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Australian Road Freight – Measuring and Modelling

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Abstract

This paper presents a methodology for removing 'survey noise' from a time series of Survey of Motor Vehicle Use (SMVU) statistics on road freight in Australia.

Once this has been done, a model is fitted to the adjusted data, allowing forecasts for future growth in road freight.

The model also allows the examination of the effects of COVID on road freight, using the ABS 4-month breakdowns of 2017-18 and 2019-20.

1.Removing the noise from SMVU survey data

The Australian Bureau of Statistics (ABS) has conducted the Survey of Motor Vehicle Use intermittently since 1971.

The survey breaks down by three freight vehicle types –Light Commercial Vehicles (LCVs), Rigid trucks (Rigids) and Articulated trucks (Artics).

It also allows the specification of four major components of freight tonne-kilometres (freight tkm -the measure of the freight task performed by each vehicle type). The formula is as follows:

Freight tkm = number of vehicles * proportion with laden business kilometres * average load per business kilometre * laden business kilometres

The process of removing the noise from the SMVU time series involves 'adjusting' each of these components over time. The following description of the methodology deals with articulated trucks.

Starting with vehicle numbers, an adjustment is made to adjust the varying survey dates to a consistent mid-financial-year definition. This is then compared to numbers of articulated trucks derived from the ABS Motor Vehicle Census (MVC - note that the SMVU sample is selected from the MVC, but the number of vehicles by vehicle type may differ between the two upon return of the survey). Finally an 'adjusted date' vehicle number is decided on. Table 1 shows the calculations behind the final adjusted vehicle number series.

The raw and adjusted 1) proportion of vehicles with laden business kilometres, 2) average load per business kilometre and 3) laden business kilometres are shown in Table 2. The adjustments are idiosyncratic, and are made on the assumptions that components only change slowly over time. When combined in the formula given above, a series for **adjusted articulated tonne-kilometres** is derived. Similar smoothing is done for the other vehicle types.

The raw SMVU and adjusted SMVU series for the components and for total tonne-kilometres are shown in Figure 1 for the three vehicles types.

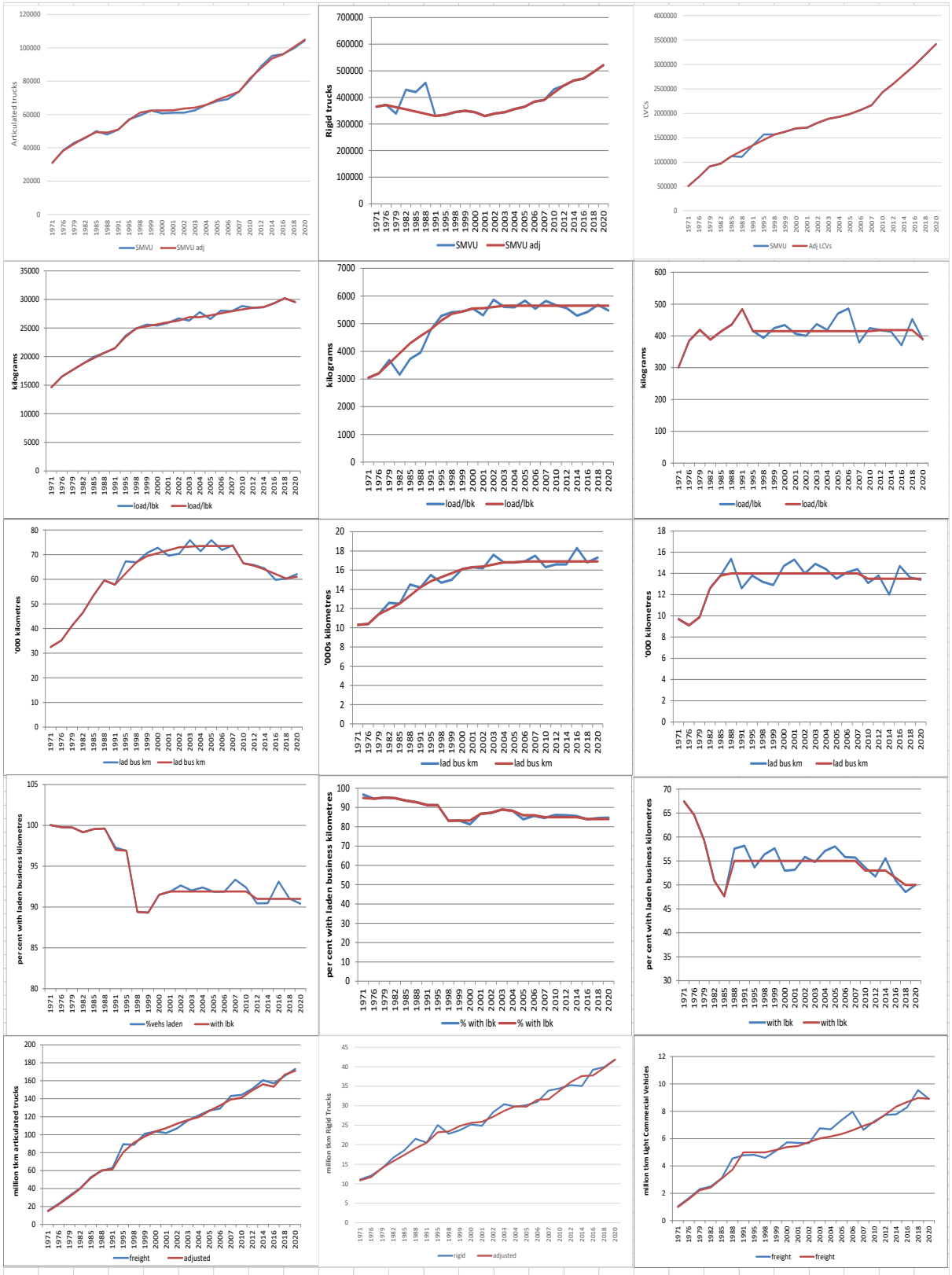
Table 1 Adjustment mechanism for Articulated Truck vehicle numbers

SMVU Dissagregation calculations				number of trucks						no. of trucks	**no. of trucks**
FY	raw artics	period	correction	adj artics		raw artics		date	correction	adj artics	**adj artics**
	SMVU	SMVU	to Jan 1	SMVU		MVC	%ch/yr	MVC	to Jan 1	MVC	**SMVU adj**
1971	32000	30-Sep	less 9 mo	31035		31982		30-Sep	less 9 mo	31018	**31018**
1976	39735	30-Sep	less 9 mo	38586		38950	4.0208429	30-Sep	less 9 mo	38342	**38342**
1979	43949	30-Sep	less 9 mo	43101		43683	3.85697005	30-Sep	less 9 mo	42419	**42419**
1982	46575	30-Sep	less 9 mo	45847		47179	2.57321563	30-Sep	less 9 mo	46268	**46268**
1985	49641	30-Sep	less 9 mo	49978		50220	2.08271978	30-Sep	less 9 mo	49436	**49436**
1988	48722	30-Sep	less 9 mo	48034		48857	-0.9039077	30-Sep	less 9 mo	49188	**49188**
1991	52106	30-Sep	less 9 mo	50910		51697	1.88206056	30-Sep	less 9 mo	50967	**50967**
1995	57939	31-May	less 5 mo	57200		58322	3.06038648	31-May	less 5 mo	57578	**56780**
1998	59573	aver 31 jul	less 1 mo	59464		62274	2.1872088	31-Oct	less 10 mo	61139	**61139**
1999	62493	aver 31 jul	less 1 mo	62408		63295	1.63952854	31-Oct	less 10 mo	62430	**62430**
2000	61117	aver 31 oct	less 4 mo	60710				none		62488	**62488**
2001	61502	aver 31 oct	less 4 mo	61092		62597	0.32499828	31-Mar	less 3 mo	62546	**62546**
2002	61519	aver 31 oct	less 4 mo	61109		63905	2.08955701	31-Mar	less 3 mo	63571	**63571**
2003	62982	aver 31 oct	less 4 mo	62562		64261	0.55707691	31-Mar	less 3 mo	64172	**64172**
2004	66197	aver 31 oct	less 4 mo	65756		66300	3.17299762	31-Mar	less 3 mo	65774	**65774**
2005	68509	aver 31 oct	less 4 mo	68052		69723	5.16289593	31-Mar	less 3 mo	68823	**68823**
2006	69696	aver 31 oct	less 4 mo	69231		71680	2.80682128	31-Mar	less 3 mo	71177	**71177**
2007	74343	aver 31 oct	less 4 mo	73847		74444	3.85602679	31-Mar	less 3 mo	73726	**73726**
2010	81376	aver 31 oct	less 4 mo	80833		82436	3.45760093	31-Mar	less 3 mo	81723	**81723**
2012	88871	aver 30 jun	none	88871		87995	3.31670391	31-Jan	less 1 mo	87752	**87752**
2014	96226	aver 31 oct	less 4 mo	95176		93853	3.27497104	31-Jan	less 1 mo	93597	**93597**
2016	96214	aver 30 jun	none	96214		96185	1.2347454	31-Jan	less 1 mo	96086	**96086**
2018	99705	aver 30 jun	none	99705		100694	2.31707636	31-Jan	less 1 mo	100500	**100500**
2020	104442	aver 30 jun	none	104442		105137	2.18237524	31-Jan	less 1 mo	104946	**104946**

Table 2 Raw and adjusted component series for articulated trucks

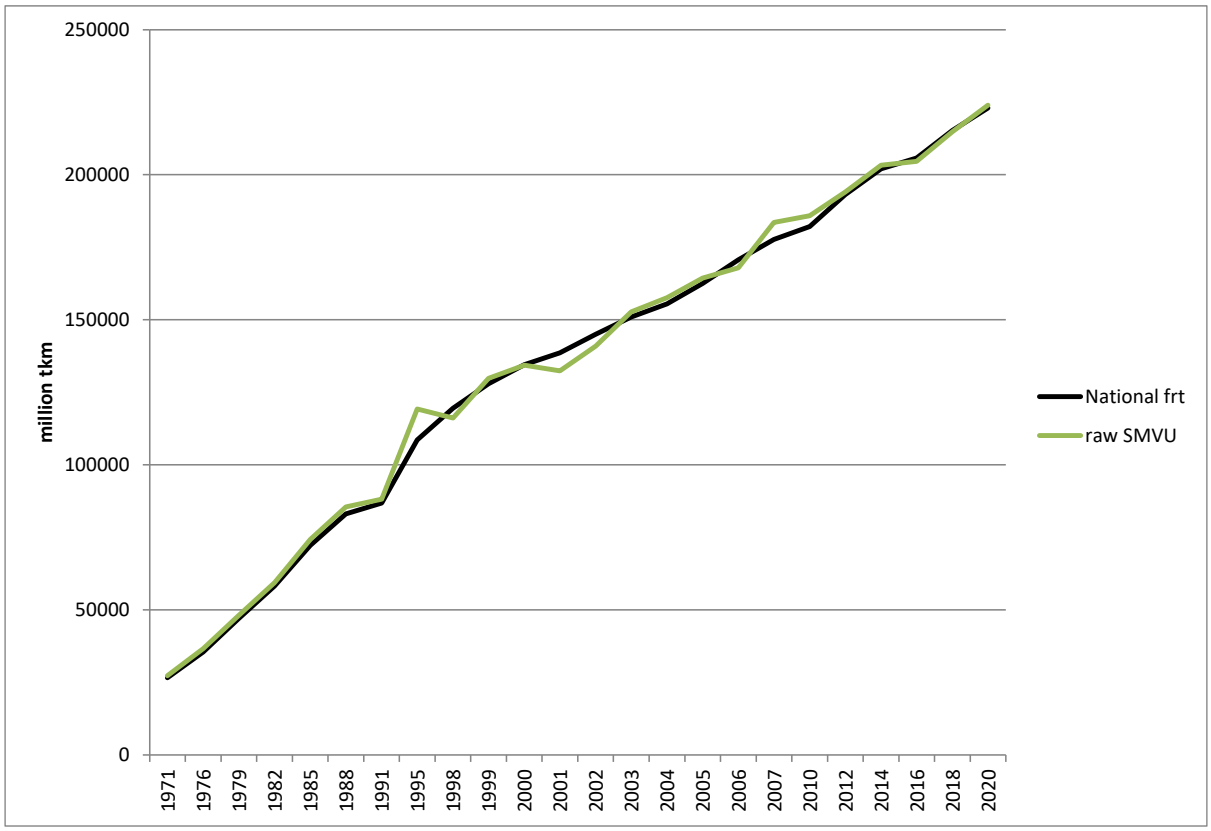
	kg		1000s		raw	**adj**
	raw aver	**adjd aver**	raw average	**adj**	proportion	**proportion**
	load/lbk	**load/lbk**	lad bus km	**lad bus km**	with lbk	**with lbk**
1971	14616	14616	32.5	**32.5**	100	100
1976	16510	16510	35.2	**35.2**	100	100
1979	17656	17656	41.2	**41.2**	100	100
1982	18784	18784	46.4	**46.4**	99	99
1985	19959	**19716**	53.4	**53.4**	100	100
1988	20648	20648	59.6	**59.6**	100	100
1991	21474	21474	57.8	**57.8**	97	97
1995	23659	**23438**	67.3	**62.4**	96.9	96.9
1998	24911	24911	66.9	**66.9**	89.4	89.4
1999	25602	**25313**	70.7	**69.4**	89.3	89.3
2000	25427	**25645**	72.8	**70.6**	91.5	91.5
2001	25907	**26000**	69.6	**71.8**	91.9	**91.9**
2002	26664	**26288**	70.4	**73.0**	92.6	**91.9**
2003	26291	**26909**	75.9	**73.3**	92.0	**91.9**
2004	27772	**26896**	71.4	**73.5**	92.4	**91.9**
2005	26570	**27200**	75.9	**73.5**	91.9	**91.9**
2006	28022	**27565**	71.9	**73.5**	91.9	**91.9**
2007	27931	**27931**	73.8	**73.5**	93.4	**91.9**
2010	28847	**28241**	66.5	**66.5**	92	**91.9**
2012	28550	**28550**	65.8	**65.5**	90.4	**91**
2014	28640	28640	64.4	**64.0**	90.5	**91**
2016	29323	29323	59.8	**62.2**	93.1	**91**
2018	30209	30209	60.3	**60.3**	91.0	**91**
2020	29542	29542	62.1	**61.1**	90.4	**91**

Figure 1 Raw and adjusted series for all freight vehicle types



The adjusted tonne kilometres for the three vehicle types (last row of graphs above) is added to produce an estimated adjusted tonne kilometre Australian freight task estimate. This estimate is shown compared to the raw SMVU series in Figure 2, where it can be seen that the adjustments eliminate some noisy deviations, but maintain the general growth trend.

Figure 2 Raw and adjusted estimates of the Australian road freight task



2. Modelling road freight growth

The adjusted road freight tonne kilometres shown in Figure 2 is divided by estimates of the Australian population to give a series for Australian road freight per person. Road freight per person is modelled as a function of 1) the natural log of gross national income per person, 2) the natural log of the real freight rate, and 3) dummy variables for the effects of the Global Financial Crisis (GFC) and for the shut-down of manufacturing plants in Australia. Table 3 shows the resulting regression equation.

Table 3 Regression equation for Australian road freight per person

Regression Statistics	
Multiple R	0.998332
R Square	0.996667
Adjusted R Squ	0.995966
Standard Error	133.0334
Observations	24

ANOVA

	df	*SS*	*MS*	*F*	*gnificance F*
Regression	4	1.01E+08	25139744	1420.493	3.07E-23
Residual	19	336260	17697.9		
Total	23	1.01E+08			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-19038	1361	-14	1.86E-11	-21886	-16190
ln Frt Rate	-2023	268	-8	3.98E-07	-2584	-1461
ln GNIpp	7642	224	34	1.64E-18	7173	8110
GFC Comod	-649	122	-5	4.01E-05	-905	-393
dum closures	-209	118	-2	0.091431	-455	37

Figure 3 shows the fit of predicted road freight *per person* to the adjusted estimate and Figure 4 shows the fit of predicted road freight *total* to the adjusted estimate of total road freight

Figure 3 Road freight per person and prediction

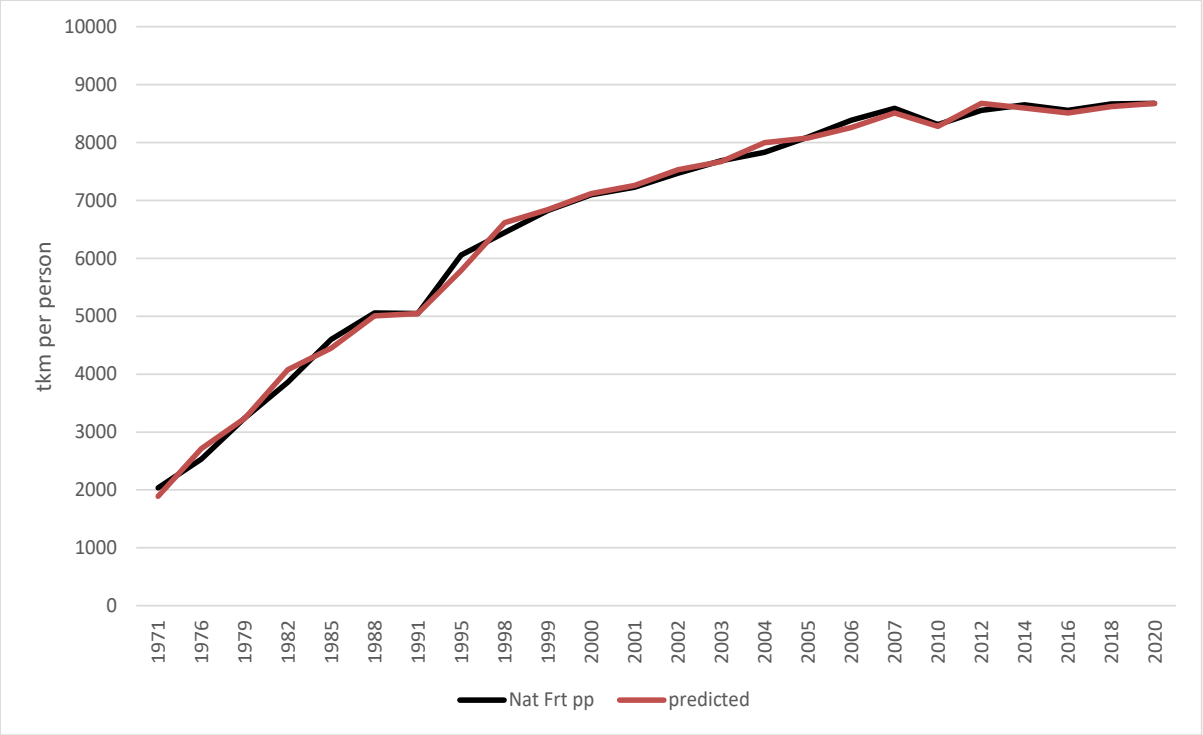
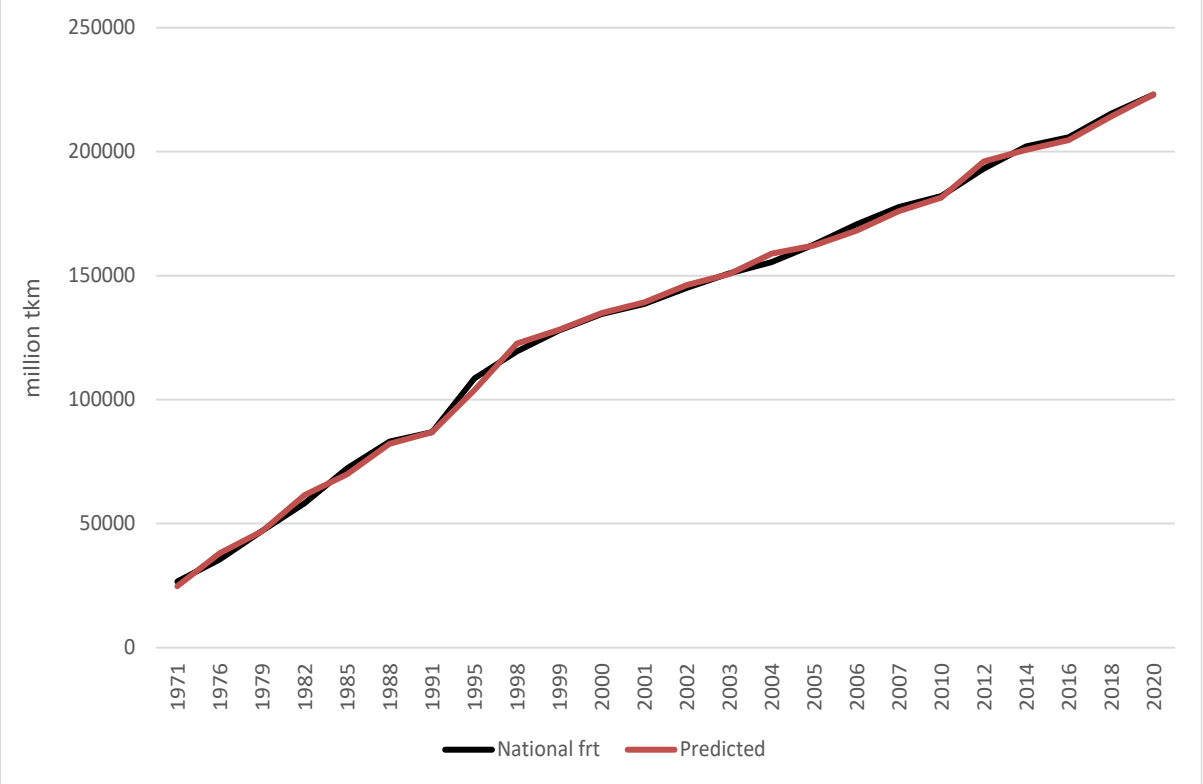


Figure 4 Total road freight and prediction



Filling in the missing years between past SMVU surveys and then forecasting with the regression equation gives Figures 5 and 6.

Figure 5 Past and forecast road freight tonne kilometres per person

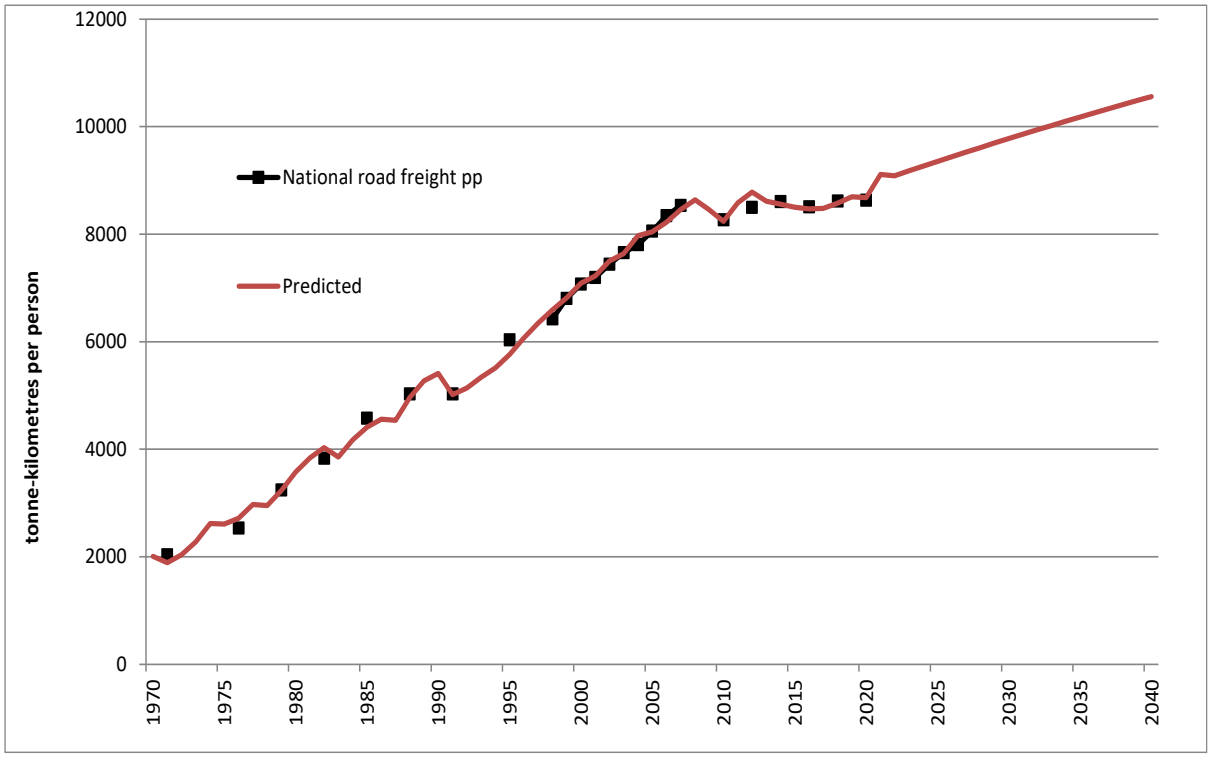
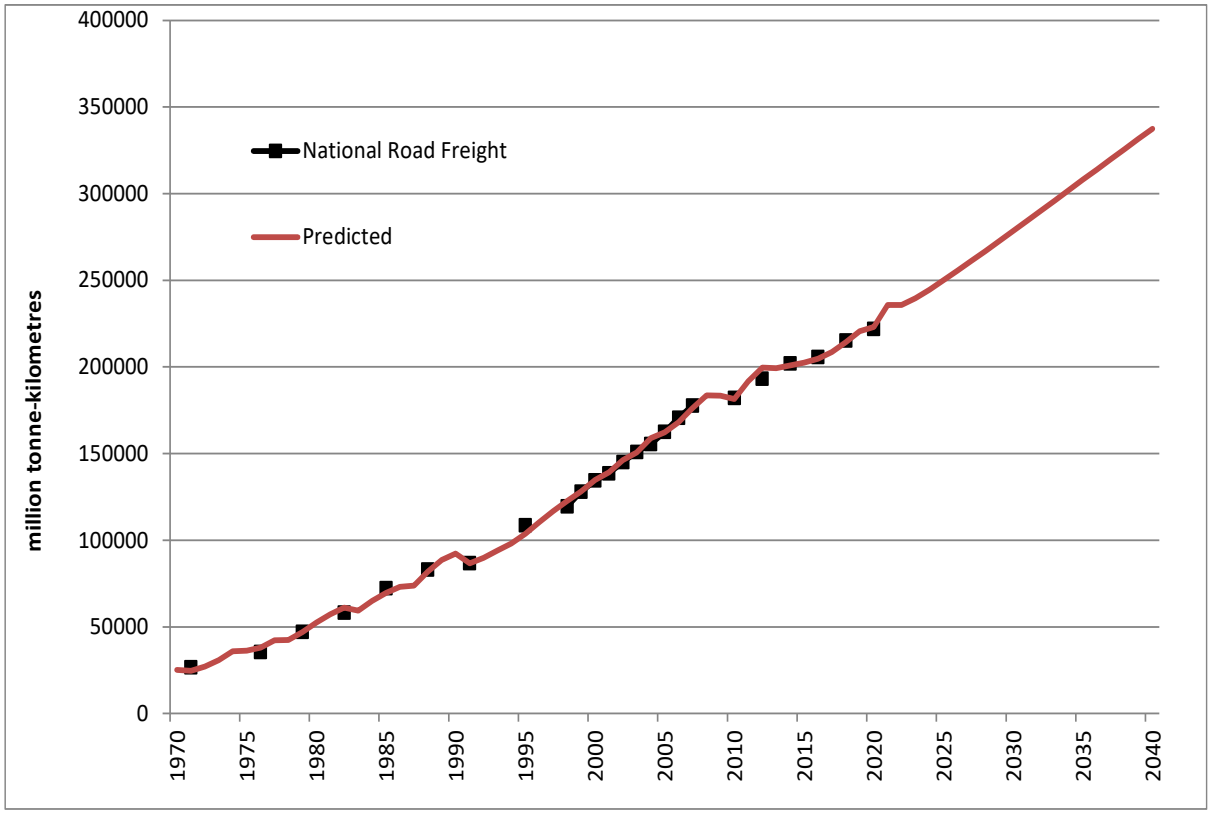


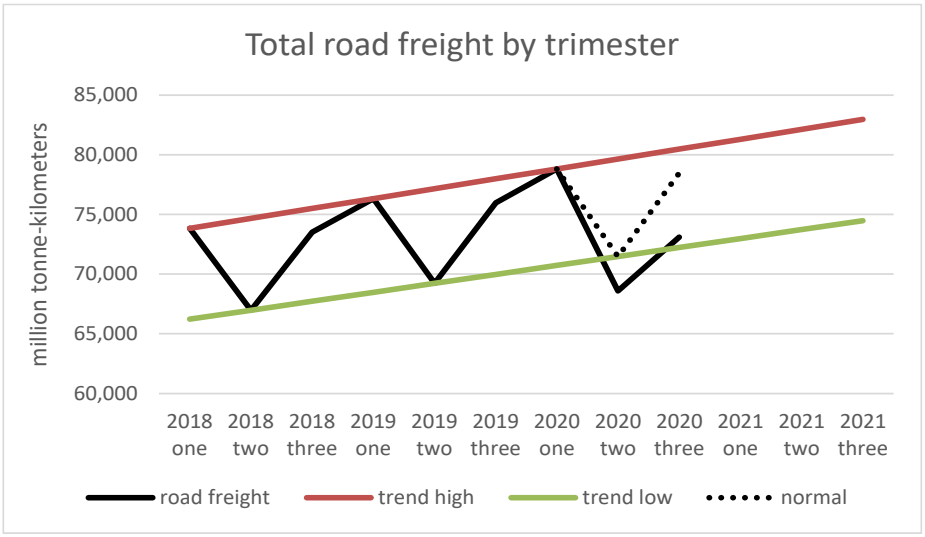
Figure 6 Past and forecast road freight tonne kilometres



3. COVID effects

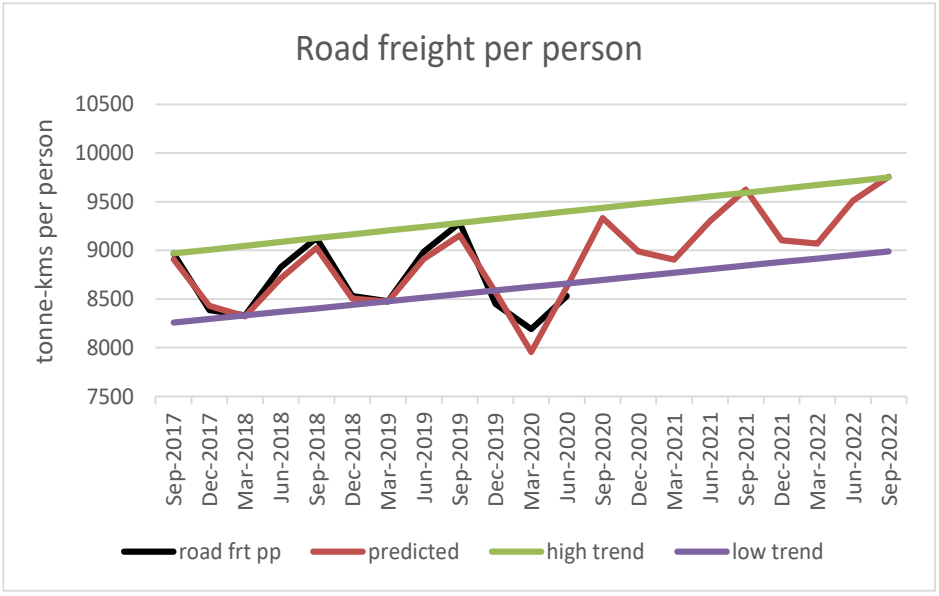
In response to COVID, the 2019-20 summer bushfires, and requests from key stakeholders, the Australian Bureau of Statistics has also released the SMVU surveys for 2017-18 and 2019-20 split into three periods – July to October, November to February, and March to June. This enables the impact of COVID to be illustrated. Figure 7 shows a rough estimate of the trimesters from July 2017 to June 2020. Also shown are the upper and lower trends, and what would normally be the levels for the last two (COVID) trimesters, using the model from Table 3. The effects of COVID are most pronounced in the period from March to June 2020.

Figure 7 COVID effects on total road freight by trimester



A rough translation to quarterly data can be made by setting the September quarter to the period 1 level, the December quarter to 1/3 period 1 plus 2/3 period 2, the March quarter to 2/3 period 2 plus 1/3 period 3, and the June quarter to period 4. The resulting numbers are multiplied by ¾ to translate 4-month rates into 3 month rates. The result is shown in Figure 8.

Figure 8 COVID effects on road freight per person by quarter



It can be seen that the model from Table 3 is quite accurate in translating a dip in Gross National Income per person during the pandemic into a dip in national road freight per person during the March and June quarters of 2020. The model suggests that road freight should have returned to near normal by the September quarter of 2020, even given the cessation of overseas migration.

Road freight is estimated to have reached its lowest value of the pandemic in the March quarter of 2020, down 5 per cent on normal trend values. In contrast, light vehicle traffic saw its COVID low in the June quarter of 2020, down about 30 per cent.

4. Conclusions

The ABS Survey of Motor Vehicle Use has been conducted intermittently from the 1970s. It has been the major source of data on Australian road freight (which has ended with the 2019-20 survey).

But the SMVU survey has included a fair degree of 'noise' in its estimates. The methodology presented in this paper has been an attempt to remove this noise from the components behind the road freight estimates by vehicle type, and then to reassemble the adjusted components into an estimate of road freight that is as 'noise-free' as possible.

The adjusted estimates of road freight per person have been modelled as a function of Gross National Income per person and real road freight rates. The model fits the road freight estimates closely. Furthermore, it closely matches the COVID period estimates of dipping road freight.

It is hoped that forecasts using the model will, in the 'SMVU-free' future, be able to be linked to other data sources. BITRE, in consultation with other key stakeholders, is currently investigating alternative SMVU replacement options.

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