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Costs of the Australian Road System

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Abstract

The costs of constructing and maintaining the Australian road system continue to increase. This paper presents a 45-year history of construction and maintenance costs for metropolitan and non-metropolitan Australia. It also models these four time series based on time-series estimates of the value of the road system and unit costs stretching back to the early 1900s.The modelling allows forecasts out to 2030 for the four cost time-series. Traffic-related costs to metropolitan motorists are also estimated as important costs of the Australian road system.

1. The Value of the Road System

Direct (as opposed to traffic-related) road system costs are divided into two categories - construction and maintenance. Both categories assumed to be linked to the past value of the system.

Figures 1 and 2 shown estimates of the values of the metropolitan and non-metropolitan road systems from 1910 onwards These values are based on road length by road type estimates (BITRE 2017) and are expressed as value equivalent lane-kilometres, where a standard two-lane road is valued at $300,000 per kilometre, or $150,000 per lane kilometre. Assumed values of other roads vary from $150 per lane-kilometre for dirt tracks to $120,000,000 per lane kilometre for metropolitan tunnels.

Figure 1 The Metropolitan road asset in value equivalent lane kilometres

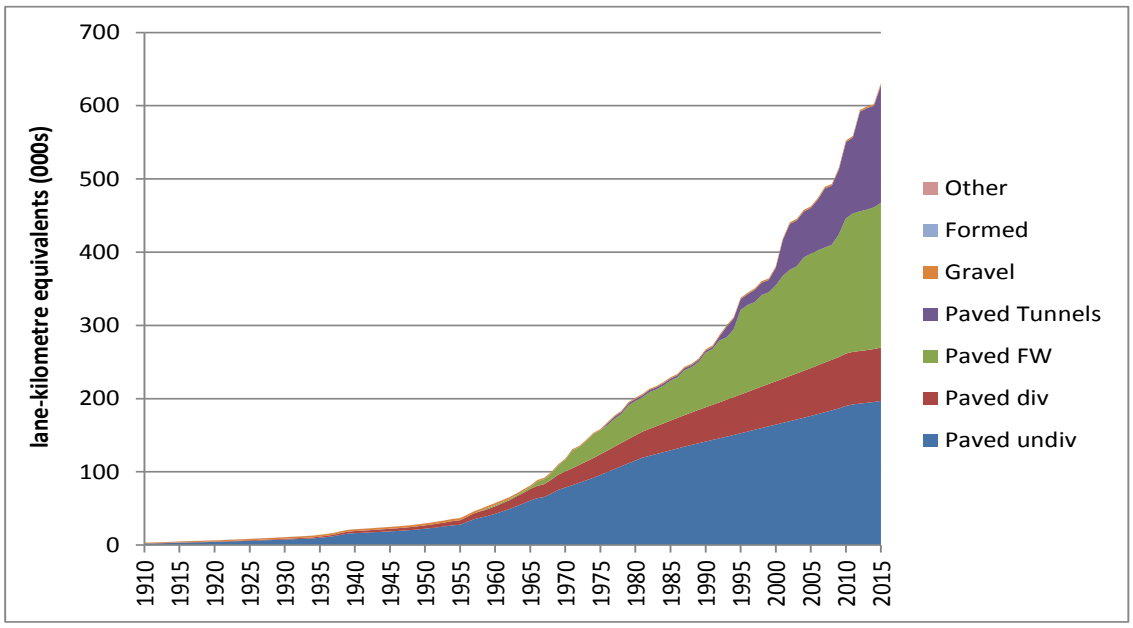
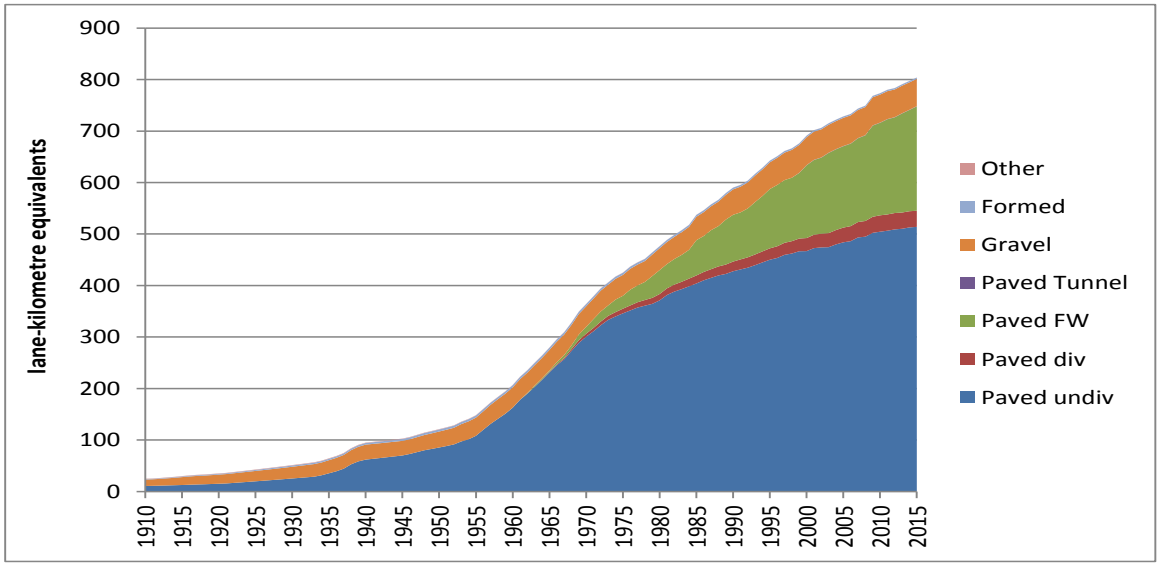


Figure 2 The Non-Metro road asset in value equivalent lane kilometres



2. Unit Cost

In dealing with long road cost time-series (past and future), it is useful to abstract from unit cost changes in order to focus on the constant cost 'volume' of road work. This is done using the BITRE Road Construction and Maintenance Price Index (RCMPI). A recent Information Sheet has estimated this index back to 1910. Dividing by the Consumer Price Index gives a real RCMP index, which can be predicted using the real price of diesel, real average weekly earnings and the capital expenditure to GDP ratio (BITRE 2016).

3. Volume of Road Maintenance

Using the RCMP index to 'hold' unit costs steady, the volume of metro and non-metro road maintenance expenditures can be calculated, as shown in Figure 3 and 4.

Figure 3 Metro maintenance expenditure and projections (real 2011-12 RCMPI$)

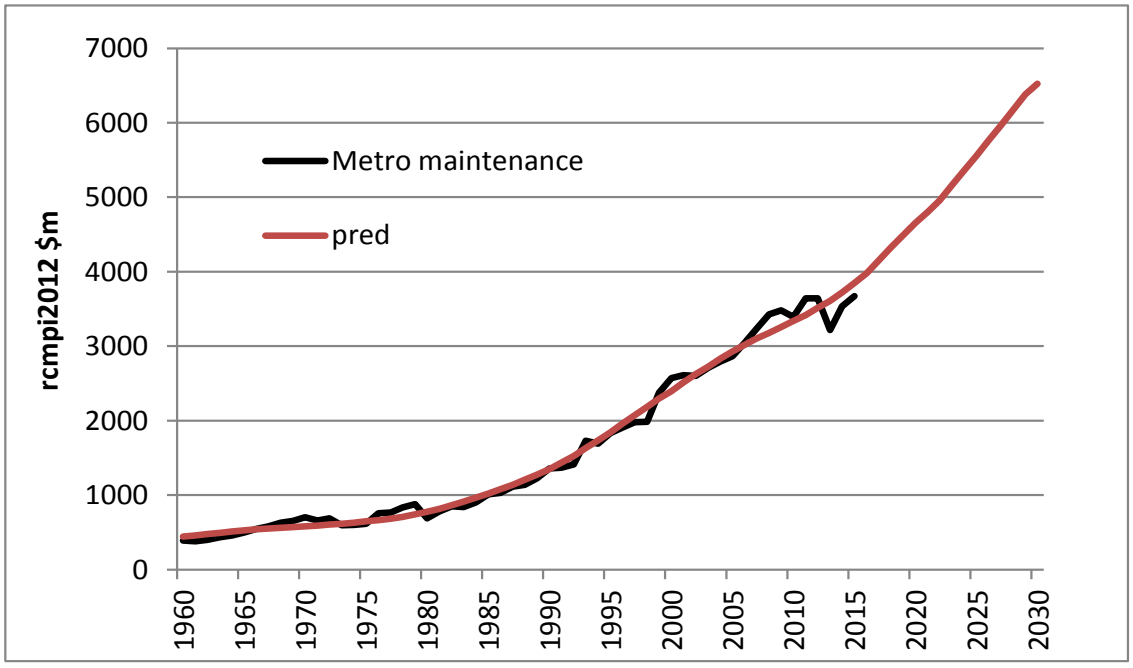
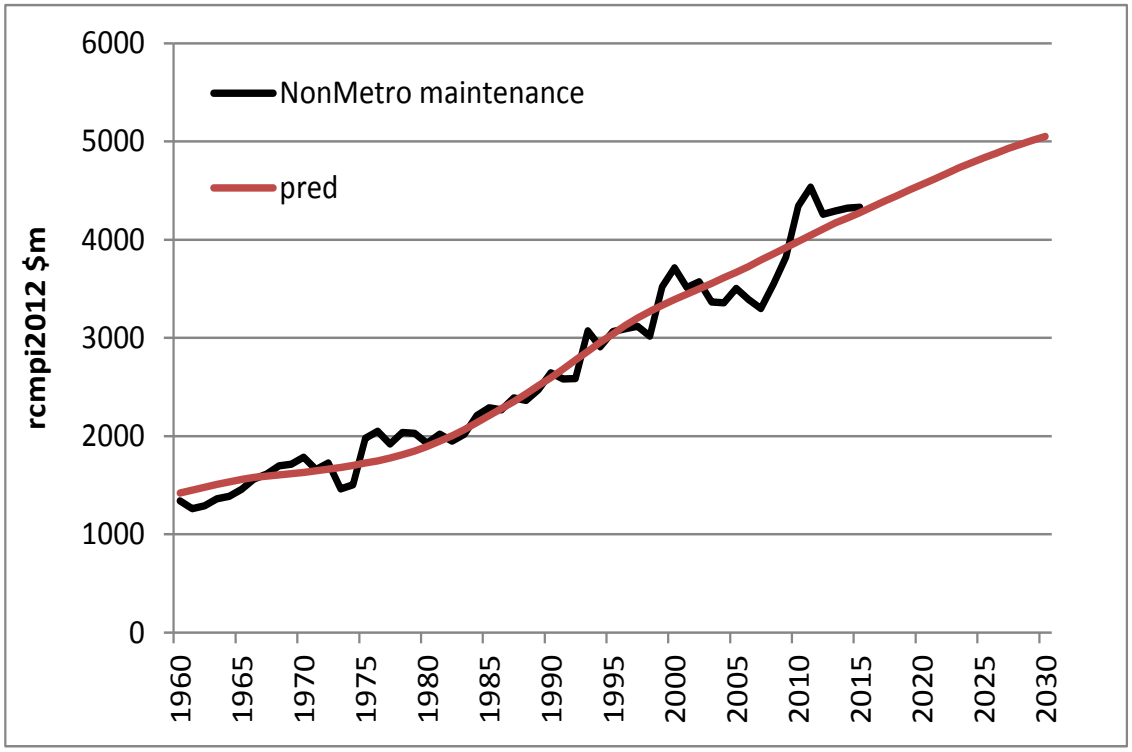


Figure 4 Non-metro maintenance expenditure and projections (real 2011-12 RCMPI$)



Also shown in the figures are predictions/forecasts of the volumes of maintenance costs (in real 2011-12 RCMPI$) based on very simple models using the 25-year lag of the value of the road systems (in value equivalent lane kilometres).

These models are detailed in Tables 1 and 2.

Table 1 Regression equation for real metro maintenance expenditure

Regression Statistics	
Multiple R	0.993098966
R Square	0.986245555
Adjusted R Square	0.985932954
Standard Error	127.7344831
Observations	46

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	51476734.62	51476734.62	3154.965977	1.33773E-42
Residual	44	717908.3197	16316.09817		
Total	45	52194642.94			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	87.79832186	36.50939877	2.404814235	0.020454814	14.21846342	161.3781803
metro LEK-25	14.23266824	0.253389717	56.16908382	1.33773E-42	13.72199482	14.74334166

Table 2 Regression equation for real non-metro maintenance expenditure

Regression Statistics	
Multiple R	0.975491151
R Square	0.951582986
Adjusted R Square	0.950482599
Standard Error	196.3711774
Observations	46

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	33347004.82	33347004.82	864.7714523	1.4388E-30
Residual	44	1696712.129	38561.6393		
Total	45	35043716.95			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	1128.629213	65.17976508	17.31563793	2.90045E-21	997.2680277	1259.990398
NonMetroLEK-25	5.201822819	0.176890652	29.40699665	1.4388E-30	4.845323134	5.558322503

4. Volume of Road Construction

Using the RCMP index to 'hold' unit costs steady, the volume of metro road construction expenditure can be calculated, as shown in Figure 5 and 6.

Figure 5 Metro construction expenditures and projections (real 2011-12 RCMPI$)

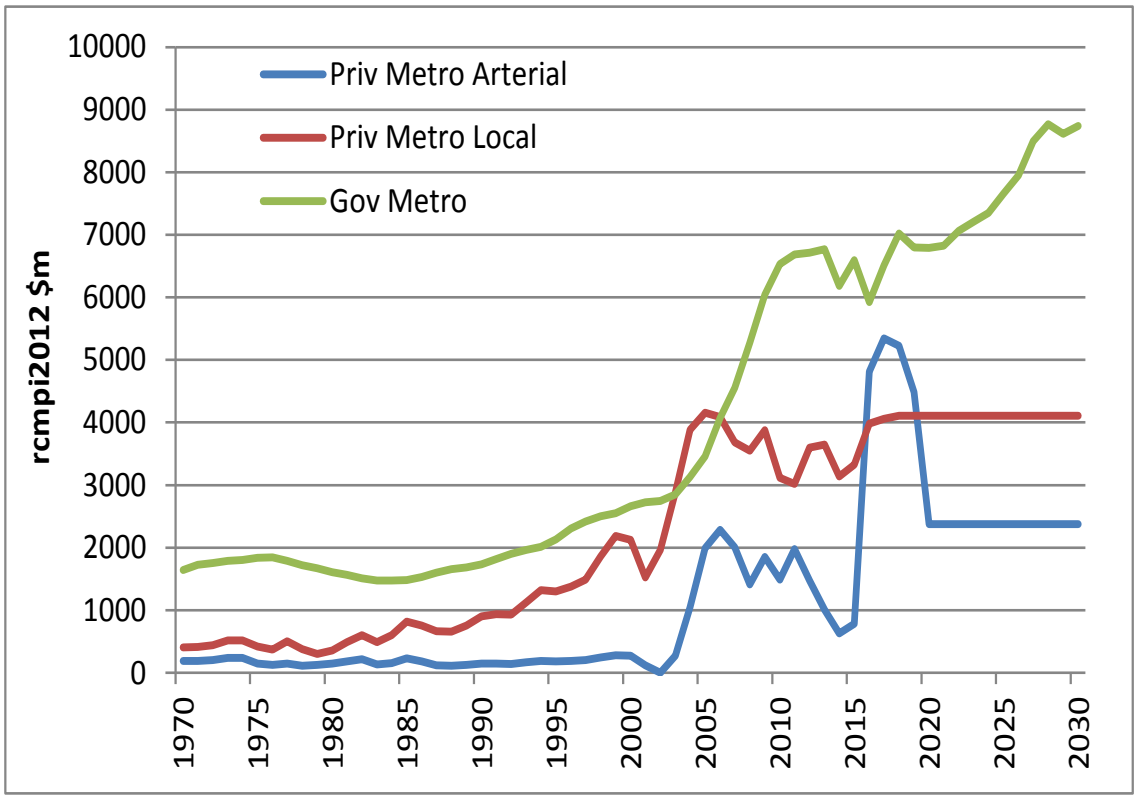
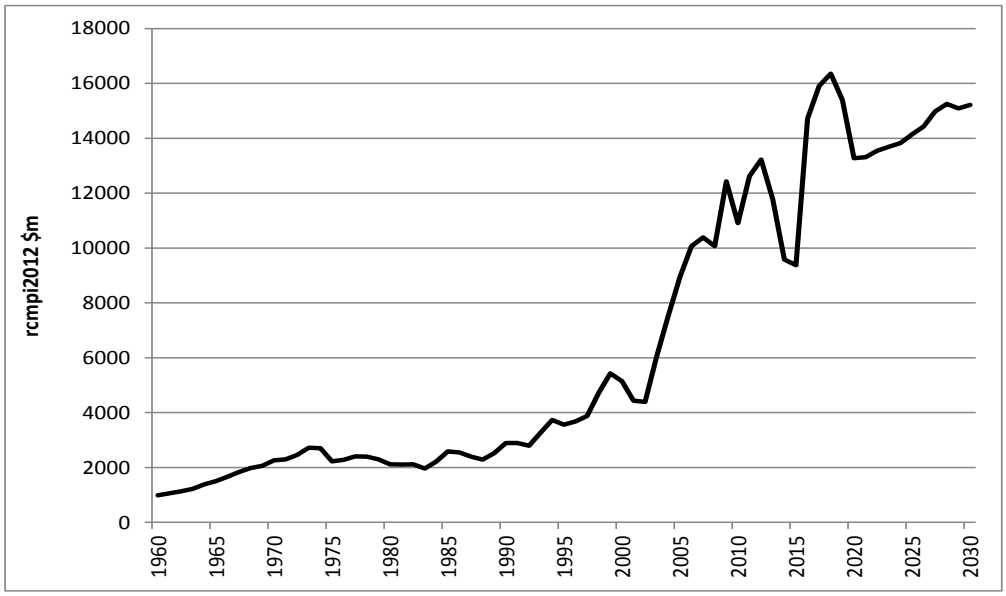


Figure 6 Total Metro construction expenditures and projections (real 2011-12 RCMPI$)



The three construction components are private arterial, private local and government metro.

Private arterial construction expenditure is mostly metro freeway construction. Projected expenditure out to 2020 is based on committed projects. From 2021 onwards expenditure is assumed to hold constant in real RCMPI dollar terms at the 2020 level.

Private local metro expenditure is mostly on roads for new subdivisions. It has been modelled as a function of building approvals (lagged 2 years from 2004 on, plus a time and a dummy variable. The model is shown in Table 3, based on data from 1970 to 2015. Forecast private local expenditure is based on an assumed constant level of building approvals.

Table 3 Regression equation for real private local construction expenditure

Regression Statistics	
Multiple R	0.988169793
R Square	0.976479539
Adjusted R Square	0.973657084
Standard Error	212.6676395
Observations	29

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	46941844.6	15647281.53	345.9681149	1.78605E-20
Residual	25	1130688.123	45227.5249		
Total	28	48072532.72			

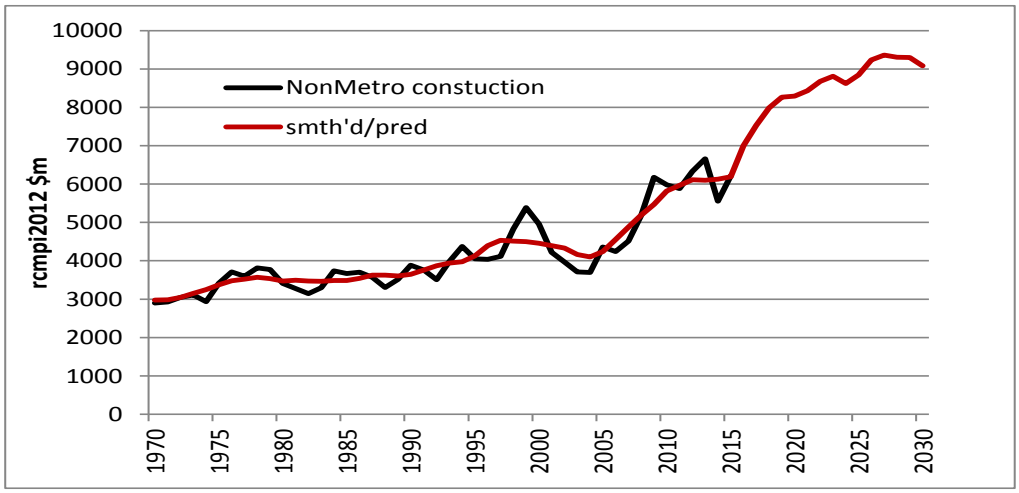
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-440.5054872	378.6910116	-1.163231959	0.255718423	-1220.434225	339.4232507
BA's current/lag2	0.14466418	0.037102123	3.899080929	0.000641749	0.068250927	0.221077433
timeles02	89.36358429	11.81047259	7.566469807	6.38972E-08	65.03946066	113.6877079
dum04on	2229.963633	147.297192	15.13921347	4.25615E-14	1926.599387	2533.327878

Government metro construction expenditure is modelled on past road construction. First, it is assumed that roads that were built 60 years ago will have to be completely rebuilt, and roads built 35 years ago will have to be half rebuilt (renovated).

The cost of constructing new roads is estimated by assuming the current change in value equivalent lane-kilometre metro totals from last year is what is constructed in the current year. This is then smoothed with a 7-year centred average and divided into the smoothed 7-year centred average of government road construction expenditure. The implied price is then held constant in the future and multiplied by the construction implied by keeping the increase in value equivalent lane-kilometre metro totals the same as for the last eight years

Non-metro road construction is modelled in a similar way to metro government construction, based on replacing 60-year old roads, renovating 35–year old roads and keeping up the trend of expansion of the non-metro lane-kilometre equivalents. Figure 7 shows the implied future non-metro road construction.

Figure 7 Non-metro construction expenditures and projections (real 2011-12 RCMPI$)



5. Road Expenditures: Base Case

The final estimates of road expenditures for metro and non-metro construction and maintenance are shown in Tables 4 and 5. The expected path of total road expenditure in the base case is shown in Figure 8.

Figure 8 Total road expenditure (real 2011-12 RCMPI$)

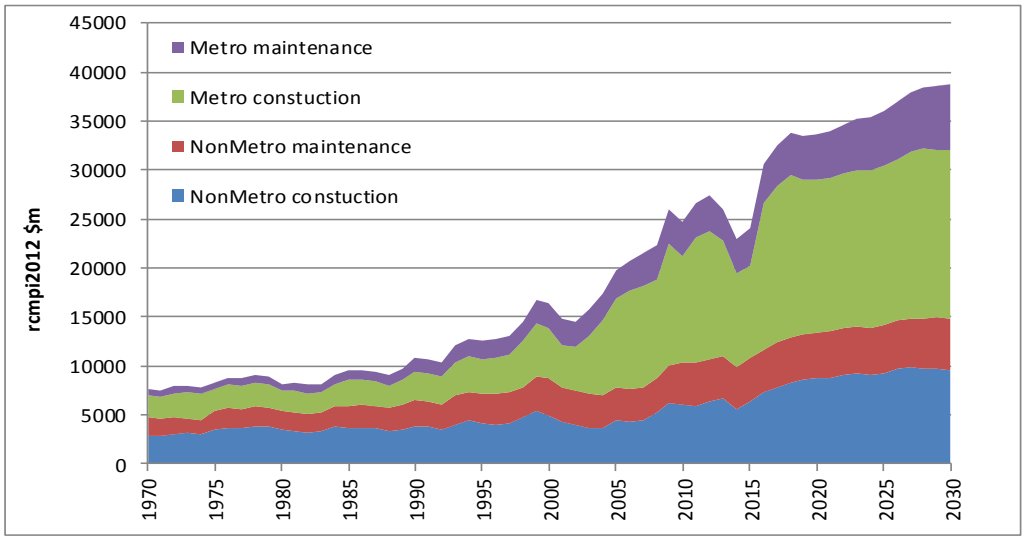


Table 4 Metro construction and maintenance expenditures (real 2011-12 rcpmi $millon)

	rcmpi2012 $m	rcmpi2012 $m	rcmpi2012 $m	rcmpi2012 $m		rcmpi2012 $m	rcmpi2012 $m	rcmpi2012 $m	rcmpi2012 $m
	CONSTRUCTION					**MAINTENANCE**			
	Priv Metro Arterial	Priv Metro Local	Gov Metro Constr	Metro constuction		Metro Arterial	Priv Metro Arterial	Metro Local	Metro maintenance
1970	189	405	1663	2256		181	14	510	705
1971	191	412	1690	2293		169	13	476	658
1972	204	442	1811	2458		177	14	500	691
1973	235	516	1972	2723		153	12	432	597
1974	235	518	1950	2702		156	12	432	600
1975	146	420	1657	2222		201	13	401	615
1976	124	372	1784	2280		205	13	541	759
1977	145	503	1757	2405		226	13	530	769
1978	111	377	1910	2397		246	14	577	837
1979	125	301	1871	2297		269	14	599	881
1980	147	359	1608	2114		220	12	456	689
1981	181	491	1438	2110		216	12	554	783
1982	216	598	1303	2117		200	12	641	853
1983	131	492	1342	1965		193	12	636	841
1984	155	602	1457	2214		241	14	648	903
1985	233	820	1531	2583		241	16	756	1012
1986	188	749	1612	2549		246	16	769	1031
1987	138	646	1614	2397		266	18	828	1112
1988	130	647	1515	2291		273	19	844	1136
1989	142	745	1641	2528		296	21	911	1228
1990	161	887	1843	2891		328	24	1005	1357
1991	160	923	1813	2896		332	25	1011	1368
1992	153	923	1718	2794		344	26	1043	1412
1993	177	1119	1979	3275		422	32	1274	1728
1994	200	1315	2215	3731		414	32	1246	1692
1995	190	1295	2081	3565		450	35	1349	1835
1996	194	1373	2108	3674		470	37	1401	1908
1997	203	1488	2187	3878		489	39	1454	1983
1998	244	1857	2615	4716		491	40	1453	1983
1999	279	2188	2959	5426		590	49	1740	2378
2000	263	2125	2761	5149		640	53	1881	2574
2001	118	1522	2796	4437		744	37	1829	2609
2002	0	1963	2427	4390		754	41	1805	2599
2003	263	2892	2899	6055		853	91	1764	2707
2004	1027	3904	2598	7528		942	75	1775	2791
2005	1948	4191	2796	8936		950	101	1816	2867
2006	2238	4131	3696	10066		1095	117	1831	3042
2007	1961	3719	4700	10381		1318	113	1805	3235
2008	1381	3578	5110	10069		1408	109	1913	3429
2009	1815	3912	6694	12420		1415	100	1968	3483
2010	1454	3142	6305	10902		1459	99	1835	3393
2011	1936	3055	7625	12616		1561	132	1952	3644
2012	1445	3628	8148	13221		1760	147	1735	3642
2013	983	3668	7123	11773		1455	153	1607	3215
2014	610	3152	5815	9577		1636	160	1730	3525
2015	797	3384	5367	9548		1696	167	1887	3749
2016	4987	3982	5961	14930					3980
2017	5380	4060	6522	15962					4154
2018	5103	4108	7054	16265					4327
2019	4561	4108	6788	15457					4487
2020	4175	4108	6756	15040					4656
2021	4175	4108	6776	15060					4804
2022	4175	4108	6955	15239					4958
2023	4175	4108	7054	15337					5187
2024	4175	4108	7174	15457					5406
2025	4175	4108	7365	15648					5622
2026	4175	4108	7510	15793					5850
2027	4175	4108	8092	16375					6068
2028	4175	4108	8401	16685					6302
2029	4175	4108	8295	16579					6533
2030	4175	4108	8455	16738					6676

Table 5 Non-Metro construction and maintenance expenditures (real 2011-12 rcpmi $millon)

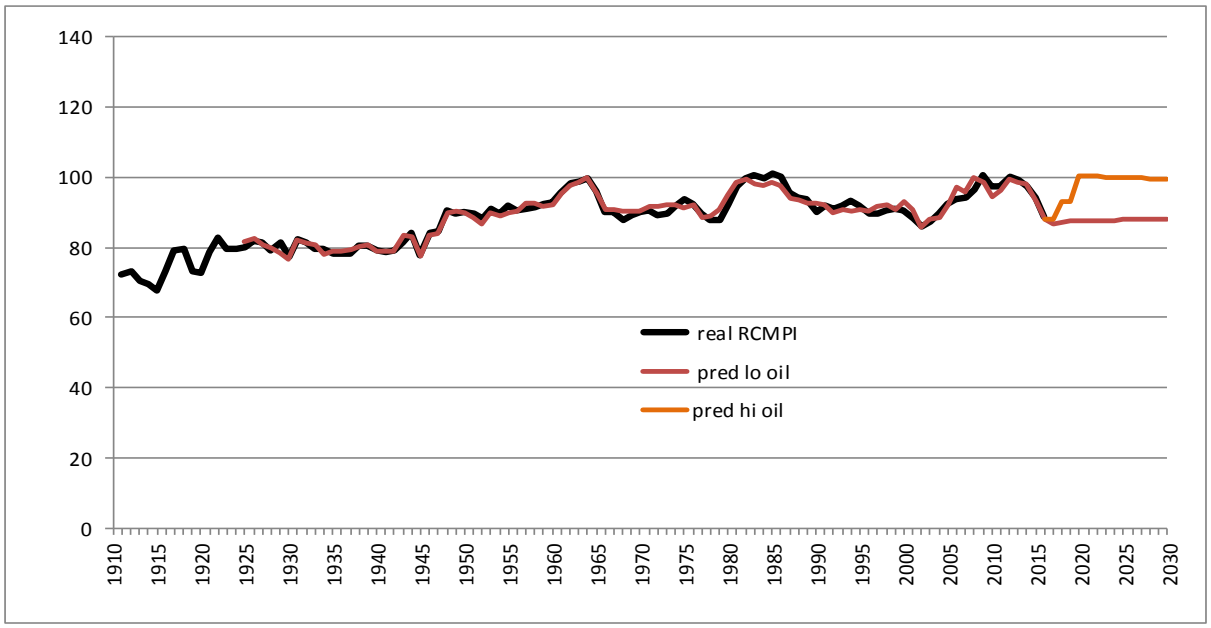
	rcmpi2012 $m	rcmpi2012 $m
	NonMetro constuction	NonMetro maintenance
1970	2900	1787
1971	2927	1659
1972	3044	1728
1973	3105	1465
1974	2933	1505
1975	3415	1979
1976	3709	2051
1977	3600	1921
1978	3814	2035
1979	3769	2028
1980	3411	1926
1981	3278	2020
1982	3142	1950
1983	3295	2018
1984	3735	2208
1985	3667	2288
1986	3702	2269
1987	3570	2387
1988	3301	2363
1989	3516	2471
1990	3883	2643
1991	3759	2582
1992	3510	2587
1993	3980	3071
1994	4371	2908
1995	4048	3065
1996	4035	3092
1997	4117	3117
1998	4824	3017
1999	5383	3522
2000	4963	3714
2001	4221	3513
2002	3968	3571
2003	3712	3365
2004	3692	3359
2005	4361	3505
2006	4242	3389
2007	4513	3299
2008	5185	3550
2009	6176	3823
2010	5979	4341
2011	5885	4533
2012	6326	4259
2013	6655	4294
2014	5551	4321
2015	6212	4328
2016	7001	4333
2017	7528	4392
2018	7984	4448
2019	8262	4504
2020	8295	4559
2021	8435	4616
2022	8674	4674
2023	8806	4731
2024	8622	4781
2025	8843	4831
2026	9236	4879
2027	9358	4927
2028	9306	4972
2029	9298	5013
2030	9081	5051

6. Future Costs of Road Construction and Maintenance

To turn forecasts of road expenditure in real constant RCMPI dollars into real CPI dollars, it is necessary to predict the RCMP index. This can be done by using the real price of diesel, real average weekly earnings and the capital expenditure to GDP ratio (BITRE 2016).

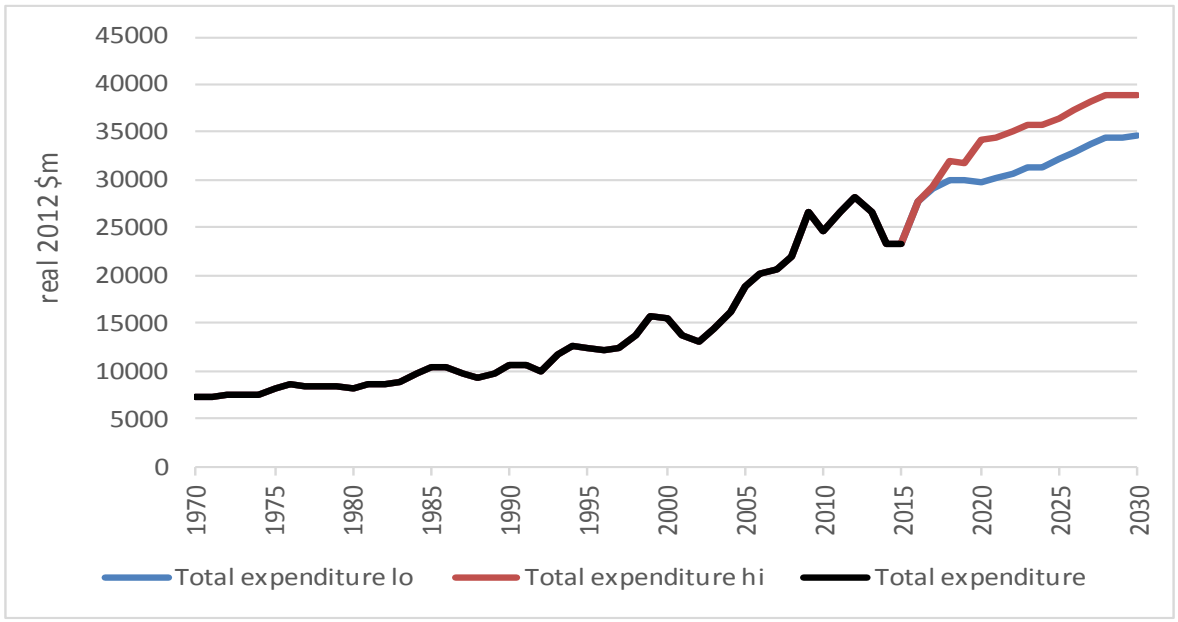
Figure 9 shows the index assuming unchanged real average weekly earnings and capital expenditure to GDP ratio, but with low and high oil prices (which feed through to the price of diesel – see BITRE 2016a). The low real oil price rises to around $US65 per barrel by 2030, while the high price rises to $US150 per barrel by 2020 and stays there.

Figure 9 RCMP Index with oil price scenarios



The effect of the two scenarios on real CPI road expenditure are shown in Figure 10.

Figure 10 Real CPI road expenditure under high and low oil price scenarios (real 2012$m)

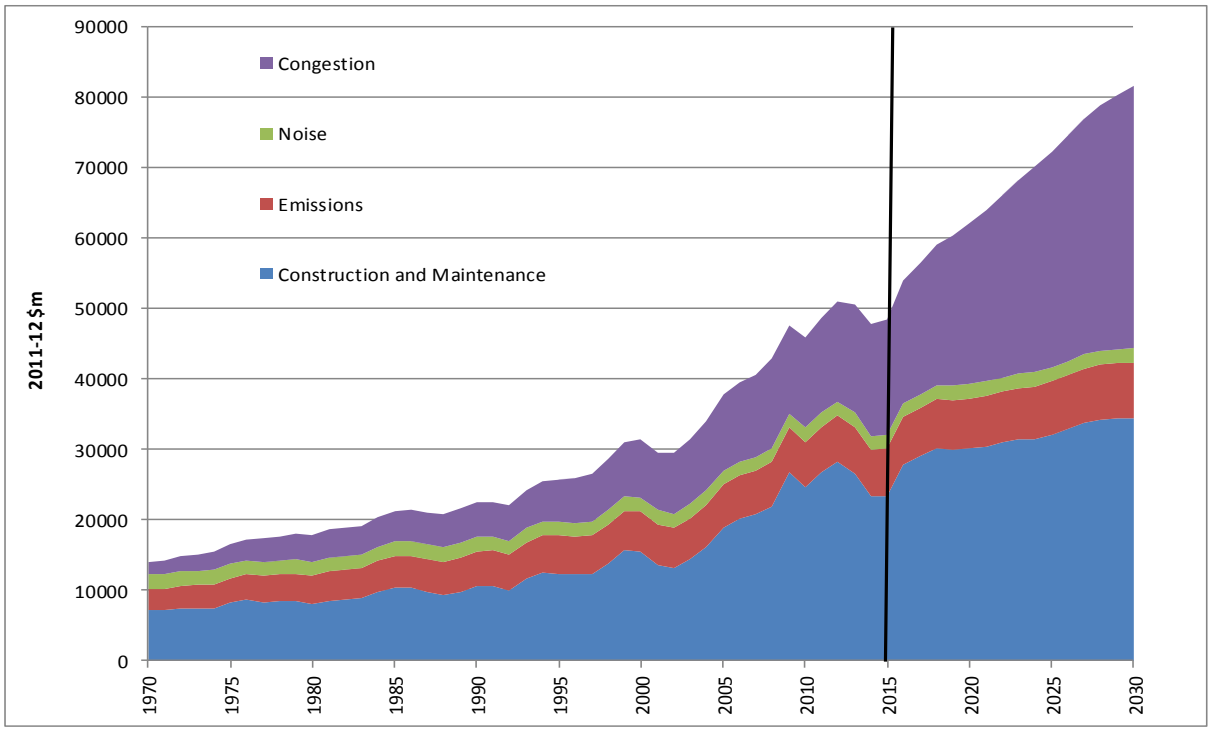


As shown in Figure 10, real road costs are set to bounce back from 2015 lows, initially due to a burst of committed metro construction, but in the medium term due to continued higher levels of construction, reconstruction and maintenance. Costs will be higher still if oil prices also rebound and increase road construction and maintenance unit costs.

7. Traffic-Related Costs of Road Infrastructure

When metropolitan traffic-related costs of congestion, emissions, and noise are included with the costs of road construction and maintenance, the total cost of the Australian road system rises dramatically – almost doubling (as shown in Figure 11). Obviously, the cost (and value) of the metropolitan road network is much higher once traffic-related costs to users of those road systems are added to the costs to Governments. Also, traffic-related costs are forecast to increase faster than construction and maintenance costs in the future. The cost of congestion in our cities is an important element (increasingly so) when considering the real costs of the Australian road system.

Figure 11 National Road Costs including Metropolitan Traffic-related Costs (real 2012$m)



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