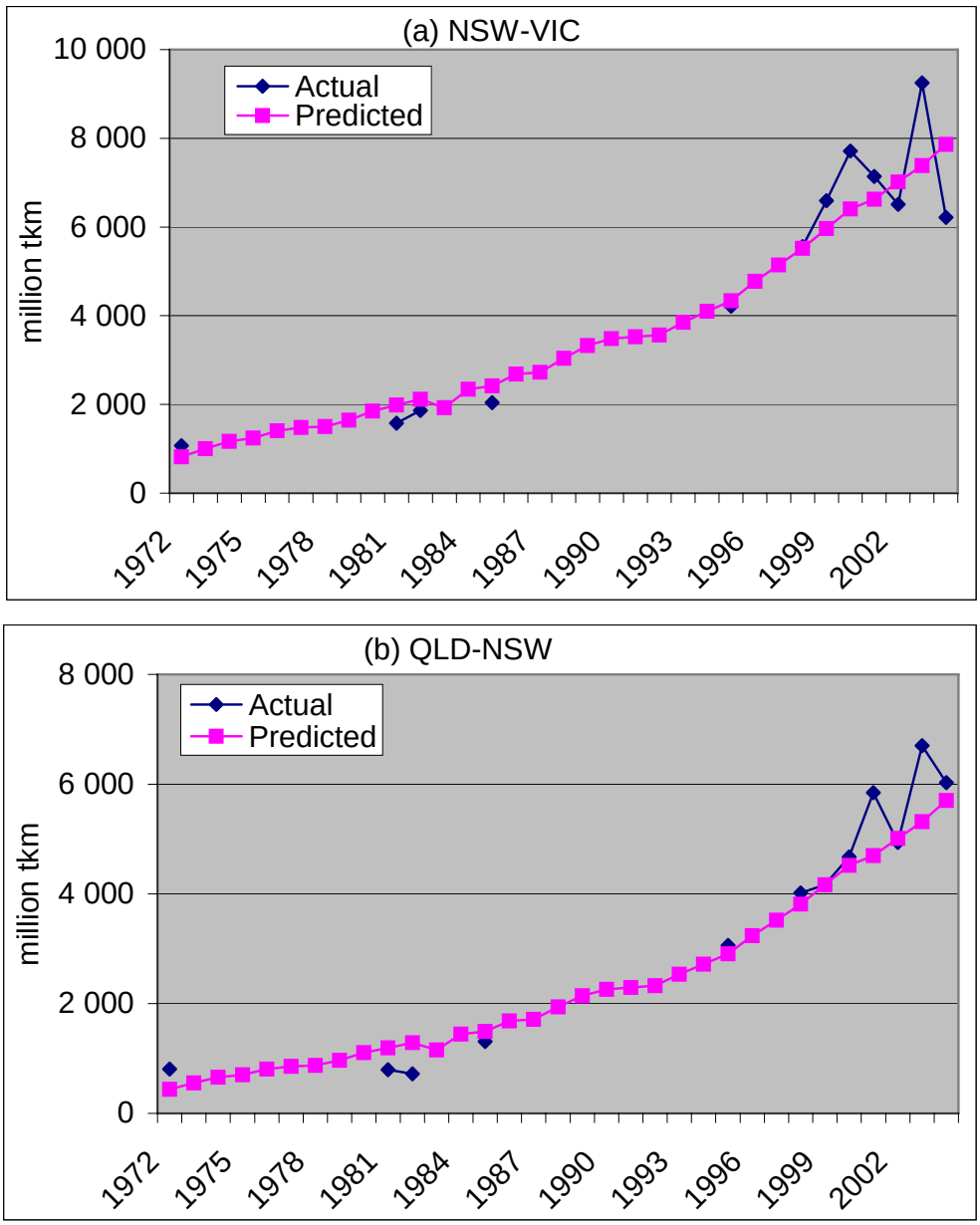


Figure 1 Actual and predicted road freight task (million tkm) between 1970–2005 for (a) NSW–VIC and (b) QLD–NSW.

Table 3 Coefficients of regression analysis for various routes, 1970–2004.

Route	Coefficients			
	Intercept	Log Marulan	Time	Eyre H'way dummy
NSW-VIC	-0.6239	0.9795		
VIC-NSW	2.8809	0.5421	0.0224	
NSW-QLD	-2.2154	1.1237		
QLD-NSW	-2.2446	1.1122		
NSW-SA	-1.4963	0.9335		
SA-NSW	-1.3426	0.9253		
VIC-SA	1.9146	0.4592	0.0493	
SA-VIC	-4.9928	1.3342		
NSW-ACT	-2.4727	0.8953		
ACT-NSW	-5.5138	1.0959		
VIC-QLD[a]	-13.6574	2.6276	-0.1227	
QLD-VIC[a]	-7.1805	1.5987	-0.0105	
ES-WA[b,c]	-0.8012	0.8038		0.9135
WA-ES[c]	-5.4154	1.3521		
ES-NT	-0.9336	0.8499		
NT-ES[d]	-1.1067	0.8298		
VIC-ACT[e]	79.0426		-1.1419	
ACT-VIC	-20.4942	2.9790	-0.1573	
QLD-SA	-3.6445	1.0573		
SA-QLD[f]	-1.7057	0.9094	-0.0149	
WA-NT[g]	-6.7440	1.3223		
NT-WA[g]	-7.2897	1.3002		

[a] VIC-QLD and QLD-VIC data regressed without 1995 and 1998.
[b] Eyre Highway dummy was included, while 2004 data was excluded due to low value.
[c] ES-WA and WA-ES data regressed without 1998 and 1999.
[d] NT-ES data were regressed without 1981, 1982 and 1985.
[e] No Marulan.
[f] SA-QLD data were regressed without 1998, due to very low value.
[g] Regressed without 1981, 1982 and 1985.
Note: ES - Eastern States include NSW, VIC, QLD and SA.

Using the equations from the regression analysis, road freight data were interpolated from 1970 to 2005 for each O–D pair. The ES–WA and ES–NT interpolations were further separated into O–D cell estimates using very rough share splits over time. Table 4 shows the results of regression interpolation for each of the O–D pair examined.

6 Splitting Origin–Destination Flows by State

To split the tonne-kilometres for an O–D pair by the state in which it is performed, we use a “fractions by state” table (Table 5). This roughly allocates the total tonne-kilometres for a specific O–D by the states in which it is performed.

For example, for the South Australia to Queensland cell of the matrix, the fractions say that the task (840 thousand tkm in 2005 – Table 4) should be split by the fractions 0.10 from the origin in SA to the VIC border, 0.05 through the north-west corner of VIC, 0.58 through NSW to the QLD border, and 0.27 within QLD (see Table 5, SA-QLD row).

Table 4 Results of regression interpolation for O–D pairs (million tkm).

	NSW-VIC	VIC-NSW	NSW-QLD	QLD-NSW	NSW-SA	SA-NSW	VIC-SA	SA-VIC	NSW-ACT	ACT-NSW	VIC-QLD	QLD-VIC	VIC-ACT	ACT-VIC	QLD-SA	SA-QLD	WA-NT	NT-WA	ES-WA NSW	ES-WA VIC	ES-WA QLD	ES-WA SA	Total ES-WA	WA-ES NSW	WA-ES VIC	WA-ES QLD	WA-ES SA	Total WA-ES	ES-NT NSW	ES-NT VIC	ES-NT QLD	ES-NT SA	Total ES-NT	NT-ES NSW	NT-ES VIC	NT-ES QLD	NT-ES SA	Total NT-ES
1970	715	936	420	375	213	234	188	123	61	13	321	97	80	5	62	147	20	10	33	99	16	16	165	37	28	9	18	92	33	0	49	65	147	12	12	71	107	202
1971	731	968	431	384	218	239	200	126	62	13	300	99	79	4	63	148	20	10	34	101	17	17	168	38	28	9	19	94	33	0	50	66	150	12	12	73	109	206
1972	818	1054	490	437	242	266	222	147	69	15	360	118	78	5	71	162	23	11	37	110	18	18	184	44	33	11	22	110	37	0	55	73	165	13	13	80	120	228
1973	1002	1206	618	550	294	322	256	194	83	18	548	163	77	8	89	192	31	15	43	130	22	22	217	58	44	15	29	146	43	0	65	87	195	16	16	96	144	271
1974	1169	1343	738	655	341	372	289	240	95	22	734	208	76	11	105	219	38	18	49	148	25	25	247	72	54	18	36	181	50	0	74	99	223	18	18	109	164	310
1975	1246	1423	794	704	362	395	313	261	101	24	770	228	74	12	112	228	41	20	52	156	26	26	260	79	59	20	39	197	52	0	78	104	235	19	19	116	173	328
1976	1406	1555	912	808	406	443	348	308	113	27	942	275	73	14	128	252	49	24	143	429	72	72	715	93	70	23	47	233	58	0	87	116	260	21	21	128	193	364
1977	1480	1637	968	856	427	465	374	330	118	29	956	296	72	14	135	260	52	25	149	448	75	75	746	100	75	25	50	250	60	0	91	121	272	22	22	134	201	381
1978	1503	1688	985	871	433	472	396	337	120	29	881	300	71	13	138	260	53	26	151	453	76	76	756	102	77	26	51	256	61	0	92	123	276	23	23	136	204	386
1979	1648	1816	1095	967	473	515	434	382	130	32	998	345	70	14	152	279	60	29	163	489	81	81	815	116	87	29	58	290	66	0	99	132	298	25	25	147	221	418
1980	1850	1980	1250	1103	528	574	482	448	145	37	1203	412	69	18	172	306	70	34	179	538	90	90	896	136	102	34	68	340	73	0	110	146	329	27	27	163	244	462
1981	1986	2106	1356	1195	564	614	523	493	154	40	1287	458	68	19	186	322	77	37	190	570	95	95	950	150	113	38	75	375	78	0	116	155	349	29	29	173	260	491
1982	2119	2232	1460	1287	600	653	566	538	164	43	1355	504	66	19	200	337	84	41	206	590	103	103	1001	164	123	41	82	410	82	0	123	164	369	31	31	183	275	519
1983	1923	2164	1307	1153	548	596	569	472	150	38	925	426	65	12	180	303	74	36	190	521	95	119	925	144	108	36	72	359	75	0	113	151	340	28	28	169	253	478
1984	2342	2467	1638	1442	661	718	655	617	179	48	1387	581	64	19	222	359	97	46	224	583	112	168	1087	189	141	47	94	471	89	0	134	178	401	33	33	200	300	567
1985	2416	2567	1697	1493	680	739	698	644	185	49	1333	604	63	18	230	364	101	48	230	569	115	201	1115	197	148	49	98	492	92	0	137	183	412	34	34	205	308	582
1986	2687	2784	1918	1685	753	817	771	744	203	56	1569	712	62	21	258	396	116	56	252	588	126	252	1217	222	163	57	128	570	100	0	150	200	451	38	38	225	338	638
1987	2723	2868	1947	1711	762	828	815	758	206	56	1438	719	61	19	262	395	119	57	255	562	127	286	1230	220	157	58	144	580	101	0	152	203	456	38	38	228	342	646
1988	3038	3116	2208	1937	846	918	901	880	228	64	1706	851	60	23	294	431	137	66	279	579	140	349	1346	249	173	68	184	675	111	0	167	222	500	42	42	251	376	710
1989	3323	3349	2448	2145	922	999	988	994	247	71	1921	975	58	25	324	461	155	74	301	584	150	414	1449	275	185	78	227	764	120	0	180	240	540	45	45	271	406	768
1990	3483	3515	2582	2262	964	1044	1061	1060	258	74	1926	1042	57	25	341	474	165	79	313	566	157	470	1506	284	185	83	262	815	125	0	187	250	562	47	47	282	423	799
1991	3525	3619	2618	2294	975	1056	1120	1077	261	75	1760	1051	56	22	346	473	168	80	317	531	158	515	1521	281	176	85	287	829	126	0	189	252	567	48	48	285	428	808
1992	3568	3726	2656	2326	987	1068	1184	1095	264	76	1609	1061	55	20	350	471	171	81	320	495	160	561	1536	277	167	87	313	843	127	0	191	255	573	48	48	288	432	817
1993	3854	3976	2901	2539	1062	1149	1289	1217	283	83	1750	1191	54	21	381	499	190	90	342	483	171	641	1636	298	171	97	372	938	136	0	204	272	612	51	51	308	462	873
1994	4096	4205	3111	2720	1125	1217	1394	1322	299	89	1822	1302	53	22	407	520	206	97	360	460	180	720	1720	313	171	106	431	1020	143	0	215	286	644	54	54	325	487	920
1995	4339	4440	3323	2904	1189	1285	1504	1430	315	95	1881	1415	52	22	433	540	222	105	378	433	189	803	1803	327	168	115	495	1104	150	0	226	301	677	57	57	341	512	967
1996	4775	4787	3709	3237	1302	1407	1653	1629	344	106	2151	1637	50	25	480	582	253	119	409	415	205	921	1951	359	172	132	597	1260	163	0	245	326	734	62	62	371	557	1051
1997	5141	5100	4037	3521	1397	1509	1797	1801	368	115	2320	1827	49	27	520	614	280	132	436	384	218	1035	2073	383	169	146	698	1395	174	0	260	347	781	66	66	396	593	1121
1998	5517	5423	4378	3815	1495	1613	1952	1983	393	124	2481	2029	48	29	561	646	308	145	462	347	231	1156	2196	405	162	162	810	1538	184	0	276	369	829	70	70	421	631	1192
1999	5965	5791	4788	4168	1610	1736	2127	2206	422	136	2705	2281	47	31	610	684	342	161	493	370	246	1232	2342	451	180	180	902	1713	197	0	295	394	886	75	75	450	675	1275
2000	6406	6160	5196	4519	1723	1857	2310	2431	450	147	2897	2535	46	33	659	720	376	176	523	392	261	1307	2483	497	199	199	995	1890	209	0	314	418	941	80	80	479	718	1357
2001	6626	6418	5401	4696	1780	1917	2466	2545	464	153	2805	2651	45	31	683	732	394	185	537	403	269	1343	2552	521	208	208	1042	1980	215	0	323	430	969	82	82	493	740	1397
2002	7014	6774	5765	5009	1879	2023	2660	2750	489	163	2891	2878	44	32	726	760	425	199	563	422	282	1408	2674	564	226	226	1128	2142	226	0	339	452	1016	86	86	518	777	1468
2003	7387	7129	6119	5313	1974	2125	2863	2951	513	172	2939	3100	43	32	768	786	456	213	588	441	294	1469	2791	606	242	242	1211	2301	236	0	354	472	1062	90	90	542	813	1535
2004	7859	7544	6569	5700	2094	2253	3097	3211	542	185	3069	3393	41	38	821	820	496	232	618	464	309	1545	2936	660	264	264	1319	2507	249	0	373	497	1119	95	95	572	858	1620
2005	8200	7898	6897	5982	2180	2345	3318	3402	564	194	3042	3599	40	44	860	840	525	245	640	480	320	1600	3040	699	280	280	1399	2658	258	0	387	516	1160	99	99	593	890	1681

Source: BTRE estimates.

Table 5 Fractions by States from origin to destination.

Origin		Task split by States (fractions)							
From		NSW						ACT	
	To		VIC	QLD	SA	WA	TAS	NT	Total
NSW-	VIC	0.50	0.50						1.00
	QLD	0.80		0.20					1.00
	SA	0.70	0.10		0.20				1.00
	WA	0.25	0.05		0.20	0.50			1.00
	TAS								0.00
	NT	0.25			0.35			0.40	1.00
	ACT	0.95						0.05	1.00
VIC-	NSW	0.50	0.50						1.00
	QLD	0.70	0.18	0.12					1.00
	SA		0.60		0.40				1.00
	WA		0.13		0.45	0.42			1.00
	TAS								0.00
	NT		0.12		0.43			0.45	1.00
	ACT	0.54	0.45					0.01	1.00
QLD-	NSW	0.80		0.20					1.00
	VIC	0.70	0.18	0.12					1.00
	SA	0.58	0.05	0.27	0.10				1.00
	WA	0.29	0.02	0.08	0.31	0.30			1.00
	TAS								0.00
	NT			0.62				0.38	1.00
	ACT								0.00
SA-	NSW	0.70	0.10		0.20				1.00
	VIC		0.60		0.40				1.00
	QLD	0.58	0.05	0.27	0.10				1.00
	WA				0.51	0.49			1.00
	TAS								0.00
	NT				0.46			0.54	1.00
	ACT								0.00
WA-	NSW	0.25	0.05		0.20	0.50			1.00
	VIC		0.13		0.45	0.42			1.00
	QLD	0.29	0.02	0.08	0.31	0.30			1.00
	SA				0.51	0.49			1.00
	TAS								0.00
	NT					0.85		0.15	1.00
	ACT								0.00
NT-	NSW	0.25			0.35			0.40	1.00
	VIC		0.12		0.43			0.45	1.00
	QLD			0.62				0.38	1.00
	SA				0.46			0.54	1.00
	WA					0.85		0.15	1.00
	TAS								0.00
	ACT								0.00
ACT-	NSW	0.95						0.05	1.00
	VIC	0.54	0.45					0.01	1.00
	QLD								0.00
	SA								0.00
	WA								0.00
	TAS								0.00
	NT								0.00

Source: BTRE estimates.

The fractions presented in Table 5 are then multiplied by the O–D cell's total freight task of 840 thousand tkm to give the tkm task split by state. Thus SA=0.10*840=84, VIC=0.05*840=42, NSW=0.58*840=487, and QLD=0.27*840=227 (see Table 6, SA-QLD row).

Next these tkm O–D task components are characterised as either ‘from’, ‘through’, or ‘to’. Thus in our example, SA ’from’=84, VIC ‘through’=42, NSW ‘through’=487, and QLD ’to’=227.

Table 6 Road freight task for 2005 by States, calculated using fractions.

Origin		Task split by States (million tkm)								
From	To	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	Total
NSW-	VIC	4100	4100							8200
	QLD	5518		1379						6897
	SA	1526	218		436					2180
	WA	160	32		128	320				640
	TAS									
	NT	64			90			103		258
	ACT	536							28	564
VIC-	NSW	3949	3949							7898
	QLD	2130	548	365						3042
	SA		1991		1327					3318
	WA		62		216	202				480
	TAS									
	NT		0		0			0		0
	ACT	22	18							40
QLD-	NSW	4785		1196						5982
	VIC	2519	648	432						3599
	SA	499	43	232	86					860
	WA	93	6	26	99	96				320
	TAS									
	NT			240				147		387
	ACT									
SA-	NSW	1641	234		469					2345
	VIC		2041		1361					3402
	QLD	487	42	227	84					840
	WA				816	784				1600
	TAS									
	NT				237			278		516
	ACT									
WA-	NSW	175	35		140	350				699
	VIC		36		126	118				280
	QLD	81	6	22	87	84				280
	SA				713	685				1399
	TAS									
	NT					446		79		525
	ACT									
NT-	NSW	25			35			40		99
	VIC		12		43			44		99
	QLD			368				225		593
	SA				409			480		890
	WA					208		37		245
	TAS									
	ACT									
ACT-	NSW	184							10	194
	VIC	24	20						0	44
	QLD									
	SA									
	WA									
	TAS									
	NT									

Source: BTRE estimates.

7 Final Origin-Destination-Based Interstate Freight Flow Estimates

Once all the O–D component tasks for each cell of one year's O–D matrix are sorted by 'from', 'through' and 'to', and are cumulated, one row of Table 7 is produced. It gives an estimate of the amount of different types of interstate freight being carried on each state's roads.

The last column of Table 7 gives the new O–D-based estimate of interstate freight nationally. Figure 2 shows that it compares quite well to the previous estimate of total interstate freight published in BTRE Report 112, Freight Measurement and Modelling (BTRE, 2006). This previous estimate was based on total Australia interstate freight on the ABS definition, times 1.4 to account for the portion of interstate trips done within a state by that state's trucks.

But the state estimates calculated in this paper are now different, being based on a true 'state of task performance' basis, rather than a 'state of registration by main area of operation outside of the state' basis.

This, then, was the solution we sought to the problem posed at the beginning of the paper. The new data for each state tells state authorities the growth rates of interstate freight flowing across their roads. In addition, it allows them to understand the growth rates of particular O–D combinations. This allows a focus on growth along the probable routes the trucks will be taking.

8 Summary

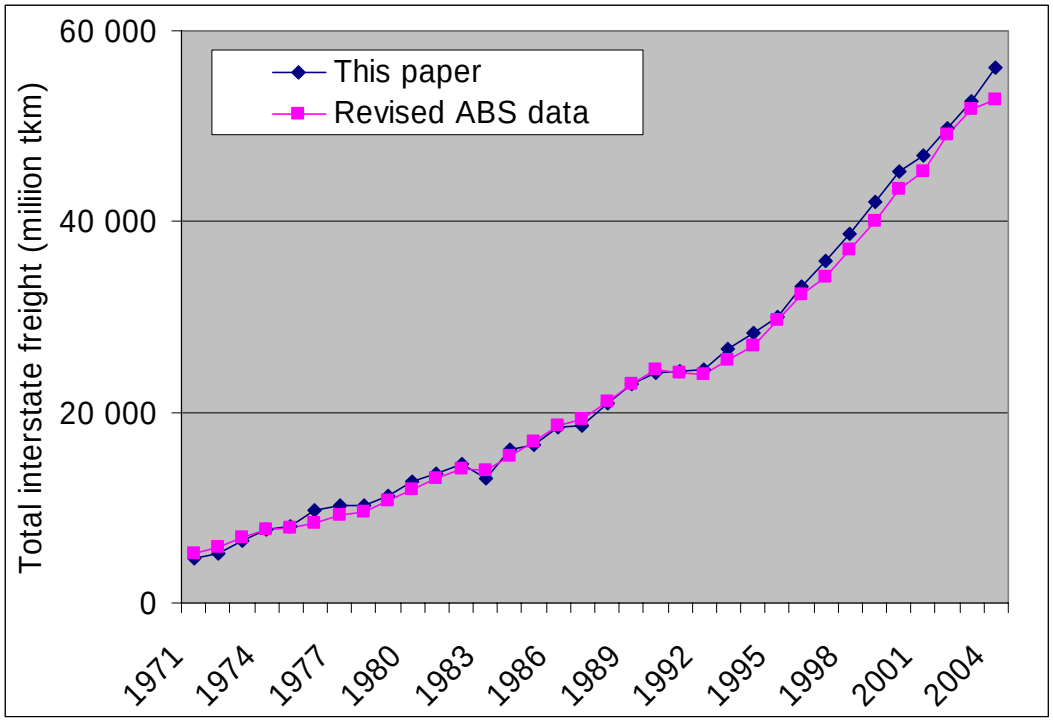
The origin-destination matrices derived for multiple years from 1972 to 2004, allow for logical control over the definition of interstate freight. The method of analysis developed in the paper generates levels of total interstate freight similar to previous BTRE estimates, but the state split differs. The new estimates allow us to derive the first estimates of the concept 'the interstate freight task performed on each state's roads'.

Using the methods outlined, rough annual updates of the O–D matrix can be derived from each new Survey of Motor Vehicle Use. In addition, the time series estimates, rough as they are, can be used as the basis for forecasting the matrix into the future, and thus generating forecasts of the volume of interstate freight on states' roads.

Table 7 Final estimates of interstate freight (million tkm) on States' roads.

	NSW				VIC				QLD				SA				WA				NT				ACT				IS Total			
	From	To	Thru	Total	From	To	Thru	Total	From	To	Thru	Total	From	To	Thru	Total	From	To	Thru	Total	From	To	Thru	Total	From	To	Thru	Total	From	To	Thru	Total
1970	917	956	467	2339	687	456	59	1202	135	207	0	342	149	183	99	431	58	79	0	137	97	70	0	166	1	4	0	5	2044	1954	625	4624
1971	938	983	455	2376	707	466	60	1233	138	208	0	346	152	190	101	443	60	81	0	141	98	71	0	170	1	4	0	5	2094	2003	617	4713
1972	1055	1091	524	2669	774	527	67	1368	156	236	0	392	171	211	113	495	70	89	0	159	109	79	0	187	1	4	0	5	2336	2236	704	5276
1973	1302	1304	717	3323	907	658	81	1646	196	302	0	498	212	251	138	601	92	106	0	199	130	94	0	223	1	5	0	6	2839	2720	936	6496
1974	1529	1500	906	3935	1030	780	94	1905	232	364	0	596	250	288	160	699	114	122	0	236	149	107	0	256	1	6	0	7	3306	3167	1161	7633
1975	1633	1598	956	4187	1091	836	100	2027	249	386	0	635	268	309	170	747	125	129	0	254	157	113	0	270	1	6	0	7	3525	3377	1226	8128
1976	1874	1789	1147	4810	1245	955	118	2318	289	445	0	734	327	346	338	1011	147	328	0	475	175	126	0	301	1	6	0	8	4058	3995	1603	9656
1977	1977	1887	1181	5045	1306	1010	123	2439	306	464	0	769	345	367	355	1066	158	343	0	501	183	132	0	314	2	7	0	8	4275	4209	1659	10144
1978	2009	1931	1132	5072	1331	1027	125	2483	311	459	0	770	350	379	360	1089	161	348	0	509	185	134	0	319	2	7	0	8	4349	4283	1617	10250
1979	2211	2108	1268	5587	1443	1136	136	2716	344	508	0	852	386	415	392	1193	183	376	0	559	201	145	0	345	2	7	0	9	4770	4695	1796	11261
1980	2494	2350	1491	6335	1596	1292	152	3041	392	581	0	972	437	463	436	1336	214	415	0	629	222	160	0	382	2	8	0	10	5358	5269	2079	12706
1981	2686	2522	1601	6809	1703	1398	163	3264	424	623	0	1047	472	499	466	1436	236	441	0	677	236	171	0	407	2	8	0	11	5760	5661	2230	13651
1982	2875	2692	1700	7267	1806	1501	174	3481	456	663	0	1119	507	535	492	1534	258	466	0	725	250	181	0	431	2	9	0	11	6156	6046	2366	14567
1983	2599	2501	1306	6406	1687	1345	158	3189	408	562	0	970	468	508	439	1415	226	431	0	657	230	166	0	396	2	8	0	10	5621	5520	1902	13042
1984	3193	2990	1806	7989	1981	1677	191	3849	510	719	0	1229	594	602	515	1712	296	512	0	809	273	197	0	471	3	10	0	12	6850	6708	2512	16069
1985	3298	3100	1792	8190	2045	1734	196	3975	528	729	0	1257	629	630	517	1776	309	528	0	837	281	203	0	484	3	10	0	13	7091	6935	2506	16532
1986	3686	3430	2073	9189	2241	1953	217	4412	595	823	0	1418	721	705	554	1980	358	581	0	939	308	223	0	531	3	11	0	14	7913	7726	2844	18483
1987	3737	3500	1988	9225	2282	1979	219	4481	603	814	0	1418	747	735	541	2024	365	590	0	955	312	225	0	537	3	11	0	14	8051	7855	2748	18654
1988	4191	3884	2315	10390	2508	2238	243	4989	684	923	0	1607	859	826	580	2265	425	651	0	1076	344	249	0	592	3	12	0	15	9013	8782	3138	20934
1989	4605	4237	2594	11437	2715	2475	265	5455	757	1019	0	1776	965	915	609	2489	481	706	0	1188	372	269	0	641	4	13	0	17	9900	9634	3468	23002
1990	4836	4452	2665	11953	2840	2606	276	5722	798	1057	0	1856	1035	980	612	2627	514	738	0	1252	388	281	0	668	4	13	0	17	10415	10127	3553	24095
1991	4898	4537	2555	11991	2893	2637	279	5808	808	1046	0	1854	1068	1021	594	2683	523	749	0	1272	392	284	0	675	4	14	0	18	10586	10287	3429	24302
1992	4962	4625	2457	12044	2952	2669	281	5902	818	1037	0	1855	1102	1064	576	2742	533	760	0	1293	396	287	0	683	4	14	0	18	10767	10456	3314	24537
1993	5380	4990	2687	13057	3164	2910	302	6376	894	1124	0	2017	1218	1169	593	2980	593	815	0	1409	424	307	0	731	4	15	0	19	11677	11329	3582	26588
1994	5734	5307	2847	13888	3350	3114	320	6784	958	1191	0	2148	1323	1267	599	3189	646	863	0	1508	447	324	0	772	5	15	0	20	12462	12081	3766	28310
1995	6091	5628	2999	14719	3540	3320	337	7198	1022	1257	0	2279	1431	1370	603	3404	700	911	0	1610	470	342	0	812	5	16	0	21	13260	12845	3939	30043
1996	6736	6174	3406	16316	3849	3701	369	7919	1141	1398	0	2539	1611	1530	628	3769	799	994	0	1793	512	372	0	884	6	18	0	23	14654	14186	4403	33243
1997	7280	6644	3707	17632	4118	4022	395	8536	1243	1509	0	2751	1771	1679	638	4088	886	1064	0	1949	547	398	0	944	6	19	0	25	15850	15334	4741	35925
1998	7842	7129	4012	18984	4396	4356	422	9175	1348	1621	0	2969	1940	1839	643	4422	977	1136	0	2113	582	424	0	1006	7	20	0	27	17091	16526	5078	38695
1999	8513	7705	4406	20624	4728	4763	455	9945	1475	1760	0	3235	2107	2004	696	4808	1087	1216	0	2304	623	455	0	1078	7	22	0	29	18540	17925	5557	42022
2000	9176	8279	4778	22234	5059	5168	487	10714	1601	1894	0	3495	2274	2172	748	5195	1199	1295	0	2494	664	485	0	1149	8	23	0	31	19982	19316	6013	45312
2001	9508	8604	4819	22932	5266	5368	503	11137	1663	1937	0	3600	2358	2282	774	5414	1256	1334	0	2590	684	500	0	1184	8	24	0	32	20744	20048	6097	46889
2002	10096	9127	5088	24311	5578	5729	531	11837	1776	2044	0	3820	2506	2445	820	5772	1358	1402	0	2760	720	527	0	1246	8	25	0	33	22042	21299	6440	49781
2003	10663	9640	5324	25627	5888	6079	558	12525	1885	2144	0	4029	2650	2609	865	6124	1458	1468	0	2926	753	552	0	1306	9	26	0	35	23307	22518	6747	52572
2004	11383	10274	5685	27342	6261	6530	592	13384	2025	2279	0	4304	2834	2807	922	6563	1588	1551	0	3138	796	584	0	1380	10	28	0	37	24897	24052	7199	56148
2005	11904	10759	5854	28517	6568	6857	616	14041	2126	2361	0	4487	2967	2972	963	6902	1683	1610	0	3293	827	607	0	1434	10	29	0	39	26085	25196	7434	58714

Note: No data for Tasmania.
Source: BTRE estimates.



Source: BTRE estimates.

Figure 2 Current versus previous estimates of total interstate road freight.

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