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A correction framework for improving the robustness of motor vehicle registration data.

By

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TITLE: **A correction framework for improving the robustness of motor vehicle registration data**

ABSTRACT: An important key to reducing the environmental impact of motor vehicles is to identify those in-services vehicles which are likely to excessively contribute to air pollution. Such an assessment is dependent on quantifying vehicle scrappage which, in turn, relies upon the provision of temporally consistent motor vehicle registration data. There exist a number of issues that adversely impact on the temporal accuracy of motor vehicle registration data. This paper identifies these issues and proposes a cost effective correction framework for motor vehicle registration time series data. An application to Australian data demonstrated the efficacy of the framework, identifying the need to introduce an additional vehicle category into the data, adjusting annual vehicle counts and removing the erroneous incidence of the number of vehicles of a particular vintage increasing substantially beyond two years after the year of manufacture.

KEY WORDS: ***Motor vehicle registration data; scrappage rates; vehicle sales.***

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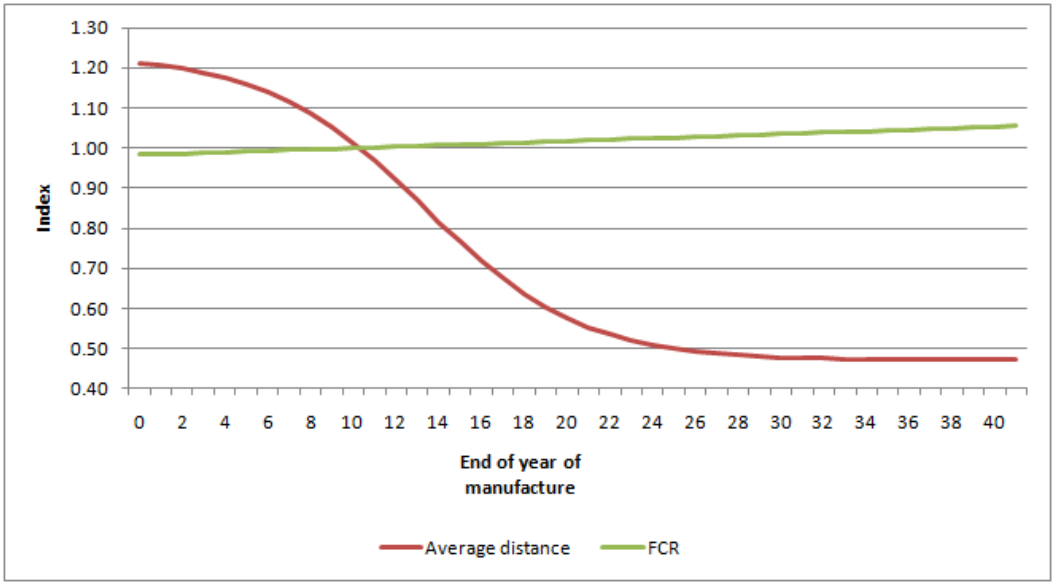
1. Introduction

An important key to reducing the environmental impact of motor vehicles is to identify those in-services vehicles which excessively contribute to air pollution (FORS, 1996). Identifying these vehicles necessitates a detailed assessment of the vehicle stock, with particular reference to the interdependencies between, age, distance travelled (ABS SMVU, 2008; Hickman, A.J. 1999), the fuel consumption rate, technology and emissions (Wang, M., Huo, H., Johnson, L. and He, D. 2006; Zachariadis, T et. al. 2001; Hassounah and Miller, 1994, Johnson, L. and Ferreira, L. 2001).

Figure 1 illustrates indices for distance travelled and the fuel consumption rate by vehicle age for passenger vehicles in Australia. The figure demonstrates the variation of fuel consumption rate and average distance travelled by year of manufacture. Without identifying the number of vehicles by age, vehicle type, fuel consumption rate and average distance travelled, quantifying emissions from motor vehicles and the subsequent development of appropriate strategies to address motor vehicle emissions (including the ongoing development of national and international emission legislation), associated fuel consumption and travel demand is compromised. Further, such differentiation allows consideration of the introduction of new vehicle technology, the varying travel demand achieved by vehicles of differing vintage and the degradation of existing vehicle technology (Davis et. al., 2005).



Note: For passenger vehicles in New South Wales. The FCR data pertains to unleaded petrol.
Source: Apelbaum Consulting Group (2008)

Figure 1: Impact of year of manufacture on average distance travelled and the fuel consumption rate

In recognition of the importance of identifying the age structure of the vehicle stock, many road emission models have differentiated vehicle stock by vintage and vehicle type (Transport and Mobility Leuven, 2007; U.S. Department of Energy, 2003; US Environmental Protection Agency, 2003; Apelbaum, 2007; BTCE, 1996; California Air Resources Board, 2007 and Gkatzoflias, D. et. al, 2007). Projecting the vehicle fleet by vintage (as a descriptor for vehicle technology) and vehicle type is dependent on forecasting the diffusion of new vehicles into the fleet and quantifying scrappage of existing vehicles (Hensher, 1987).

Vehicle scrappage rates differ substantially by vehicle type (Apelbaum, 2007, Mitchell, 2002 and Thoresen and Stella, 1977). Deriving robust scrappage rates by vehicle type requires the provision of a consistent time series of motor vehicle registration data, by vintage, vehicle type and jurisdiction. Significantly, the time series must be long term if scrappage functions are to be meaningful as the average age of the fleet can be large with many vehicles in excess of 15 years (ABS, 2007). The median age of passenger vehicles in the United States (as at 2007) was 9.2 years (R.L. Polk & Co., 2009), compared with 9.7 years in Australia (ABS, 2007) and 8.1 years in Europe (Transport and Mobility Leuven, 2007). Given that the numbers of in-service vehicles overwhelmingly exceeds the number of new vehicles, any error in the development of scrappage functions, can have a profound impact on motor vehicle emission forecasts.

Despite the importance of motor vehicle registration data in the development of road based environmental policies and the provision of evidence based transport planning; little attention has been directed to the temporal accuracy of motor vehicle registration data. Thoresen and Stella (1977), Berkovec (1985) and Apelbaum (2007) identified instances where the number vehicles of a particular vintage at a period well in advance of the year of manufacture exceed the number of vehicles manufactured at or near the year of manufacture. While such an outcome at the jurisdictional level may be influenced (in part) by cross border trading of vehicles and , occurrences at the national level are of concern particularly when the incidence of second hand vehicle and imports is comparatively insignificant (of the order of 0.3 per cent for the Australian road fleet).

The purpose of the paper is to outline a correction process for time-series motor vehicle data and to demonstrate the impact of the framework using Australian motor vehicle data. In so doing, the paper identifies issues associated with motor vehicle registration data and proposes a correction process that assesses the quality, accuracy and completeness of motor vehicle data.

The paper is presented in four sections. The following section details the correction framework for motor vehicle data. Section 3 overviews Australian motor vehicle registration data and demonstrates application of the correction framework to Australian motor vehicle registration data. The final section summarises the major outcomes of the paper.

2. Correcting motor vehicle data

The motor vehicle correction framework encompasses three components; assessing the accuracy of motor vehicle data, adjusting the data according to seven measures of accuracy and validating the outcome. Figure 2 illustrates the motor vehicle registration data correction framework and the attributes associated with adjusting motor vehicle registration data. A description of the framework and associated data correction processes is detailed below.

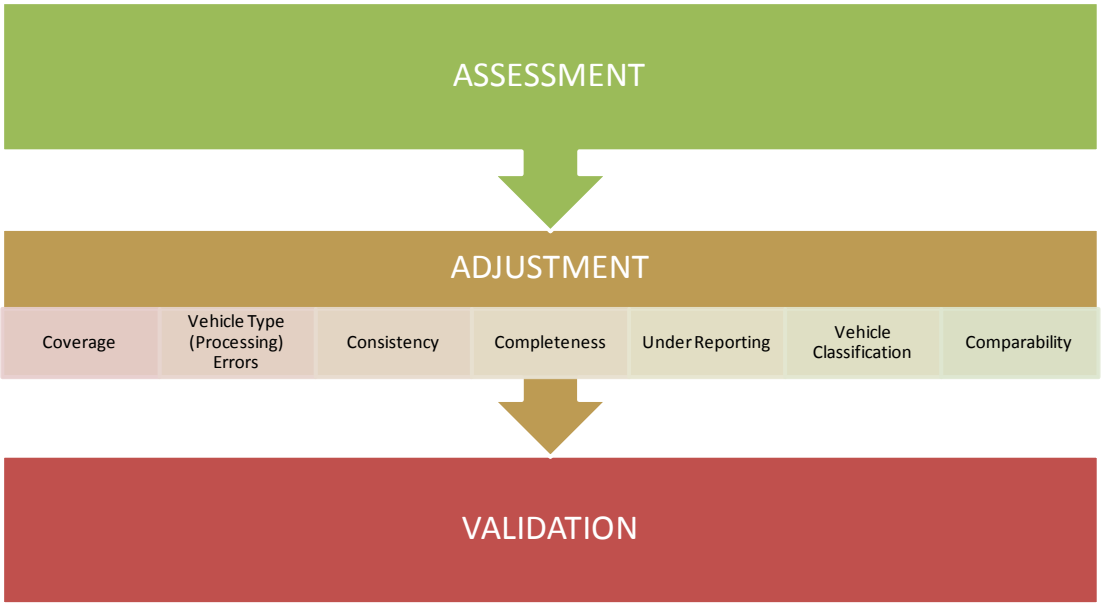


Figure 2: Motor vehicle data correction framework

2.1 Assessing the robustness of motor vehicle data

The robustness of motor vehicle data can be examined using alternative vehicle inventory data and/or the ratio of the number of vehicles in any year to that in any previous year, by year of manufacture.

Alternative vehicle inventory data can often be found within surveys of motor vehicle use (ABS, 2009 and Natural Resources Canada, 2009). While the sample population for vehicle surveys may be sourced from motor vehicle registration data, the surveys provide a valuable audit mechanism for motor vehicle registration data as they reflect nationally consistent definitions of body type as compared to vehicle classifications which can vary by jurisdiction (Gibbs, 1996).

The ratio of the number of vehicles in any census year to that in the previous census should be employed as a higher order measure of the robustness of motor vehicle registration data. The ratio should be less than one, except if second hand imports or the net impact of cross border trading exceeds the scrappage rate for a year of manufacture and a jurisdiction. The ratio should only be applied to registration data post the period where the rate of diffusion of new vehicles exceeds the scrappage rate of in-service. If this ratio increases (or the scrappage rate exceeds one) then the motor vehicle registration data is inappropriate for deriving meaningful vehicle scrappage rates.

2.2 Adjustment criteria and procedures

The robustness of motor vehicle registration data should be assessed according to seven criteria these being coverage, vehicle type processing errors, consistency, completeness, under reporting and exclusions, vehicle classification and comparability errors. Each of these is examined below.

Coverage is the extent to which the entire motor vehicle fleet is represented in each collection. Ideally motor vehicle inventory data should reflect a periodic counting of the entire vehicle population. However, costs associated with such collections can be prohibitive ensuring that the population for motor vehicle data may be confined to vehicles *"on register"*, that is, vehicles

licensed for unrestricted access to public roads, whether powered or towed. As such, motor vehicle registration data may be a subset of the total motor vehicle population excluding motor vehicles that are either predominantly used off-road, vehicles not required to be registered for on-road use (such as fire engines, ambulances or tractors), vehicles not registered at the time of the collection, defense vehicles, some Government vehicles, diplomatic and consular vehicles, tractors, certain motorised plant and equipment, vintage and veteran vehicles and vehicles on-sold to export markets (ABS, 2009).

To date, the extent of these omissions has not been examined within the literature largely due to a dearth of data pertaining to the number of new vehicles registered and new vehicle sales. In Australia, the Australian Bureau of Statistics published monthly statistics on new motor vehicle registrations by jurisdiction (ABS, 2001a) from the early 1950s until December 2001. Since 1991, the Federal Chamber of Automotive Industries published monthly data on new vehicle sales. As a result, between 1992 and 2001, the Australian Government and the Federal Chamber of Automotive Industries (1996) simultaneously collected data on the number of new vehicles registrations (Australian Bureau of Statistics, 2001) and new vehicle sales, respectively. Table 1 compares vehicle sales and registration data for passenger cars, light commercial vehicles and trucks between 1992 and 2001 (inclusive). The table indicates the following:

- sales for rigid and articulated trucks exceeded registrations by 2.1 per cent to 9.5 per cent, with an average annual differential of 4.9 per cent;
- for light commercial vehicles, sales exceeded registrations by 2.0 per cent to 5.6 per cent with an average annual differential of 3.4 per cent;
- differences between annual sales of passenger vehicles and registrations were lower than that evidenced with freight vehicles, with sales between 0.05 per cent less and to 1.2 per cent greater than registrations. Overall, the average annual variation between sales and registrations for passenger vehicles equated to 0.5 per cent;

Table 1: New vehicle registrations versus sales by vehicle type, 1992 to 2001 (ABS (various), "New Motor Vehicle Registrations", Cat No. 9301.0., VFACTS (various), pers. comm.)

Calendar Year	Passenger Vehicles				Light Commercial Vehicles				Trucks			
	Registration	Sales	Diff	% diff	Registration	Sales	Diff	% diff	Registration	Sales	Diff	% diff
1992	n.a.	n.a.	n.a.	n.a.	73,089	75,653	2,564	3.51%	12,704	13,115	411	3.24%
1993	n.a.	n.a.	n.a.	n.a.	75,036	78,182	3,146	4.19%	12,779	13,500	721	5.64%
1994	502,011	506,201	4,190	0.83%	86,539	90,313	3,774	4.36%	15,388	16,848	1,460	9.49%
1995	n.a.	534,078	n.a.	n.a.	n.a.	89,196	n.a.	n.a.	n.a.	16,064	n.a.	n.a.
1996	542,042	542,327	285	0.05%	88,647	91,142	2,495	2.81%	13,352	13,715	363	2.72%
1997	608,923	611,621	2,698	0.44%	89,984	93,119	3,135	3.48%	15,010	15,321	311	2.07%
1998	676,333	680,911	4,578	0.68%	102,680	105,770	3,090	3.01%	17,730	18,111	381	2.15%
1999	643,731	651,627	7,896	1.23%	107,263	113,299	6,036	5.63%	18,407	19,357	950	5.16%
2000	656,472	659,183	2,711	0.41%	104,325	106,442	2,117	2.03%	17,448	18,731	1,283	7.35%
2001	646,010	645,688	-322	-0.05%	104,770	107,047	2,277	2.17%	17,015	17,923	908	5.34%
Total	4,275,522	4,297,558	22,036	0.52%	832,333	860,967	28,634	3.44%	139,833	146,621	6,788	4.85%

Note: n.a – not available.
Sources: ABS (various), "New Motor Vehicle Registrations", Cat No. 9301.0.
VFACTS (various), pers. comm.

Resolution of the coverage issue is critical to any subsequent analysis of fuel consumed by road transport and associated emissions. Unless both registered and non-registered vehicles are incorporated within the total vehicle fleet, any concordance between the size of the fleet, the national road transport task (measured by distance travelled, passenger-kilometre or tonne-kilometre), the economy and total fuel consumed (by road transport) is compromised. If motor vehicle fleet data is confined to registered vehicles, fuel consumption data for road vehicles must be adjusted to account for fuel expended by "non-registered" vehicles, vehicles not registered at the time of the motor vehicle survey, and/or off-road vehicles. This approach will also allow the differing transport task, fuel consumption and emission attributes for "non registered" vehicles to be appropriately quantified.

Coverage issues can be addressed by either identifying the size of that component of the fleet omitted in any collection (by vehicle type) using third party data from defense agencies, Government, motoring authorities or motoring clubs or by imputation. Imputation by vehicle type and jurisdiction can reflect the proportional contribution of these vehicles as evidenced from motor vehicle collections where these vehicles were incorporated within the fleet. In adopting the second approach, it is assumed that the proportional contribution of the subset of vehicles to the total fleet does not vary significantly over time.

Having determined the number of missing vehicles by vehicle type and jurisdiction, a year of manufacture profile can be derived using alternative sources such as taxation legislation/regulation. Some "non-registered" vehicles such as those held by Government Departments, defense, diplomats and community service vehicles may be subject to specific taxation arrangements such as a tax free basis for an agreed period of time and/or vehicle kilometers travelled (Ernst & Young Management Consulting Services, 1992) prior to on-sale to the general fleet. The year of manufacture profile can be imputed by applying the fleet wide motor vehicle distribution (post not-stated and under-reporting adjustments) up to the tax free period.

Vehicle type processing errors arise from inconsistent classification by vehicle type. There are two dominant instances of vehicle type processing errors. The first is where the delineation between vehicle types is comparatively minor and a particular vehicle type can be allocated a number of categories. For example, rear end door sedans being classified as either a car or a station wagon (a passenger vehicle with a body style similar to a sedan, or saloon, but with the roofline following the full, sometimes extended rear cargo area ending with a more vertical door than on a sedan). In this instance, correction requires reference to unit record data. The second is when existing vehicle categories do not adequately reflect the attributes of a newly introduced vehicle type. For example, four wheel drive (4WD) vehicles being classified as either a car, station wagon, panel van (a solid, rigid-bodied van, smaller than a lorry or truck) or rigid truck (Gibbs, 1996). There are three potential approaches for adjusting processing errors of this type. The first requires reference to unit record data. However, such records may not exist or, if they do exist, be subject to confidentiality requirements. The second adjusts according to gross vehicle mass (GVM) or tare weight. The third necessitates comparison with vehicle use surveys where such surveys classify vehicles according to body type (ABS, 2009). Delineation by year of manufacture is achieved by reference to unit record data or the year of manufacture associated with the vehicle type for those vehicles incorrectly allocated.

Data consistency reflects anomalies arising from differing jurisdictional interpretation of vehicle type particularly where national motor vehicle aggregates are derived from individual jurisdictional records. There are three (3) major categories of jurisdictional based inconsistencies, these being inadequate data at jurisdictional level to support national vehicle classification protocols, certain vehicle types being exempt from registration in some jurisdictions within a country and changes to vehicle categories by a jurisdiction(s) independent of other jurisdictions.

Adjustment of consistency errors is best achieved by reference to unit record data across. In these circumstances, adjustment can be achieved from vehicle sales data or imputation based upon those jurisdictions where such data is available.

Completeness is the extent to which data is missing or year of manufacture is not defined. Adjusting for missing data can be aided by identifying key vehicle identification events that provide insight into the factors influencing the nature of not-stated vehicle records. Examples include the introduction of design rules/legislation/regulation such as the introduction of vehicle identification numbers at a specified date or the introduction of a new fuel type at a particular year of manufacture. Adjustments for missing year of manufacture is achieved by assuming that the year of manufacture profile for stated and not-stated records are similar for each vehicle type and jurisdiction.

Having identified the nature and timing of the events, the not-stated values can be distributed by vehicle type and jurisdiction according to:

$$ns_{y,j,v} = (A_{j,v,y} / \sum_{y(i)}^{n-1} Aj, v) * NSV_{j,v,} \quad (1)$$

where y is the year of manufacture, j is the jurisdiction, v is the vehicle type, A is the existing number of vehicles, v is the vehicle type, n is the year in which the identifying event occurred, y(i) is the initial YoM for which data is available and NSV is the number of not-stated vehicles.

Where the sample of vehicles recorded with the year of manufacture is comparatively small, the year of manufacture distribution (of a particular vehicle type in a jurisdiction) for an adjacent motor vehicle collection period can be applied to the not-stated year of manufacture values according to the following:

$$ns_{y,j,v} = (A_{j,v,y} / (\sum_{y(i)}^{n-1} Aj, v - NSVj, v)_{\text{cb-age}}) * ns_{j,v,} \quad (2)$$

where cb is the adjacent census year and age is the vehicle age in years.

Under reporting and exclusions arises from three incidences. The first relates to changes to the date of registration for the motor vehicle collection, resulting in the under reporting/exclusion of *new* vehicles registered between the date of registration in most previous motor vehicle registration collection and the current collection. The magnitude of the discrepancy can be identified from periodic vehicle sales records with these vehicles treated as new vehicles. The second reflects vehicles participating in non-jurisdictional registration schemes. These vehicles can be identified from the non-jurisdictional registrations with the year of manufacture distribution being imputed from the distributions of identical vehicle types in the jurisdictional registration collections, post not-stated adjustment. The methodology assumes that their exclusion is independent of vehicle age and that the year of manufacture distribution is identical to that of the jurisdictional register, for identical vehicle types. The final incidence pertains to vehicles being re-registered in the period between the nominated date of registration in the previous motor vehicle registration collection and the revised date of registration in the current registration collection. The extent of the discrepancy can be identified from existing registry data with year of manufacture apportioned according to the post not-stated adjusted distribution for the identical vehicle type.

Vehicle classification errors arise from ongoing definitional adjustments to vehicle classification. These include changes to gross vehicle mass limits for freight vehicles, changes to seating capacity for passenger vehicles/microbuses, the transfer of specialised vehicle types from one vehicle category to another (such as the transfer of hearses and ambulances from light commercial vehicles to non-freight trucks) or the introduction of a new vehicle category (such as campervans). A variety of adjusting methodologies can be employed to address vehicle classification issues, including;

- the use of registration unit record data;
- delineating vehicle types from combined vehicle categories and distributing the new vehicle category by year of manufacture for the historical data according to the recent year of manufacture distribution, allowing for timing differences;
- estimating the number of vehicles using log-linear relationships reflecting key socio-economic/ demographic variables and the number of vehicles. The year of manufacture profiles imputed from the pre-adjusted year of manufacture distribution;
- applying weighted average growth factors by vehicle type and jurisdiction;
- undertaking independent small scale vehicle surveys.

Comparability errors arise from timing differences as a result of three events. The first is inconsistent collection periods. Motor vehicle registration data is a count of registered vehicles *at a point in time*. Where collection dates vary, motor vehicle registration data should be normalised to reflect the most recent period using monthly vehicle registration data and/or interpolation for vehicles of vintage greater than one year.

The second event arises from inconsistent registration periods. Registration is defined as those vehicles for which registration was effective for the nominated period, with registration fees paid either in advance, at that date or retrospectively (ABS, 2009). Unit record data by jurisdiction and census is required to adjust the time series for differences in the registration period. The final event relates to the need to align the collection period to the year of manufacture period (calendar year) if deriving scrappage rates. This is best achieved by reference to unit records. If unit records are not available, linear interpolation can be adopted to reflect the calendar year period.

The adjustment framework is an enumeration exercise. While it provides a comprehensive structure, it cannot be rigidly prescriptive as the adjustment methodology will reflect the status of data in each jurisdiction.

2.3 Validation

The third component of the correction framework involves validation according to the incidence of increasing vehicle numbers of a particular vintage beyond the vehicle diffusion period and, where applicable, assessment relative to alternative motor vehicle data such as motor vehicle use surveys.

3. Application of the correction framework to Australian motor vehicle registration data

The third section of the paper demonstrates the correction framework using Australian motor vehicle data. In so doing, the section provides a brief description of Australian registration data, establishes the case for correcting Australian motor vehicle registration data and demonstrates the relative merits of the impact of the correction framework.

3.1 Australian motor vehicle registration data – A primer

There are three sources of national motor vehicle registration data for Australia, the Motor Vehicle Census, New Motor Vehicle Registrations/Sales and the Survey of Motor Vehicle Use.

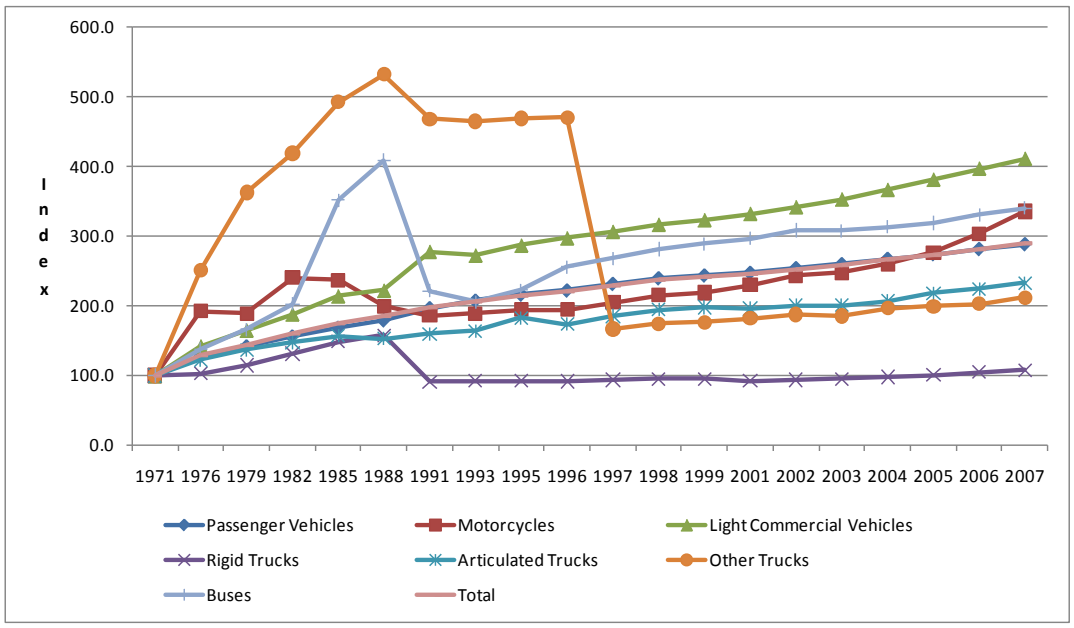
The Motor Vehicle Census is prepared by the Australian Bureau of Statistics (ABS, various) and periodically compiles data on the size and composition of the Australian vehicle fleet. The census was first published in 1921, then 1962, followed by 1971 and 1976. Triennial collections were prepared from 1976 to 1988 (inclusive), followed by biannual collections to 1995 (inclusive) and annual collections (excluding the year 2000) to the present.

The Survey of Motor Vehicle Use (ABS, 2008) is an intermittent survey of motor vehicle use (passenger and freight) and fuel use by vehicle type. The population for the survey is derived from the motor vehicle census, incorporating all vehicles (with the exception of caravans and trailers) that are registered with a motor vehicle authority at some stage during the twelve months preceding the nominated survey date. The survey was first undertaken in 1963, then 1971 and 1976. Triennial collections were prepared from 1976 to 1991 (inclusive), followed by biannual collections to 1995 (inclusive) and annual collections (excluding the year 2000) to the present. From 1998 to 2007 annual collections were compiled from four quarterly surveys.

A description of new motor vehicle registration/sales is provided in section 2.2.

3.2 The case for correcting Australian motor vehicle registration data

Figure 3 illustrates the indexed trend for the number of vehicles registered in Australia between 1971 and 2007 by vehicle type. Of specific concern is the movement of vehicle numbers for rigid trucks, light commercial vehicles (LCVs), motorcycles, other trucks and buses, particularly prior to 1993 and, for other trucks, at both 1991 and 1997.



Source: ABS, "Motor Vehicle Census", various

Figure 3: Trends in the number of Australian motor vehicles by census year and vehicle type (ABS, "Motor Vehicle Census", various)

Table 2 identifies fourteen instances (shaded cells) where the number of registered vehicles of a particular year of manufacture was identical to or greater than that recorded in the previous "census", beyond the period of diffusion. For example, the 1997 motor vehicle census recorded increases in the number of vehicles up to seven years beyond the original year of manufacture. Figure 4 illustrates the nature of events that compromised the time series robustness of the Australian motor vehicle registration data. These events occurred between 1985 and 1999.

Table 2: The incident of increasing annual vehicle numbers post two years of age – Australian fleet (excluding campervans), ABS series (ABS, various).

	Census Year																	
Vintage	1979	1982	1985	1988	1991	1993	1995	1996	1997	1998	1999	2001	2002	2003	2004	2005	2006	2007
1970	0.750	0.705	0.657	0.709	0.739	0.838	0.839	0.878	0.934	0.929	0.888	0.879	0.942	0.929	0.930	0.936	0.948	0.936
1971	0.916	0.851										0.829	0.880	0.894	0.894	0.883	0.902	0.904
1972	0.925	0.871										0.809	0.874	0.886	0.886	0.878	0.896	0.901
1973	0.930	0.887										0.788	0.871	0.873	0.876	0.877	0.885	0.893
1974	0.942	0.921	0.850		0.732	0.817						0.770	0.878	0.869	0.866	0.866	0.874	0.882
1975	0.956	0.915	0.887									0.760	0.865	0.851	0.852	0.850	0.857	0.863
1976		0.938	0.915									0.757	0.865	0.851	0.854	0.855	0.856	0.865
1977		0.938	0.943									0.757	0.855	0.849	0.851	0.847	0.852	0.860
1978			0.953		0.830	0.873		0.836				0.760	0.853	0.845	0.842	0.840	0.844	0.851
1979			0.968									0.751	0.841	0.829	0.822	0.814	0.817	0.827
1980			0.965									0.761	0.857	0.829	0.820	0.813	0.811	0.817
1981												0.783	0.855	0.840	0.828	0.811	0.809	0.812
1982					0.927	0.957	0.922	0.907				0.804	0.865	0.845	0.826	0.814	0.802	0.806
1983				0.964								0.834	0.881	0.862	0.839	0.822	0.811	0.807
1984												0.868	0.907	0.884	0.861	0.839	0.827	0.817
1985												0.896	0.928	0.906	0.883	0.859	0.844	0.832
1986						0.992	0.974	0.963				0.916	0.943	0.922	0.900	0.878	0.859	0.842
1987												0.930	0.949	0.933	0.912	0.887	0.866	0.847
1988												0.957	0.967	0.952	0.941	0.915	0.894	0.872
1989						1.005		0.984				0.964	0.978	0.965	0.949	0.938	0.922	0.894
1990							0.991	0.988	1.004			0.978	0.998	0.975	0.963	0.950	0.939	0.918
1991							0.995	0.988	1.005			0.988	0.989	0.985	0.974	0.962	0.949	0.932
1992								0.988	1.008	0.999	0.994	0.990	0.993	0.989	0.980	0.971	0.961	0.946
1993								0.990	1.009	0.998	0.993	0.990	0.994	0.993	0.985	0.977	0.970	0.957
1994									1.014	0.999	0.992	0.987	1.000	0.992	0.987	0.982	0.976	0.967
1995										1.004	0.991	0.985	0.999	0.994	0.989	0.985	0.980	0.973
1996											0.994	0.985	0.998	0.992	0.991	0.987	0.986	0.979
1997												0.986	0.998	0.993	0.992	0.989	0.988	0.984
1998												0.995	1.000	0.994	0.993	0.991	0.991	0.988
1999													1.006	0.995	0.993	0.992	0.992	0.991
2000														1.002	0.994	0.993	0.994	0.992
2001															1.001	0.994	0.994	0.993
2002																1.002	0.996	0.995
2003																	1.005	0.996
2004																		1.005
2005																		
2006																		
2007																		

Source: ABS, various.

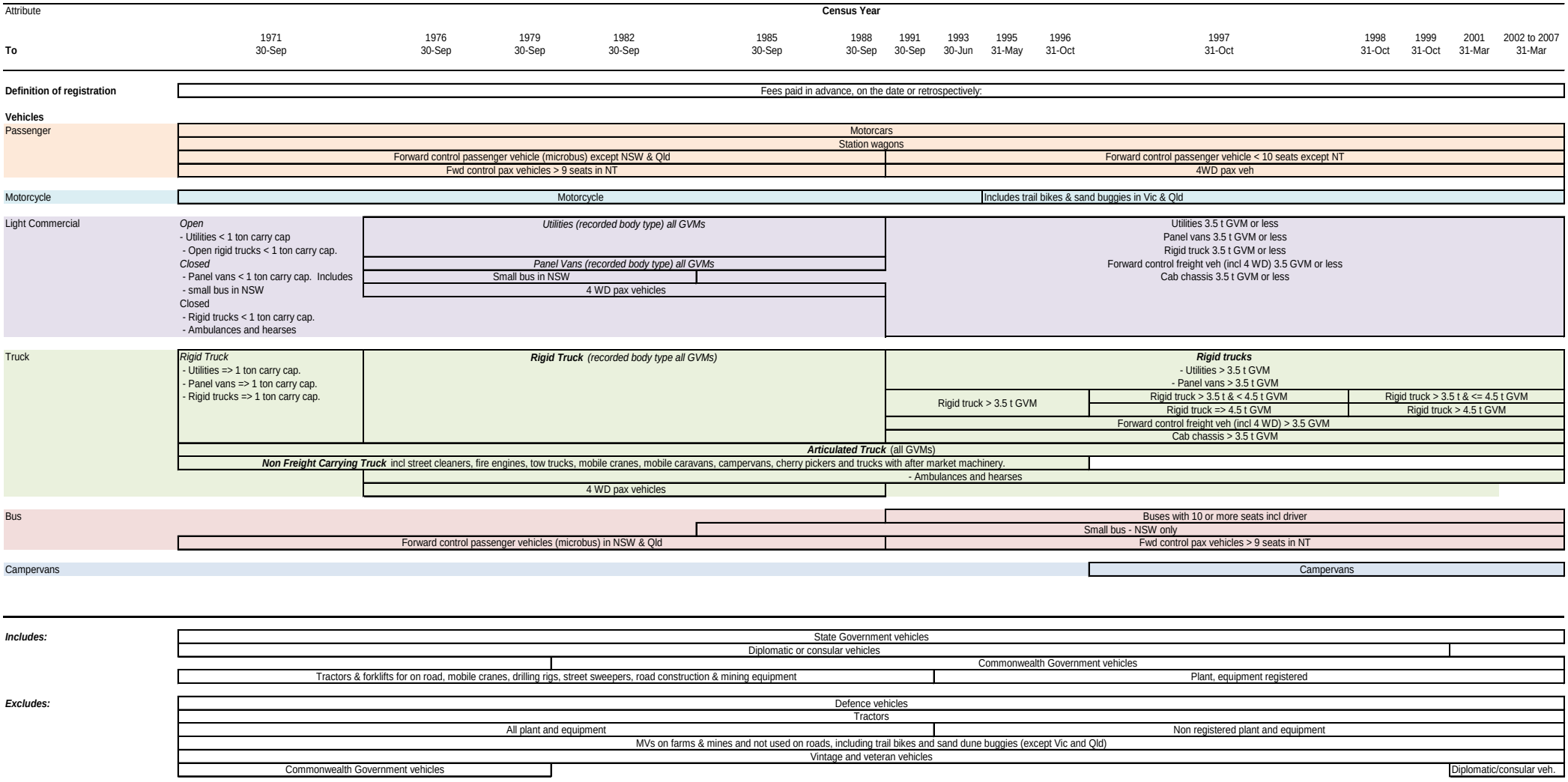


Figure 4: Changes to the motor vehicle census (ABS (various), "Motor Vehicle Census", ABS (1997)," Motor Vehicles in Australia", Cat 9311.0)

Notes: MV-motor vehicles. Cap.- capacity.
Sources: ABS (various), "Motor Vehicle Census" ABS (1997)," Motor Vehicles in Australia", Cat 9311.0

3.3 Impact of adjustments

Table 3 outlines the impact of the correction framework in deriving temporally consistent motor vehicle registration data for Australia. Overall, the adjusted series (excluding campervans) was between 176,452 vehicles (or 1.9 per cent) lower and 87,539 (or 0.8 per cent) vehicles higher than the national motor vehicle registration series. A further assessment of Table 3 indicates that:

- for rigid trucks, the adjusted series varied reported between 226,006 vehicles (or 39.2 per cent) lower to 4,054 vehicles (or 1.2 per cent) greater than that reported by the motor vehicle registration data;
- the adjusted series for buses varied between 46,981 vehicles (or 50.4 per cent) lower to 2,047 vehicles (or 4.0 per cent) greater than that reported by the ABS;
- for non-freight trucks, the adjusted series was between 36,003 vehicles (or 67.5 per cent) lower to 59 vehicles (or 0.4 per cent) higher than the ABS data largely due to the establishment of a campervan vehicle category;
- for LCVs, the adjusted series varied between 99,453 vehicles (or 6.7 per cent) lower to 12,914 vehicles (or 0.8 per cent) higher than the motor vehicle registration data;
- the adjusted series for articulated trucks varied between 1,464 vehicles (or 2.5 per cent) lower to 1,606 vehicles (or 2.9 per cent) greater than that reported by the ABS;
- the adjusted series for motorcycles differed from the ABS data by between 17,256 cycles (or 5.7 per cent) lower to 6,384 cycles (or 2.2 per cent) greater than the ABS series;
- for passenger vehicles the adjusted vehicle numbers varied between 85,135 vehicles (or 1.0 per cent) lower to 201,704 vehicles (or 2.8 per cent) higher than the ABS series.

Table 3: A comparisons of the national motor vehicle registration data and the adjusted series by vehicle type

Vehicle Type		Census Year								
		1985	1988	1991	1993	1995	1996	1997	1998	1999
Passenger Vehicle	ABS-MVR	6,734,202	7,158,807	7,853,453	8,280,211	8,628,806	8,862,337	9,239,527	9,560,552	9,719,891
	Adjusted	6,883,753	7,360,511	7,837,194	8,195,076	8,610,030	8,955,796	9,206,840	9,514,506	9,649,808
	Difference	149,551	201,704	-16,259	-85,135	-18,776	93,459	-32,687	-46,046	-70,083
	% difference	2.2%	2.8%	-0.2%	-1.0%	-0.2%	1.1%	-0.4%	-0.5%	-0.7%
Motorcycle	ABS-MVR	361,625	303,988	284,177	288,844	296,628	296,480	313,101	328,845	333,782
	Adjusted	351,704	286,732	273,069	284,328	293,841	302,864	312,697	327,367	331,948
	Difference	-9,921	-17,256	-11,108	-4,516	-2,787	6,384	-404	-1,478	-1,834
	% difference	-2.7%	-5.7%	-3.9%	-1.6%	-0.9%	2.2%	-0.1%	-0.4%	-0.5%
Light Commercial Vehicle	ABS-MVR	1,140,478	1,183,468	1,479,692	1,451,265	1,527,212	1,582,641	1,632,219	1,686,432	1,721,200
	Adjusted	1,095,014	1,131,982	1,380,239	1,440,806	1,529,035	1,595,555	1,628,345	1,679,614	1,713,110
	Difference	-45,464	-51,486	-99,453	-10,459	1,823	12,914	-3,874	-6,818	-8,090
	% difference	-4.0%	-4.4%	-6.7%	-0.7%	0.1%	0.8%	-0.2%	-0.4%	-0.5%
Rigid Truck	ABS-MVR	543,722	576,334	333,083	336,587	337,421	335,984	342,412	347,214	346,823
	Adjusted	373,535	350,328	329,401	333,170	336,286	340,038	341,659	345,616	344,291
	Difference	-170,187	-226,006	-3,682	-3,417	-1,135	4,054	-753	-1,598	-2,532
	% difference	-31.3%	-39.2%	-1.1%	-1.0%	-0.3%	1.2%	-0.2%	-0.5%	-0.7%
Articulated Truck	ABS-MVR	50,220	48,857	51,014	52,505	58,322	55,450	59,292	62,274	63,295
	Adjusted	49,517	48,433	50,893	52,536	56,858	57,056	59,221	62,040	62,772
	Difference	-703	-424	-121	31	-1,464	1,606	-71	-234	-523
	% difference	-1.4%	-0.9%	-0.2%	0.1%	-2.5%	2.9%	-0.1%	-0.4%	-0.8%
Non Freight Truck	ABS-MVR	49,380	53,362	46,937	46,559	46,971	47,163	16,699	17,458	17,697
	Adjusted	16,320	17,359	15,381	15,167	15,133	15,746	16,758	17,443	17,662
	Difference	-33,060	-36,003	-31,556	-31,392	-31,838	-31,417	59	-15	-35
	% difference	-66.9%	-67.5%	-67.2%	-67.4%	-67.8%	-66.6%	0.4%	-0.1%	-0.2%
Bus	ABS-MVR	80,069	93,161	50,535	46,853	50,689	58,172	61,143	64,082	65,891
	Adjusted	41,572	46,180	49,773	46,701	52,736	58,710	61,120	64,007	65,593
	Difference	-38,497	-46,981	-762	-152	2,047	538	-24	-75	-298
	% difference	-48.1%	-50.4%	-1.5%	-0.3%	4.0%	0.9%	0.0%	-0.1%	-0.5%
Campervan	ABS-MVR	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	33,291	33,819	33,622
	Adjusted	33,028	35,162	31,433	31,216	31,903	32,413	n.a.	n.a.	33,205
	Difference	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-417
	% difference	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-1.2%
All Vehicles excluding campervans	ABS-MVR	8,959,696	9,417,977	10,098,891	10,502,824	10,946,049	11,238,227	11,664,393	12,066,857	12,268,579
	Adjusted	8,811,415	9,241,525	9,935,950	10,367,783	10,893,918	11,325,766	11,626,639	12,010,594	12,185,183
	Difference	-148,281	-176,452	-162,941	-135,041	-52,131	87,539	-37,754	-56,263	-83,396
	% difference	-1.7%	-1.9%	-1.6%	-1.3%	-0.5%	0.8%	-0.3%	-0.5%	-0.7%
All Vehicles including campervans	ABS-MVR	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	11,697,684	12,100,676	12,302,201
	Adjusted	8,844,443	9,276,686	9,967,383	10,399,000	10,925,821	11,358,178	n.a.	n.a.	12,218,389
	Difference	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-83,812
	% difference	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-0.7%

All Vehicles including campervans	ABS-MVR	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	11,697,684	12,100,676	12,302,201
	Adjusted	8,844,443	9,276,686	9,967,383	10,399,000	10,925,821	11,358,178	n.a.	n.a.	12,218,389
	Difference	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-83,812
	% difference	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-0.7%

Notes: n.a. - not available.
ABS-MVR Motor vehicle registration data

An additional measure of the relevance of the adjustment process is an assessment of the distribution of vehicle registration by jurisdiction, vehicle type and year of manufacture. Of particular interest is the elimination of increasing vehicle numbers, for a particular year of manufacture, at periods well in advance of the year of manufacture.

Table 4 details the proportion of vehicles that survived the next census, post the diffusion period of two years, by year of manufacture for the national road fleet (excluding campervans, as year of manufacture campervan data was not available for 1998 and 1999). The table demonstrates that the application of the correction framework entirely eliminated the incident of increasing vehicle numbers in excess of two years post the year of manufacture.

Table 4: The proportion of vehicles surviving to the next census post two years of age – Australian fleet (excluding campervans), adjusted series

	Calendar Year																
Vintage	1979	1982	1985	1988	1991	1993	1995	1996	1997	1998	1999	2001	2002	2003	2004	2005	2006
1970	0.738	0.698	0.659	0.709							0.892	0.851	0.924	0.935	0.938	0.945	0.941
1971	0.895												0.881	0.900	0.890	0.898	0.905
1972	0.903												0.870	0.893	0.885	0.892	0.902
1973	0.904												0.859	0.884	0.882	0.883	0.893
1974	0.910	0.908		0.761									0.856	0.876	0.872	0.873	0.882
1975	0.921	0.910											0.841	0.861	0.856	0.856	0.863
1976		0.919											0.839	0.863	0.861	0.857	0.865
1977		0.914											0.840	0.857	0.853	0.852	0.860
1978				0.879								0.695	0.839	0.848	0.844	0.844	0.851
1979													0.827	0.827	0.819	0.817	0.826
1980													0.832	0.825	0.817	0.813	0.818
1981													0.839	0.835	0.819	0.811	0.814
1982				0.944	0.928	0.947	0.908					0.739	0.846	0.834	0.819	0.807	0.807
1983													0.863	0.848	0.829	0.815	0.811
1984													0.887	0.869	0.847	0.832	0.822
1985													0.909	0.891	0.867	0.850	0.838
1986					0.972	0.992	0.970					0.884	0.925	0.907	0.885	0.865	0.849
1987													0.935	0.919	0.895	0.873	0.854
1988													0.954	0.945	0.923	0.901	0.880
1989							0.987					0.951	0.967	0.954	0.941	0.926	0.901
1990							0.992						0.979	0.967	0.954	0.942	0.923
1991							0.994					0.981	0.985	0.977	0.965	0.952	0.937
1992											0.994	0.986	0.989	0.983	0.973	0.964	0.950
1993											0.993	0.986	0.992	0.988	0.980	0.972	0.960
1994											0.992	0.988	0.993	0.989	0.983	0.978	0.969
1995											0.991	0.985	0.994	0.990	0.986	0.981	0.975
1996											0.993	0.985	0.993	0.991	0.988	0.986	0.981
1997												0.986	0.993	0.992	0.990	0.989	0.985
1998													0.994	0.993	0.992	0.991	0.989
1999													0.997	0.994	0.993	0.992	0.991
2000														0.997	0.994	0.993	0.993
2001															0.996	0.994	0.994
2002																0.998	0.995
2003																	0.998
2004																	
2005																	
2006																	
2007																	

4. Conclusions

Projecting the vehicle fleet is crucial to the preparation of evidence based road transport emissions, demand and associated energy policies. The provision of vehicle fleet forecasts is dependent on quantifying scrappage (or mortality) of existing vehicles which in turn requires a consistent time series of motor vehicle registration data, by vintage, vehicle type and jurisdiction. The paper has outlined a three step correction framework for deriving temporally consistent motor vehicle data.

The proposed framework was subsequently applied to Australian motor vehicle registration data, resulting in the introduction of a new vehicle category into the time series and adjustments to vehicle counts for all vehicle types, in all jurisdictions. As a result, the erroneous incidence of the number of vehicles (on a national basis) of a particular vintage increasing more than two years after the year of manufacture was entirely eliminated. The next phase of the research concerns the derivation of scrappage functions by vehicle type and jurisdiction based upon the corrected motor vehicle registration data.

Finally, the paper noted that unless both registered and non-registered vehicles are incorporated within the total vehicle fleet, any concordance between the size of the fleet, total fuel consumed, the national road transport task and the economy is compromised. In the event that motor vehicle fleet data is confined to registered vehicles, fuel consumption data pertaining to road vehicles must be adjusted to account for fuel expended by “non-registered” vehicles, vehicles not registered at the time of the motor vehicle survey, and/or off-road vehicles.

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