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AUSTRALIAN BUREAU OF STATISTICS

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INQUIRIES

The ABS welcomes comments on the research presented in this paper.
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CONTENTS

LIST OF ABBREVIATIONS

ABS	Australian Bureau of Statistics
BothOD	Both odometer readings (initial and final) provided to the SMVU
BTRE	Bureau of Transport and Regional Economics
DITR	Department of Industry Tourism and Resources
FCAI	Federal Chamber of Automotive Industries
ML	Megalitre
MVR	Motor Vehicle Registry
NMVR	New Motor Vehicle Registrations
NoOD	No odometer readings provided to the SMVU
NVP	New Vehicle Provision
RPM	Revolutions per minute
RTA	Road Traffic Authority
SingleOD	One odometer (either initial or final) reading provided to the SMVU
SMVU	Survey of Motor Vehicle Use
TPS	Total petrol sales
UVU	Unregistered Vehicle Use
VKT	Vehicle Kilometres Travelled

SURVEY OF MOTOR VEHICLE USE – AN INVESTIGATION INTO COHERENCE

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ABSTRACT

This research paper presents the results of a joint Australian Bureau of Statistics and Bureau of Transport and Regional Economics project which investigated the disparities between the Survey of Motor Vehicle Use (SMVU) estimates of total petrol consumption and annual Total Petrol Sales (TPS) data, published by the Department of Industry, Tourism and Resources (DITR).

The quality of SMVU estimates are subject to debate amongst transport analysts. Since 1991 the petrol consumption estimates for registered vehicle use have been lower than total petrol sales, by between 5 and 15 per cent. This disparity could not hitherto be explained by sampling error. It was known that petrol consumed in off-road uses, or by unregistered and out-of-scope motor vehicle use would be an important consideration, however, the significance of these respective factors was not known.

The investigation focused on the 1998–2003 surveys. Two broad aspects of data quality were investigated: (i) differences in scope between the SMVU and TPS data; and (ii) coverage of the SMVU. [1] The purpose of the analysis was to identify where scope and coverage factors may impact upon the disparity between SMVU petrol consumption estimates and the total petrol sales data published by DITR.

The investigation found that a significant amount of petrol is consumed by unregistered vehicles, boats, lawnmowers and machinery. Furthermore, the current survey methodology results in an under-representation of newer vehicles, which tend to be driven further and hence consume more petrol. Together, these factors explain the majority of the observed discrepancy between petrol consumption estimates and petrol sales figures.

1 Survey scope is the definition of the target population that the survey is able to obtain survey frame information from. The target population and the survey population may differ where incomplete information about the target population exists (such as unregistered vehicles). Reduced survey coverage occurs where sample units that are in scope of the survey, are not available for selection on the survey frame (such as newly registered vehicles).

1. INTRODUCTION

The Australian Bureau of Statistics' Survey of Motor Vehicle Use (SMVU) is the principal source of data on registered motor vehicle use across Australia. The survey provides national and State/Territory estimates of distance travelled, fuel use, and freight carried, by vehicle type and is widely used by Australian, State and Territory Government agencies for policy and planning. Transport analysts rely on the SMVU estimates of current registered motor vehicle use, and use the estimates to derive time series data sets for investigating trends in key variables over time.

The SMVU was first undertaken in 1963 and a second survey was conducted in 1971. Between 1976 and 1991 the survey was conducted triennially. The survey was conducted again in 1995, which was the last time the SMVU used a 'recall methodology'. Since 1998, the survey has been undertaken annually, using a pre advice methodology.

The quality of SMVU estimates are subject to some debate amongst transport analysts. Since 1991 the SMVU automotive gasoline [2](petrol) consumption estimates have been 5–15% lower than total petrol sales (TPS) published by the Department of Industry, Tourism and Resources (DITR).

As part of a fitness-for-purpose review of the SMVU, the ABS investigated the impact of out-of-scope and off-road vehicle use on survey estimates of petrol consumption and invited the Bureau of Transport and Regional Economics (BTRE) to assist the review by investigating the unit record survey response data obtained by the SMVU.

This paper focuses on the disparity between the SMVU estimates of petrol consumption and total petrol sales data published by DITR. The investigation concentrated on passenger vehicles, because passenger vehicles account for approximately 90 per cent of total petrol consumption by registered motor vehicles. [3] The analysis also included other vehicles and petrol using engines such as boats and lawnmowers. Related analysis covered other vehicle types, such as articulated trucks, and the issues raised, particularly with regard to survey coverage, were found to be similar to those of passenger cars.

The structure of the paper is as follows. Section 2 introduces the scope and background of the SMVU and TPS collections prior to presenting the detail of the disparity between the two series in Section 3. Section 4 discusses vehicles and machinery that are not in scope of the SMVU and establishes the extent of the disparity attributable to petrol use by these 'out-of-scope' and off-road factors. In

2 To facilitate readability, we have referred to 'automotive gasoline' as 'petrol' and 'automotive diesel oil' as 'diesel' throughout the paper.

3 Diesel use by road transport accounts for approximately half of total diesel sales, with rail transport , the mining and agricultural sectors major users. It was not possible to undertake a similar analysis for diesel fuel use.

Section 5 we describe the unit record analysis, which was undertaken to identify if coverage factors have the potential to impact upon SMVU estimates and therefore the disparity. Conclusions and a reconciliation between total petrol sales and SMVU petrol consumption estimates are presented in Section 6. The overall conclusions of the paper are presented in Section 7.

2. BACKGROUND TO THE SURVEY OF MOTOR VEHICLE USE AND TOTAL PETROL SALES COLLECTIONS

This section establishes the necessary background for explanation of the disparity between the SMVU and TPS series which is presented in Section 3. The scope of the two collections is presented, prior to a brief discussion on comparability of the respective data items.

The scope of the two collections is relatively close. The TPS represents the Australian supply of petrol and, in broad terms, the SMVU represents demand for petrol. The disparity between the two series essentially represents unaccounted for use of petrol. [4]

2.1 Scope and sample design of the Survey of Motor Vehicle Use

The SMVU passenger vehicle samples were stratified by State/Territory and Capital city/ rest-of-state in each of the 1998–2003 surveys. [5] For the 2004 SMVU, passenger vehicles were stratified by vehicle age and State/Territory of registration. [6] The scope of the SMVU covers all vehicles that were registered with a motor vehicle authority for unrestricted use on public roads at some time during the 12 month reference period (1 November to 31 October for each of the 2000–2003 surveys; and 1 August to 31 July for the 1998 and 1999 surveys) except:

- caravans;
- trailers;
- tractors;
- plant and equipment;
- vehicles belonging to the defence services;
- vehicles with diplomatic or consular plates;
- vintage and veteran cars (where they are registered as such); and
- recreational vehicles such as trail bike and sand dune buggies intended for off-road use in most states and territories (in Victoria and Queensland these vehicles must be registered and are thus included in the statistics).

Boats and marine vessels are not within scope of the SMVU. [7]

4 There may be some losses due to petrol evaporation, spillage and seepage from underground storage tanks.

5 Part of state refers to the metropolitan/non metropolitan geographic split.

6 Methodological investigations found that vehicle age was more significant than 'part of state' for identifying homogenous strata.

7 A significant number of these craft use petrol and, therefore, need to be considered when comparing SMVU petrol consumption estimates with administrative data on total petrol sales.

SMVU petrol consumption estimates are calculated according to the following formula:

$$\text{Total petrol consumption} = \sum \left\{ \begin{array}{l} \text{Total vehicle kilometres travelled (per vehicle)} \times \\ \text{Average petrol consumption rate (per vehicle)} \end{array} \right\}$$

Where the average petrol consumption rate is the average petrol consumption per vehicle, or total petrol consumption of the vehicle divided by the vehicle total VKT.

The formula shows every reporting vehicle contributes to the total petrol consumption estimate, according to the reported value of average petrol consumption, multiplied by the reported value for total distance travelled. Therefore, the population characteristics associated with diverging petrol use, such as acceleration behaviours, traffic congestion, engine capacity, or highway use, are encompassed within the final petrol consumption estimate.

2.2 Data sources for Total Petrol Sales

Australian Total Fuel Sales data are collected monthly and published by DITR in Australian Petroleum Statistics. These data constitute total petrol sales (TPS) and total diesel sales by Australian refineries to petrol wholesalers and retailers, for resale to final consumers. TPS data are based on aggregating reported sales (in litres) of the seven Australian refineries. The data are collated by the refiners for internal reporting purposes in addition to reporting to DITR.

The *Liquid Fuel Emergency Act* (1984) gives the Minister the power to direct companies to provide data to DITR, however, this legislative power has never been invoked. The published data are used by the refineries to determine market share and therefore commercial incentive, rather than legislative power, provides reporting motivation. DITR state that imputation is not required since there are no instances of 'nil' or 'part' reporting by the refineries.

TPS is considered a good source of non-ABS data with which to compare SMVU estimates because the scope characteristics between the two collections are very similar.

2.3 Data quality and issues associated with data confrontation

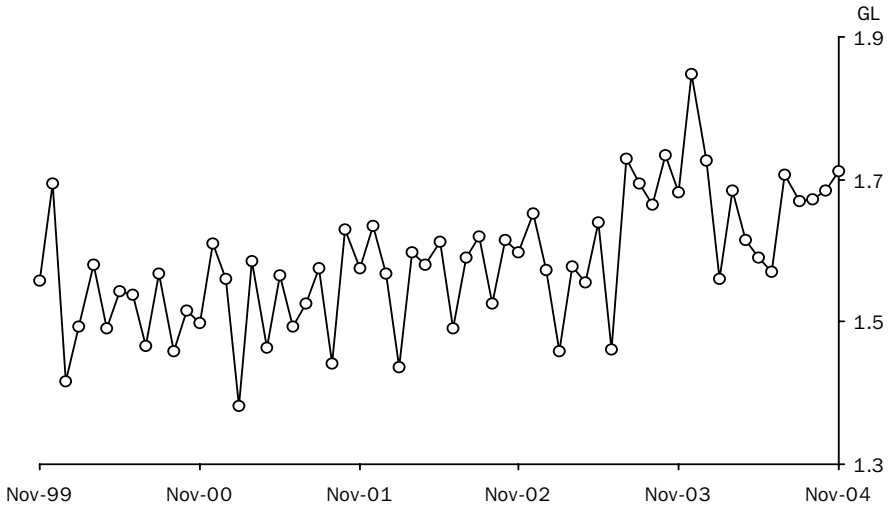
DITR are careful to exclude potential double counting of reported sales, by excluding any sales to petrol-based marketing companies. Petrol exports and sales to Australia's external territories and areas outside Australia are also excluded from the domestic petrol sales published by DITR.

TPS data cover a transfer in ownership between the refinery and either a wholesaler or a retailer. It does not specifically correlate to sales to the end user (vehicle). The

DITR statistics indicate that refineries generally hold between 15 and 19 days consumption cover in stocks of petrol, which implies an average two to three week lag between production and end use of petrol in Australia. It is feasible that these time lags may result in petrol sales data and petrol consumption data being recorded in different reference periods, thus providing apparent, but not erroneous differences between the two series.

Figure 2.1 shows there is substantial variability in TPS from month to month. While it is difficult to determine clear seasonality from the graph, the peak sales occur in December while the troughs are often in February. Due to the high monthly variability in TPS, it is recommended that comparative movements between SMVU and TPS are based on aggregating monthly data according to the same reference period as the SMVU. This will ensure that extreme values in monthly TPS, just before or just after the SMVU reference period (such as December), do not result in differences in percentage movements between the two series.

2.1 Monthly petrol fuel sales – Australia, Gigalitres



Source: Australian Petroleum Statistics

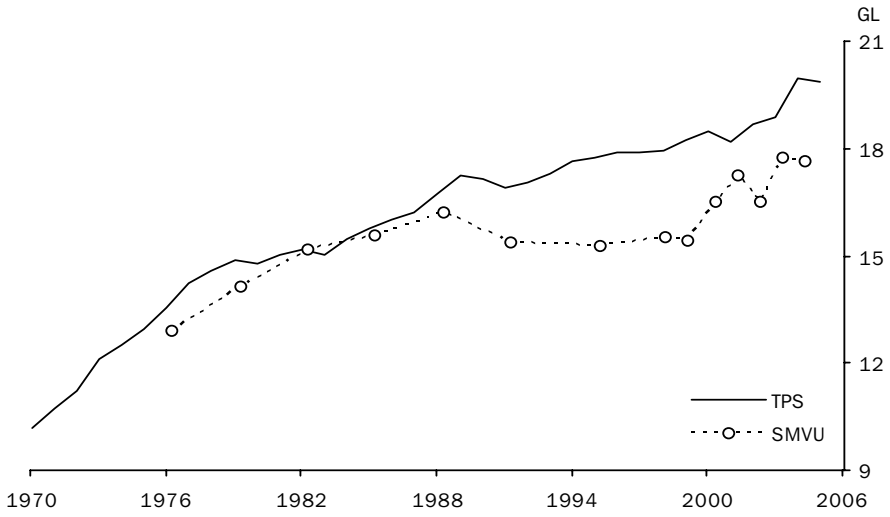
3. DISPARITY BETWEEN THE SURVEY OF MOTOR VEHICLE USE AND TOTAL PETROL SALES ESTIMATES

This section establishes the magnitude of the disparity between the DITR petrol sales data and SMVU petrol consumption estimates.

3.1 Comparison of petrol consumption and petrol sales estimates

A disparity between the two series emerged in 1991 and has been evident since. Since 1998, the magnitude of the disparity has fluctuated between 900 and 2 800 megalitres (ML) which accounts for 5–15% of TPS. Figure 3.1 shows that the SMVU petrol consumption time series tracks the TPS series closely until the late 1980s. The series begin to diverge from 1991 onwards, with the total petrol consumption estimates considerably lower than total petrol sales data from this time onwards.

3.1 Annual total petrol sales and SMVU petrol consumption, 1970–2005



Sources: Australian Petroleum Statistics, SMVU (ABS cat. no. 9208.0)

SMVU data users have questioned the coherence of SMVU petrol use estimates, given that they have been notably lower than total petrol sales data since the late 1980s. There was an expectation amongst users that the two series should track closely since they broadly reflect the total supply (TPS) and the majority of demand (SMVU) for petrol. The ongoing gap between the series after 1991 suggests that a persistent non-sampling factor may be impacting on SMVU estimates. This gap also coincided with reduced SMVU sample sizes from 1991, a change in the treatment of nil-use and deregistered vehicles, and from 1998 onwards, a change in the SMVU methodology from recall-based to a pre-advice methodology. The gap between the two series, introduction of new methodology and concurrent reduced sample sizes, affected

confidence in the SMVU estimates. This was despite the fact that the new pre-advice methodology improved the basis for addressing recall bias.

The disparity between the two series, cannot be explained by sampling error of the SMVU.

Table 3.2 contains TPS volumes and SMVU petrol use estimates for 1998–2003. The table shows the magnitude of the difference between the two series. The SMVU estimate varies between 84.5 and 94.1 per cent of TPS. The size of the disparity between the two series varies between 928 ML in 2001 and 2 832 ML in 1999. The average disparity over the seven year period is 1 963 ML. [8]

3.2 Disparity between total petrol sales and SMVU consumption estimates, 1998–2004

	1998	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*
Total petrol fuel sales (ML)	17 950	18 230	18 477	18 168	18 669	18 873	19 962
SMVU consumption estimates (ML)	15 539	15 398	16 526	17 240	16 507	17 758	17 618
Disparity (ML)	2 411	2 832	1 951	928	2 162	1 115	2 344
Ratio of SMVU to TPS (%)	86.6%	84.5%	89.4%	94.9%	88.4%	94.1%	88.3%

Sources: Australian Petroleum Statistics, SMVU (ABS cat. no. 9208.0)

3.2 SMVU methodology and coherence of estimates

The move to the 'pre-advice' collection method (of the post-1995 SMVUs), from a 'recall-based' approach (of the 1963 to 1995 surveys) was considered to be more methodologically sound. However, improvement of SMVU estimates in terms of coherency, is questionable, given the continuous disparity between SMVU and TPS. In isolation, the odometer recording methodology of the post-1998 surveys should yield significant data quality improvements over the earlier surveys. However, as discrepancies are still apparent, other factors appear to be affecting the estimates.

It is not possible to quantify the impact of the different collection methods, because unit record data are no longer available for SMVUs conducted prior to 1998. It is therefore not possible to identify potential systematic elements relating to the data, using quantitative analysis.

8 Note that the two largest disparities are associated with the first two surveys conducted on the basis of the new pre-advice methodology. The average disparity associated with the 2000–2004 surveys is 1 700 ML.

4. SCOPE FACTORS CONTRIBUTING TO THE DISPARITY

This section identifies vehicles and machinery which contribute to annual petrol consumption, but which are outside the scope of the SMVU, and therefore not captured in the SMVU petrol consumption estimates. For explanatory ease, we shall refer to these off-road engines and out-of-scope vehicles as 'factors'. An assessment of the likely annual petrol consumption by out-of-scope factors was undertaken, with the purpose of identifying how much of the disparity between SMVU and TPS is likely to be attributable to the differences in scope between the two series. This is the first time that a systematic analysis of the impact of usage beyond the SMVU scope, has been undertaken.

In order to determine the likely petrol consumption not accounted for by the SMVU, we sought to identify population numbers of each out-of-scope factor, then estimate annual usage for each factor. Where data on usage was not available, assumptions on usage characteristics have been made. The investigation made every attempt to check these assumptions against available evidence. All assumptions are clearly identified in the paper, along with the evidence supporting them, so that they can be tested at a later date if new data becomes available. Readers are encouraged to take note of the assumptions in each of the sub investigations that are presented in this section.

Sections 4.1–4.5 explain the method used to quantify (or estimate) the likely extent of petrol use by each out-of-scope factor. Where possible, the discussion of each factor is presented in the following order: purpose, method, assumptions, results, conclusion. Section 4.6 draws together the results of each investigation.

The following petrol-using vehicles are outside the scope of the SMVU:

- Unregistered vehicles (discussed in Section 4.1), and
- Defence, diplomatic and consular vehicles (discussed in Section 4.2).

The following petrol-using engine types are outside the scope of the SMVU:

- Marine vessels (discussed in Section 4.3),
- Lawnmowers and other petrol-using engines (discussed in Section 4.4), and
- Off-road motorcycles (discussed in Section 4.5).

The analysis found that the likely impact upon petrol consumption by out-of-scope factors is approximately an additional 3.1–5.4% of SMVU petrol consumption estimates.[9] This would account for approximately 40% of the disparity between SMVU

9 The calculation of petrol consumption by unregistered, Defence, diplomatic and consular vehicles is based on SMVU petrol consumption estimates and it makes sense to define these categories as a percentage of SMVU estimates. For consistency, we have also defined the estimated volume of petrol use by marine vessels and lawnmowers as a percentage of SMVU estimates.

petrol consumption estimates and petrol sales data. The largest component of the disparity is likely to be due to the use of registered vessels on State/Territory waterways and coastal regions, which is estimated to account for 2–2.8% of SMVU petrol consumption estimates. Unregistered vehicles are likely to account for 0.5–1.5% of SMVU petrol consumption estimates. Remaining out-of-scope factors account for less than one per cent of SMVU petrol consumption estimates.

4.1 Unregistered vehicle use

4.1.1 Purpose

The purpose of this subinvestigation was to identify the nature and likely extent of unregistered vehicle use (UVU) on Australian public roads, so as to identify the likely contribution to the disparity between the two petrol series.

4.1.2 Method

The ABS contacted State and Territory police authorities, transport agencies and motor vehicle registries seeking data and evidence on the extent of UVU. The investigation focussed on the time period 1998–2003. Data were received from a range of agencies in different jurisdictions (Appendix C provides a list of agencies who provided data.). The following processes were undertaken:

- The total number of speeding infringements were pooled from the individual State/Territories which provided speed camera data. The proportion of the number of these vehicles which were unregistered at time of detection were classified as the share of unregistered vehicles in use. A similar process was undertaken for red light cameras.
- State/Territory data on the detection of unregistered vehicles from traffic flow, where no traffic offence was involved in vehicle identification, was identified.
- State/Territory data on unregistered vehicle traffic infringements which were manually issued by law enforcement officers was identified. A proportion of UVU to total traffic infringements issued for comparison with the other detection methods was formed.
- The representativeness of the respective data sources was then analysed.
- Data which were based on manual issuing of traffic infringements were excluded on the basis of potential detection bias, and a likely range of UVU at the national level was estimated from the remaining sources.
- A thorough examination of specific assumptions was undertaken, particularly those required to identify a likely range of UVU at the national level, based on pooled State/Territory data.

- We then determined the likely range of UVU at the Australia level and identified the likely contribution to the disparity between SMVU and TPS series.

The comparison of State/Territory data on detected UVU, is potentially sensitive. For this reason, no data has been presented that may allow the reader to make State/Territory comparisons.

Detection methods used by the State/Territory authorities

The detection methods used by the respective State/Territory jurisdictions to identify UVU, can be categorised into three broad groups:

1. traffic flow detection;
2. speed/red light camera detection; and
3. manual detection.

A number of factors limit the extent of comparability of the data, however we can make some general statements about the likely range of UVU at the Australia level, by grouping jurisdictional data based on the same detection method. [10]

Traffic flow identification occurs via interrogation of a registration database, with the number plate details of vehicles in the traffic flow. Unregistered number plates are detected as a percentage of the total traffic flow. With this technology, a traffic offence (speeding or travelling through a red light) is not required to trigger the recording of the vehicle, thus bias associated with traffic offences can be avoided. For this reason, we consider traffic flow data to be the best source of identifying UVU.

Speed camera and red light detection occurs where unregistered vehicles are identified as a percentage of the traffic flow that have committed traffic infringements. This detection method is another reasonable indicator of UVU, due to the very large number of observations.

Manual detection occurs where a police officer or road transport agency inspecting officer detects unregistered vehicles while performing their policing/inspecting duties. Selection of vehicles in these cases is purposeful or targeted, which may result in greater bias than the other detection methods. We observe that unregistered vehicles account for approximately 5–10% of total traffic infringements but only account for 1–2% of measured total traffic flow. The suggested higher levels of UVU, based on anecdotal evidence, appears to be attributable to UVU infringements as a percentage of total traffic infringements. It is likely that some earlier stationary vehicle counts in public car parks before 1999–2000 also contributed to this misconception.

10 This investigation is assuming that error detection factors are constant across the comparative detection methods that are discussed in this paper.

4.1.3 Assumptions about representativeness of the observed data

Since the data on UVU is not comprehensive, it is necessary to make a number of assumptions about its underlying nature, in order to make conclusions about the extent of UVU at the National level. Part of this process involves assessing the bias that may be associated with the data.

The majority of evidence collected on UVU, requires a traffic offence to have occurred in the first instance. This raises the question of the representative nature of the observed information. The paramount issue is whether the proportion of unregistered to registered vehicles detected by speed/red light cameras is the same as the proportion of unregistered vehicles in the population that haven't commit a traffic offence.

Potential biases associated with differences in risk aversion

The proportion of the population that are detected committing traffic offences, may display different risk preference characteristics to the proportion of the population that does not commit traffic offences. If risk preferences, in relation to driving unregistered vehicles and/or committing traffic offences, differ between the respective subpopulations, then the observed data on UVU may not be representative. For this investigation, in the absence of information on the relative likelihood of unregistered vehicle drivers to speed or run red lights, we assumed that the risk preferences of the respective subpopulations are similar enough, not to affect the chance of detection by speed and red light cameras.

Multiple observations

Multiple observations of the same unregistered vehicle may occur at the one recording site, or at different recording sites. Both registered and unregistered vehicles will be subject to the possibility of multiple recordings. Any bias due to multiple recordings will only occur if they are more prevalent, as a proportion, in either of the observed subpopulations detected by traffic cameras.

Multiple recording data were not provided by the State/Territory jurisdictions and we are not aware if separate records for this category are available. We have assumed that any multiple observations have a neutral effect on the observed rate of UVU.

Geographic bias

The majority of data used in this investigation were collected within State/Territory capital cities. There may be differences in the respective population characteristics of UVU, between metropolitan and rural and remote areas. The probability of detection in rural and remote areas is arguably lower than within capital cities, due to a higher prevalence of speed and red light cameras within capital cities. However, the majority

of VKT undertaken by passenger vehicles, occurs within metropolitan regions (approximately 60–65%). Moreover data from one particular State, which has incorporated a geographic dimension to UVU detection, suggests that any difference between general metropolitan and general rural, is relatively minor.

Non-issuing of traffic offences detected by cameras

The observed proportion of unregistered to registered vehicle use, detected by cameras, may be influenced by obscured number plates. There is evidence of a substantial number of camera offence records which are discarded due to faulty number plate recordings. [11] For example, 2.4 per cent of vehicle number plates in one particular study, were either not recognisable, or deemed to have been 'handed in' to the traffic authority. If there is a different proportion of unregistered vehicles within this 'non-recognised' category, compared to the population, then there is potential for bias in the observed data.

Assumptions on usage characteristics of UVU

Accounting for UVU in the population, requires assuming unregistered vehicles have the same usage characteristics as registered vehicles and then extrapolating. A driver knowingly using an unregistered vehicle has a logical incentive to behave in a manner that minimises detection. Given that the probability of detection, among other factors, will increase as distance travelled increases, drivers of unregistered vehicles may attempt to minimise detection by driving less.

This investigation has assumed that unregistered vehicle usage characteristics can be represented by the usage characteristics of the registered vehicle population. We acknowledge the rational arguments which would imply that distance travelled by unregistered vehicles, for the same make/model, would be less than for a registered vehicle due to drivers desire to minimise detection, however, this cannot be quantified.

Differing impact of short-term and long-term unregistered vehicle use

The duration of time spent unregistered at point of detection, is a key aspect of the underlying assumptions and final conclusions relating to the contribution of UVU to the disparity between SMVU and TPS. There are three categories of unregistered vehicle, that have significance to the scope discussion of the SMVU:

- Category 1: Short-term unregistered vehicles (< 1 month);
- Category 2: Medium-term unregistered vehicles (1–12 months); and
- Category 3: Long-term unregistered vehicles (> 12 months).

11 Data on the number of reading errors were not requested for this investigation.

The first category relates to vehicles that have been unregistered for up to one month. The Motor Vehicle Registry (MVR) record of a vehicle with elapsed registration, is maintained by the respective State/Territory information systems for a period of one month. Therefore, unregistered vehicles in the first category are in scope of the SMVU since their records are active at the point of survey frame creation. Even if these vehicles do not get selected, they are represented by those vehicles which are selected from the survey frame.

The second category relates to vehicles that have been unregistered for one to twelve months. Evidence suggests that these 'medium-term' unregistered vehicles account for approximately 50 per cent of detected unregistered vehicles travelling on public roads (see table 4.4). Having been unregistered for more than a month, these vehicles are not included on the SMVU survey frame and are therefore not represented in SMVU estimates. These unregistered vehicles do impact on the disparity between SMVU and TPS.

Category 3 relates to long-term unregistered vehicles. This group does not have a chance of selection in the SMVU and is therefore not represented in the survey estimates. Evidence on the relative proportion of long-term UVU varies across jurisdictions. Data indicates that 5–30% of UVU is of a long-term duration. Long-term unregistered vehicles will impact upon the disparity between SMVU and TPS.

4.1.4 Results

Three states provided traffic flow data which did not rely on a traffic offence for vehicle identification. The results from these data do not indicate that there is any identifiable bias attributable to identification of unregistered vehicles via traffic cameras.

The percentage of traffic flow recorded as UVU, which is detected by red light cameras (1.7 per cent) is higher than the percentage of UVU detected by speed cameras (1.4 per cent). This difference while minor, is consistent across jurisdictions and over time (see tables 4.1 and 4.2 below). This phenomenon is also consistent for the unpooled data for each year and each reporting jurisdiction. We do not know if this difference is due to minor bias between the respective detection techniques or whether we have observed a consistent behavioural characteristic of the population. [12]

Given the preceding discussion, the authors have a reasonable degree of confidence that the true extent of UVU, at the Australia level, is in the order of 1.0–2.0% of total vehicle use.

12 Drivers of registered vehicles may have different risk preferences for speeding as opposed to travelling through a red light. Drivers of unregistered vehicles may have different preferences for the respective infringements and these may also differ to the preferences of registered vehicle drivers, thus causing the difference in the detected proportion of unregistered vehicles.

Data from a number of the populous State/Territories reveals that a significant portion of vehicles are unregistered for a duration of less than one month. Table 4.4 below shows that 30–45% of unregistered vehicles detected by red light cameras, are typically unregistered for less than one month. Other data have revealed the proportion of short term unregistered vehicles to vary between 25–56%. As these vehicles are accounted for in SMVU estimates, the impact upon the disparity between the SMVU and TPS series, attributable to unregistered vehicles, is lower than the total identified percentage of UVU. Most of the duration data obtained was grouped data, and therefore we were not able to calculate the exact ratio of short-term UVU.

Speed camera results

Table 4.1 shows the percentage of unregistered vehicles that are detected by speed cameras. The data from separate jurisdictions were pooled to increase observation sizes and to provide confidentiality for individual jurisdictions. The pooled results for each year reveal percentages of 0.92–1.66%.

4.1 Unregistered vehicles detected via speed cameras, 1998–2004

Year	*Speed camera infringements*	*Unregistered vehicles*	*Percentage unregistered*
1998	4 451	50	1.12
1999	196 388	2 220	1.13
2000	762 884	6 981	0.92
2001	805 680	11 109	1.38
2002	1 025 909	13 755	1.34
2003	1 231 581	20 445	1.66
2004	923 633	14 541	1.57
1998–2004	4 950 526	69 101	1.40

Source: State/Territory Transport authorities and Police departments.

Red light camera results

Table 4.2 shows the percentage of unregistered vehicles that are detected by red light cameras. The difference between red light detection and speed camera detection, while slight, is consistent across jurisdictions and time period examined. [13]

13 It is also possible that the respective subpopulations have the same UVU characteristics but an unknown form of non-sampling error is accounting for the apparent difference.

4.2 Unregistered vehicles detected via red light cameras, 1999–2004

Year	*Red light infringements*	*Unregistered vehicles*	*Percentage unregistered*
1999	16 022	219	1.37
2000	64 686	867	1.34
2001	65 100	1 141	1.75
2002	70 203	1 164	1.66
2003	64 187	1 134	1.77
2004	61 517	1 137	1.85
1999–2004	341 715	5 662	1.66

Source: State/Territory Transport authorities and Police departments.

Traffic flow results

Table 4.3 shows the results of unregistered vehicle detection via traffic flow surveys, which do not require a traffic offence to have occurred. The percentage of unregistered vehicles detected is defined as the ratio of unregistered to total vehicles travelling past the survey site. The proportion of UVU shows slightly more variance, but is of a similar magnitude to the results for speed and red light cameras.

4.3 Unregistered vehicles detected via traffic flow survey

Year	*Survey type*	*Time period*	*Vehicles observed*	*Percentage unregistered*
2003	Number plate recognition	May–June	63 252	1.20
2004	Safe-T-Cam	24 hours (11 May)	17 365	1.91

Source: State/Territory Transport authorities and Police departments.

Unregistered duration at time of detection

4.4 Unregistered duration at time of detection

	Red light camera detection			Speed camera detection		
Year	<1 month	1–12 months	>12 months	<1 month	1–12 months	>12 months
1999	31.1%	53.9%	15.1%	38.1%	41.9%	19.9%
2000	44.8%	46.1%	9.1%	50.3%	42.0%	7.7%
2001	36.2%	51.1%	12.7%	49.3%	42.4%	8.3%
2002	44.6%	42.2%	13.2%	52.0%	39.1%	8.9%
2003	43.8%	44.5%	11.7%	49.7%	40.3%	10.0%
2004	44.6%	46.1%	9.3%	51.7%	39.8%	8.4%

Source: State/Territory Transport authorities and Police departments.

Likely impact of unregistered vehicle use on SMVU estimates

The impact upon the SMVU/TPS disparity, attributable to UVU, will depend upon the distances travelled by unregistered vehicles (which is partly a function of the age structure of these vehicles), and the extent of short-term UVU. It is possible that actual unregistered use in percentage terms (kilometres travelled by unregistered vehicles), is less than identified traffic flow counts, due to the risk aversion of drivers and lower average utilisation of these vehicles. Data on the duration of time since last registered, indicates that 25–50% of unregistered vehicles detected travelling on public roads, are unregistered for less than one month. These vehicles will remain on the State/Territory MVRs and will be represented within SMVU estimates.[14] The discussion in Section 5 (see figures 5.3 and 5.4) demonstrates that VKT is a function of vehicle age, therefore the age distribution of unregistered vehicles will be a consideration in estimating the distance travelled by them.

4.1.5 Conclusions

This UVU investigation concludes that the extent of unregistered vehicle numbers on Australian public roads is likely to be in the order of 1.0–2.0% of daily traffic flow. This is based on large observations of traffic flow data from a number of jurisdictions and over a number of years (1999–2004). This estimate is consistent with the findings of the New South Wales Auditor General's 2003 report, which concluded that unregistered vehicle use in the State is 2.07 per cent. Allowing for the possibility of an UVU age distribution that is similar to the registered vehicle population, 50–75% of the detected unregistered vehicles are likely to contribute to the disparity between SMVU

14 Even if these vehicles are not sampled, being on the MVR database will ensure these vehicles are represented by vehicles captured within the SMVU sample.

and TPS. Due to the prevalence of very short-term UVU, the extent of UVU that is likely to impact on SMVU petrol consumption is in the order of 0.5–1.5%. This accounts for approximately 5–14% of the averaged disparity between TPS and SMVU during the 1998–2004 time period.

4.2 Defence, diplomatic and consular vehicles

Petrol consumption by Defence, diplomatic and consular vehicles can be determined with high precision, since much of the required information is publicly available. These vehicles consume a relatively minor volume of petrol each year.

4.2.1 Purpose

The purpose of this subinvestigation is to determine the annual petrol consumption of defence, diplomatic and consular vehicles. Administrative data exist on the number of diplomatic and consular vehicles and on petrol volume consumed by defence vehicles.

4.2.2 Method and assumptions

Defence petrol use

Defence vehicles are excluded from the SMVU survey scope.[15] These vehicles have specific Department of Defence registrations and are therefore not on the survey frames created from the State/Territory Motor Vehicle Registries (MVRs).

Eighty per cent of Department of Defence petrol use is for defence operations purposes, however, petrol accounts for less than ten per cent of total defence fuel use (see table 4.5 below). Variations in total Department of Defence use of fuel is subject to variation due to the type and extent of defence operations that the Australian defence forces engage in.

15 It would be feasible to create supplementary survey frames for Defence and diplomatic/consular vehicles. The Victorian RTA does have separate register information for diplomatic and consular vehicles. The Department of Defence also maintains information that could be used to derive a supplementary survey frame. This process would be costly and the marginal benefit, in terms of data quality, would not necessarily justify the required expense and administrative effort. Another option would be to obtain counts by vehicle type and incorporate these values within the existing SMVU sampling fractions. Again the benefits would be unlikely to outweigh the costs.

4.5 Use of automotive fuels by Department of Defence, '000 litres

	1998	*1999*	*2000*	*2001*	*2002*	*2003*
Petrol						
Passenger vehicles	1 611	1 690	7 530	6 290	962	1 012
Other transport	8 841	6 983	na	na	5 395	5 564
Defence operations	na	242	na	na	na	na
Total	10 452	8 915	7 530	6 290	6 357	6 576
Diesel						
Passenger vehicles	321	188	49	54	52	38
Other transport	12 804	5 601	43	1	3	2
Defence operations	169 912	129 706	250 663	215 034	182 600	134 581
Total	183 037	135 495	250 755	215 089	182 654	134 621
Ratio of petrol/diesel use (%)	5.7%	6.6%	3.0%	2.9%	3.5%	4.9%

Source: Department of Industry, Tourism & Resources 2001 and 2003.

Diplomatic and consular vehicles

Approximately 1220 consular/diplomatic plates are registered in the Australian Capital Territory and a further 600–800 are registered in State capital cities (see table 4.6 below). Approximately half of the Australian Capital Territory registrations are 'new registrations', therefore it is reasonable to assume that these vehicles will have similar VKT characteristics to SMVU vehicles that are less than one year old. On the basis of these estimates and assumptions, diplomatic and consular vehicles are estimated to consume approximately 4.15 megalitres of petrol per annum.

4.6 Estimated annual petrol use – Diplomatic and consular vehicles

Age of vehicle	*Estimated number of vehicles*	*Assumed average vehicle kilometres travelled*	*Assumed average petrol consumption (litres/100km)*	*Estimated petrol use (ML)*
0–12 months	1 000	25 000	0.10	2.50
More than 12 months	1 000	15 000	0.11	1.65
Total	2 000			4.15

Source: Investigation estimates.

4.2.3 Conclusion

Based on estimates of petrol consumption by Department of Defence, and estimated consumption by diplomatic and consular vehicles, we estimate total petrol consumption by these vehicles would be of the order of 10–12 megalitres in 2003. This accounts for under one per cent of the average disparity between SMVU and TPS.

4.3 Registered marine and waterway vessels

4.3.1 Purpose

The purpose of this subinvestigation was to identify a likely range of petrol consumption (purchased domestically) that is used by petrol powered vessels in Australia's marine areas and inland waterways over a 12 month period.

4.3.2 Method

Administrative data on the number and estimated usage of registered petrol using vessels were sourced from the State/Territory water/marine regulatory authorities. All jurisdictions were able to provide actual numbers of private and commercially registered vessels but not estimates of annual usage. [16]

We were not able to receive data on a common basis from all of the jurisdictions. We requested data on the following critical variables:

- Number and type of vessels (registered and unregistered);
- Engine size (engine petrol consumption rates);
- Distance travelled or a measure of duration of engine use; and
- Typical usage pattern.

Other than numbers of registered vessels by fuel-use type, much of the other requested data items were not available.

Given the absence of marine vessel usage data, we estimated annual national usage of petrol powered vessels, using assumptions about usage, engine size and petrol consumption rates and combining the following components of information:

- The majority of registered marine vessels in Australia are privately registered and powered by petrol-fuelled outboard engines. Victoria had 157 131 marine vessels registered in 2004. The majority of these (95 per cent) were petrol powered and privately registered. Commercially registered Victorian vessels only accounted for 2.4 per cent of all registered vessels in 2004. This private/commercial ratio is consistent across most of the States. Private vessels are not required to be registered in the Northern Territory. However, we were informed by the Northern Territory Department of the Environment & Heritage that there are approximately 20,000 privately owned vessels in the Northern Territory. Queensland and New South Wales data shows that 74.6 per cent of commercially registered vessels use petrol engines (outboard and inboard motors);

16 There was no legislative requirement to register private usage vessels in the Northern Territory at the time of this investigation.

- We received detailed delineation of vessel type from Victoria and South Australia, and these proportions were applied to the gross vessel numbers provided by other jurisdictions;
- The average annual duration of unregistered vessel use is unknown. We have assumed an annual usage figure for registered vessels to be approximately 70 hours. [17]

The petrol use calculation for marine vessels is simply the following:

Petrol consumption rate (by vessel type) ×
Number of vessels in the category ×
Average annual use.

We were not able to obtain engine capacity with the registered vessel data, however, we used typical consumption rates as described in table 4.7.

4.7 Typical petrol consumption rates for outboard motors

Engine size	*Full throttle*	*Half throttle*	*Idle*
15 hp	10	3	1
50 hp	18	6	1
150 hp	48	9	3
300 hp	100	20	5

Source: Investigation estimates.

4.3.3 Key assumptions used in this exercise

To estimate an Australian value of petrol use for all registered petrol powered vessels in Australia, the following seven assumptions were made:

- The privately registered vessels in each of the Australian states have the same vessel type proportional breakdown as derived from the Victorian data;
- The type of commercially registered vessel in each state have the same proportional breakdown as depicted in table 4.8;
- Average vessel use in one particular State/Territory is a meaningful concept and one which can be extrapolated to all vessel types in all jurisdictions;

17 Note that vessel usage does not necessarily equate to engine usage, particularly for vessels that are used for fishing purposes.

4.8 Breakdown of registered vessels by type of craft, Victoria

Type of craft, by registration type	*Number of craft*	*Proportion*	*Petrol consumption (litres/hour)*
Private registration			
Open boat	111 982		
Tinny	na	0.374	3.0
Runabout	na	0.374	10.0
Half cabin	23 626	0.158	15.0
Cabin cruiser	4 324	0.029	20.0
Hovercraft	349	0.002	10.0
Trail sail	2 381	0.016	10.0
Yacht	733	0.005	5.0
PWC	6 148	0.041	10.0
Canoe	20	0.000	1.0
All privately registered craft	149 563	1.000	4.3
Commercial registration			
Tinny	na	0.375	5.0
Runabout	na	0.375	10.0
Half cabin	na	0.200	15.0
Cabin cruiser	na	0.050	20.0
All commercial craft	na	1.000	9.6

Source: State/Territory marine transport authorities and investigation estimates.

Note: The 'Tinny' and 'Runabout' categories are assumed subcategories of the 'Open boat' vessel type.

- The average annual use of commercially registered vessels is assumed to be the same as for private vessels. This assumption was due to the absence of any guiding information upon which to place parameters around an estimate of average annual use for commercial vessels. Sensitivity analysis was undertaken to test the impact of assuming annual use of 500 hours per annum for commercially registered vessels;
- Due to the absence of guiding data, the average annual usage value is assumed to be uniform across the states, although arguably in jurisdictions with a higher proportion of the population living along the coast and in milder climates such as Queensland, the annual use may be higher;
- Changes in demographics, per capita income and the relative price of vessels, have not impacted on demand since the average annual vessel use value was determined; and
- The largest proportion of vessels are in the 'Open boat' category. Considerable variation in engine capacities and consumption rates would occur within the subcategories of this particular vessel type. This investigation is assuming 50 per cent of the Open boat category are 'Tinnies' (average petrol consumption of 3.0 L/hour) and 50 per cent are 'Runabouts' (average petrol consumption of 10.0 L/hour).

We were not able to obtain data on registrations by engine capacity. This was imputed on the basis of cabin or vessel type. Victoria and South Australia were the only states that were able to provide data by cabin type (see table 4.8 for proportional breakdowns used to estimate vessel types for the jurisdictions which only provided gross vessel numbers) for private and commercially registered vessels. The detail on vessel type was used to produce proportion factors, which were applied to the gross registered vessel numbers, reported by the other jurisdictions.

4.3.4 Results

There were 724 664 petrol engine vessels registered with State/Territory authorities in 2004. This number includes a figure of 20 000 private use vessels in the Northern Territory, where registration for private use is not required. Given the assumption of 70 hours per annum, vessel type breakdown and consumption rates, these vessels are estimated to have used 432.7 megalitres of petrol. We used the following sensitivity analysis to identify a likely range of annual petrol consumption.

Sensitivity analysis on the following key assumptions reveals the following impact on petrol use:

- Assuming average annual usage of 60 hours results in 371 megalitres of petrol use (decrease of 14.3 per cent from the concluded value of 432.7);
- Assuming average annual usage of 80 hours results in 494.5 megalitres of petrol use (increase of 14.3 per cent from the concluded value of 432.7 megalitres);
- Increasing the average consumption rates by 20 per cent results in a value of 519.2 megalitres (increase of 20.0 per cent from the concluded value of 432.7);
- Decreasing the average consumption rates by 20 per cent results in a value of 346.1 megalitres (decrease of 20 per cent from the concluded value of 432.7);
- Adjusting the assumed average annual usage for commercial vessels to 500 hours/per annum (10 hours/week), while holding the privately registered vessels to 70 hours/per annum, results in a value of 545.9 megalitres (increase of 26.2 per cent from the concluded value of 432.7 megalitres).

4.3.5 Conclusion

Petrol use by registered marine and waterway vessels appears to account for the largest share of the disparity between SMVU and TPS. The assumptions formed on average annual vessel use, average petrol consumption rates and the annual utilisation of commercial vessels are critical in forming the final conclusion as to the likely range of petrol use by out-of-scope factors. This investigation concludes that the likely annual range of petrol used by private and commercial vessels in Australia is between 350–500 megalitres, which accounts for approximately 20–25% of the average disparity between the SMVU and TPS series.

4.4 Lawnmowers and other petrol-using engines

4.4.1 Purpose

An increasing number, and range, of petrol engines are now being sold, leased and hired by Australian retailers and hiring businesses. The largest of these subgroups are lawnmowers and off-road motorcycles, however, a significant number of petrol powered generators and pumps are also now entering the market. The purpose of this subinvestigation is to estimate the likely range of annual petrol consumption of these engines.

4.4.2 Method

The following petrol powered machinery are likely to contribute toward the bulk of petrol use by this subcategory of petrol-using engines:

- lawnmowers;
- whipper snippers and brush cutters;
- petrol-fuelled leaf blowers; and
- petrol-fuelled generators, pumps and compressors.

Rather than attempt to estimate the petrol usage of each component, we estimated a range of likely usage per household and multiplied this by the number of Australian households.

Given the lack of data availability, we sought to produce a crude estimate of lawnmowers and petrol generators and other petrol-fuelled engines, by multiplying a conservative estimate of petrol use per household (10–20 litres) by the estimated number of Australian households in 2003.

The number of households (7 614 948 – see table 4.9) was multiplied by the assumed average annual petrol use (litres) per household, to determine the likely use at the National level (114 megalitres).

4.9 Number of households

	1997	*1998*	*1999*	*2000*	*2001*	*Projected 2003*
Households	6 901 143	7 015 213	7 126 529	7 249 911	7 366 692	7 614 948
Annual growth rate		1.65%	1.59%	1.73%	1.61%	
Two-year growth rate			3.27%	3.35%	3.37%	3.37%

Source: *Australian Demographic Statistics*, ABS cat. no. 3101.0.

Note: The projected number of households for 2003 is calculated by applying the two-year growth rate to the 2001 estimate. The official estimate for 2003 is currently under review, and is expected to be available in October 2006.

4.4.3 Assumptions

The key assumption in this subinvestigation is that average annual petrol use of lawnmowers and other household machinery is 15 litres per household. This is a relatively crude assumption given differences in household type. A significant portion of households will not use lawnmowers or petrol powered equipment, however, local council use may well offset the lack of petrol use by these households.

4.4.4 Results

This subcategory investigation has shown that a moderate estimate of likely petrol use by households is 114 megalitres (see table 4.10 below). The conservative assumption of 10 litres per household, yields 76 megalitres per annum of petrol use and the high use assumption yields 152 megalitres per annum.

4.10 Estimated annual petrol consumption – Households

Assumption	*Household usage (litres per annum)*	*Petrol used (ML)*
Conservative	10	76
Moderate	15	114
High use	20	152

Source: Investigation estimates.

4.4.5 Conclusion

We conclude that likely petrol use by lawnmowers and related household equipment is between 75 and 150 megalitres. This petrol volume accounts for approximately 4–8% of the average disparity between SMVU and TPS.

4.5 Off-road motorcycles

4.5.1 Purpose

The purpose of this subinvestigation is to determine how much of the disparity between SMVU and TPS is attributable to off-road motorcycle use.

4.5.2 Method

This subcategory investigation has assumed that the number and VKT of off-road motorcycles is approximately 40 per cent of the number of registered motorcycles reported in the SMVU.[18] The following formula was used to produce an estimate for petrol used by off-road motorcycles:

0.4 (2003 SMVU Average Vehicle kilometres travelled – motorcycles) ×
0.4 (an estimate of the registered motorcycle population) ×
Petrol consumption rate (8.0 L/100km).

4.5.3 Assumptions

The Federal Chamber of Automotive Industries (FCAI) reported in 2003 that 40 per cent of new motorcycle sales in Australia are off-road motorcycles (including competition dirt bikes, enduroes and farm motorcycles and all terrain vehicles). In 2004, the percentage of off-road new motorcycle sales increased to 47.7%. Sales of these types of vehicles have doubled in the ten years to 2003. The off-road motorcycle market has grown by 86.7 per cent since 1995.

Therefore the off-road population has been increasing quite dramatically recently, however, we do not know the size of the base this growth has come from. We also do not know the scrappage rates of these vehicles, or whether the scrappage rates are similar to road-registered motorcycles. Another complicating factor is that the FCAI data for off-road motorcycles will include a number of road-trail bikes which are often registered for on-road use.

Data availability

The absence of data in terms of quantity of petrol used by off-road motorcycles is analogous to that of marine vessels. The petrol consumption rates of on-road motorcycles are in the order of 4–9 litres/100km. Revolutions per minute (RPM) is a major determinant of petrol consumption rates. Frequent acceleration and breaking, associated with off-road trail bike use, consumes up to 50 per cent extra petrol consumption per VKT, compared to driving at a cruising speed of 45km/hour. Given that petrol use increases with engine revolutions per minute (RPM), and that off-road

18 A more accurate estimate of the off-road motorcycle population would require accurate sales information by motorcycle type, over a number of years, and accurate information on the scrappage rates by motorcycle type.

motorcycle use is typically higher RPM based, with more varied throttle use than on-road motorcycles, petrol consumption per VKT for off-road motorcycles will arguably be higher than for on-road motorcycles.

Petrol consumption rates for off-road motorcycles are comparable to road-going motorcycles, in test conditions for similar engine capacities. Engine capacity aside, petrol consumption rates of off-road motorcycles are dependant upon the following factors:

- throttle control;
- terrain and surface conditions (dry, wet, muddy etc.); and
- tyre pressure.

Assumptions relating to off-road motorcycle use

In order to determine an estimate for off-road motorcycle use, a number of assumptions will need to be made on the following attributes:

- the number of off-road motorcycles in use;
- the distance travelled by these motorcycles; and
- the likely petrol consumption of these motorcycles.

Assumption 1

Given new and existing stock of motorcycles, we will assume that 40 per cent of new and aged motorcycles in use, are unregistered off-road motorcycles.

Justification of Assumption 1

- New off-road motorcycle sales have been trending upwards over the last 10 years. Therefore the proportion of the total motorcycle stock that is actually off-road is likely to be less than the current value of 47.7 per cent identified in 2004; and
- the incidence of road-trail bikes that are legally registered will have the effect of over-inflating the estimate of unregistered motorcycles.

Assumption 2

The average distance travelled by off-road motorcycles is 40 per cent that of registered motorcycles.

Justification of Assumption 2

- In the absence of any data, given the limited legal opportunities for general travel use of unregistered motorcycles, we know that pure recreational use will be considerably less than the distance travelled by registered motorcycles.

Assumption 3

The petrol consumption rates for unregistered motorcycles are slightly higher than registered on-road motorcycles.

Justification of Assumption 3

- The higher RPM of trail bikes tends to increase petrol consumption; and
- constant accelerating and breaking tends to increase petrol consumption.

4.5.4 Results

This subcategory investigation has concluded that the extent of unregistered petrol use is in the order of 44 megalitres per year (see table 4.11). Given that the value of petrol use identified in this investigation is relatively low, a sensitivity analysis was not conducted.

4.11 Estimated annual petrol use – Motorcycles

	Number of vehicles		*Vehicle kilometres travelled (million km)*		*Petrol consumption (litres/100km)*		*Petrol used (ML)*	
	2003	*2004*	*2003*	*2004*	*2003*	*2004*	*2003*	*2004*
On-road	378 475	392 648	1 376	1 478	6.0	6.3	83	92
Off-road	Unknown		Unknown		8.0	8.0	18	19

Source: SMVU and investigation estimates.

4.5.5 Conclusion

We conclude that the petrol used by off-road motorcycles is in the 16–20 megalitre range. This accounts for approximately one per cent of the average disparity between SMVU and TPS.

4.6 Summary

This investigation has demonstrated that once we account for scope factors, the actual difference between SMVU petrol use and TPS, is considerably less than the perceived disparity. Based on petrol use assumptions, the combined scope differences is approximately equal to four per cent of the 2003 TPS volume. These combined scope differences account for up to 85 per cent of the 2003 disparity and up to 49 per cent of the average disparity over the six year period 1998-2003.

Petrol powered marine vessels are estimated to account for the largest component of the disparity attributable to differences in scope. There is possibility for variance in the final consumption estimate for this category to be between 1.6 and 3.2 per cent of SMVU petrol consumption estimates depending on changes to the key assumptions.

4.12 Summary of assumed scope difference between TPS and SMVU consumption estimates

Scope component	*Petrol use (ML)*	*% SMVU estimate*	*% average disparity*	*% 2003 disparity*
Unregistered vehicles	90 – 270	0.5 – 1.5%	4.6 – 13.8%	8.1 – 24.2%
Defence, diplomatic & consular	10 – 12	0.1 – 0.1%	0.5 – 0.6%	0.9 – 1.1%
Registered marine vessels	350 – 500	2.0 – 2.8%	17.8 – 25.5%	31.4 – 44.8%
Lawnmowers & machinery	75 – 150	0.4 – 0.9%	3.8 – 7.6%	6.7 – 13.5%
Off-road motorcycles	16 – 20	0.1 – 0.1%	0.8 – 1.0%	1.4 – 1.8%
Total	541 – 952	3.1 – 5.4%	27.6 – 48.5%	48.5 – 85.4%

The second largest scope component is unregistered vehicles. There is scope for minor variance in the final petrol use estimate due to short-term unregistered vehicle use, however the likely range of the impact on SMVU petrol consumption estimates is 0.5–1.5%.

5. COVERAGE FACTORS CONTRIBUTING TO THE DISPARITY

This section outlines the underlying methodological issues associated with newly registered and nil-use vehicles. Regression analysis on pooled, unweighted SMVU data formed the basis of the investigation into the New Vehicle Provision (NVP) factors. A combination of regression and odometer analysis formed the basis of the investigation into nil-use vehicles.

Section 5.1 explains the NVP factor and the underlying frame issue which it seeks to compensate for. The discussion then explains how insufficient sample information is available, with which to produce reliable NVP factors. The discussion provides evidence suggesting that the NVP factor may be contributing to the temporal variability in SMVU estimates, particularly at the State/Territory level.

Section 5.2 outlines the data issues associated with nil-use. Accurate reporting and incorporation of nil-use within the estimation process, is critical for robust SMVU estimates. The SMVU does not produce specific estimates on nil-use, however, reported nil-use activity is contained within a number of key estimates. Section 5.2.1 discusses the plausibility of the extent of nil-use contained within SMVU estimates, by focusing on the reporting characteristics of the sample.

Section 5.3 briefly outlines the investigation into the validity of reported petrol consumption. Since total petrol consumption is calculated by multiplying the reported average rate of petrol consumption by total distance travelled (VKT), reported petrol consumption is a critical component of the final petrol consumption estimate.

The analyses presented in this section were undertaken on SMVU passenger vehicle sample sizes of between 2000 and 2300 vehicles in each of the 1998–2003 surveys. (Table 5.6 contains the exact sample size for each year, delineated by odometer response category). The passenger vehicle analysis excluded taxis because their population characteristics are significantly different to general passenger vehicles. The regression analysis was for the purpose of identifying model parameters and sample characteristics, rather than for the purpose of estimating the population. [19]

The chapter concludes that the coverage of new vehicles in the SMVU sample is sub-optimal, unless the sample is supplemented with additional newly registered vehicles. [20] The conclusions on reported nil-use are less certain, however, the extent of reported nil-use reported by some categories of data providers, is not consistent with the age distribution of their vehicles.

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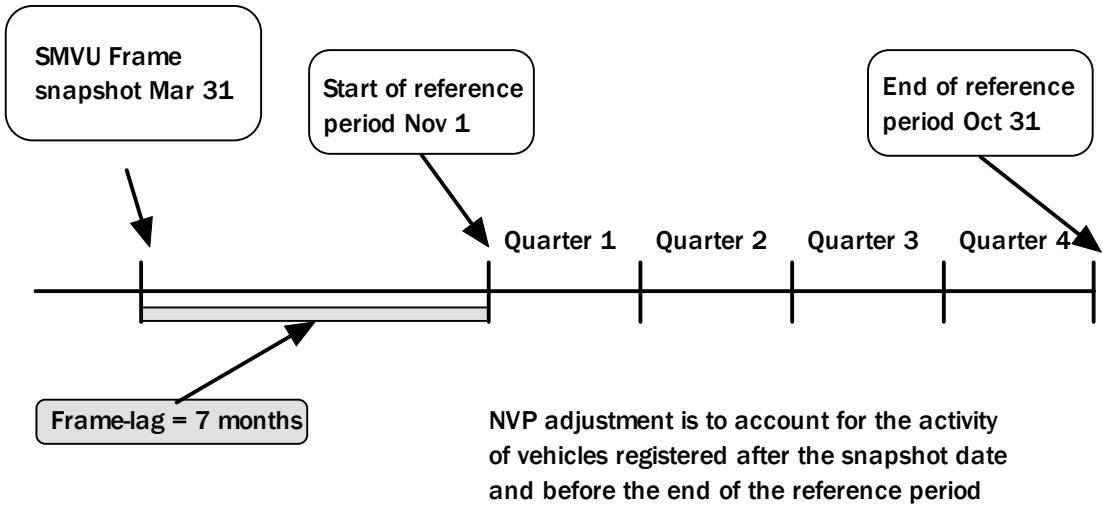
19 The ABS generally cautions users against inferring information about the population from unweighted sample responses, as the unweighted sample estimates may not be representative of the target population.

20 Stratifying the SMVU sample by vehicle age, and designing the sample with minimum vehicle numbers of the youngest vehicles, is likely to partly address this coverage issue.

5.1 New vehicle provision factor

The SMVU frame is typically created on the 31st March, seven months prior to the start of the reference period.[21] This creates a frame lag which has the potential to adversely affect sample coverage of the survey. Under-coverage occurs because vehicles registered after the frame date, but prior to the start of the reference period are excluded from the frame. Figure 5.1 illustrates the SMVU reference period and the associated frame lag.

5.1 Time lag between creation of the survey frame and beginning of the reference period



The time lag between the initial SMVU sample frame, from a particular Motor Vehicle Census, and the end of the SMVU four quarterly survey period is typically around 19 months. The 1998 and 1999 surveys had a longer frame lag. A SMVU sample therefore includes few records from the newer portion of the fleet (i.e. vehicles owned for 18 months or less). Appendix B explains the frame lag issue in further detail.

The number of new passenger vehicles sampled in the SMVU has varied between surveys, according to whether the sample was 'topped-up' with newly registered vehicles (selections of new vehicles, registered since the original frame snapshot date). Such 'top-ups' were added to the 2000, 2001 and 2002 SMVUs using the ABS *New Motor Vehicle Registration* (NMVR) data. The NMVR series was discontinued during the 2002 reference year and so top-ups were not added to the 2003 survey.

5.1.1 NVP factor at the national level

Under the current NVP method, not only do significant numbers of extra vehicles have to be allowed for when weighting the unit record data to represent the population,

21 The survey frame was created on 31 October for the 1998 and 1999 SMVUs.

but actual usage by new vehicles is typically approximated by using the average VKT of 'similar' vehicles found within the sample – vehicles typically around two years old and in some cases three years old. By contrast, in those survey years where the SMVU includes sample 'top-ups' the new vehicle provision was mostly accounted for by 'one year' old vehicles. Table 5.2 shows the number of passenger vehicles sampled, for vehicles up to three years of age, as well as the new vehicle provision weights applied to these vehicles. Even in those years where vehicles aged zero or one year are present, two year old vehicle responses still account for some share of the vehicle use estimates in the new vehicle provision.

5.2 Numbers of vehicles sampled and weights used to estimate total VKT by new passenger vehicles

	Age of vehicle				
Survey year	*0 years*	*1 year*	*2 years*	*3 years*	*Total*
Sample size					
1998	na	na	111	187	298
1999	na	na	177	120	297
2000	12	52	85	127	276
2001	7	107	74	65	253
2002	1	97	141	118	357
2003	na	21	149	139	309
NVP vehicle weights					
1998	na	na	785 451	45 273	830 723
1999	na	na	825 136	63	825 199
2000	59 002	430 953	16 744	22 884	529 584
2001	15 946	262 957	9 780	na	288 683
2002	4 808	287 242	14 640	na	306 690
2003	na	82 926	621 329	na	704 255

Source: ABS (SMVU unit record data) and investigation estimates.

Notes:

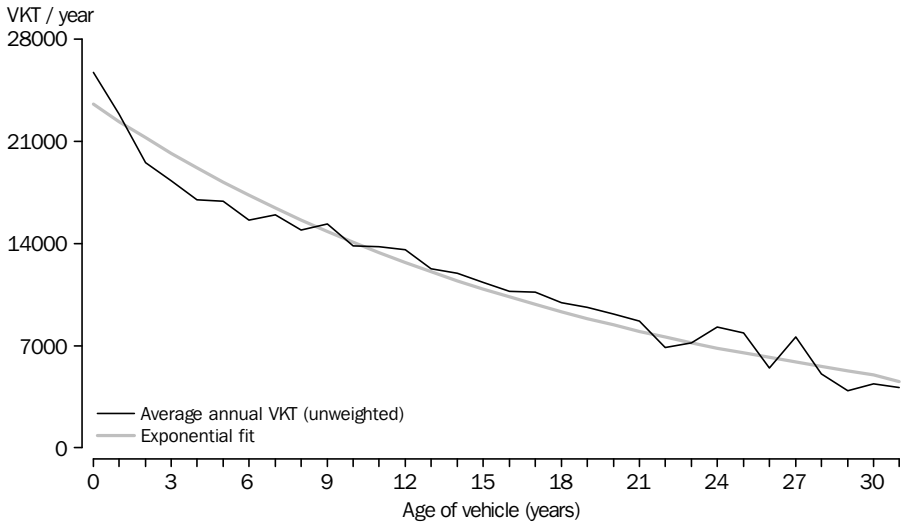
1. 'Age' is defined as the difference between the survey year and the vehicle's recorded year of manufacture.
2. 'na' is defined as nil or rounded to zero (including null cells)
3. None of the three year old vehicles contributed to the NVP factor in 2001–2003, since enough sample information for the NVP factor was obtained from the one and two year old vehicles.

Not including newer vehicles in the sample frame is significant because new vehicles are typically used far more intensively than older vehicles, even when compared with two and three year old vehicles. Therefore, the primary problem caused by this coverage issue, is lack of representative sample information on the 0–18 month old target population. We therefore need to make assumptions about the VKT characteristics of these vehicles. The implicit SMVU assumption is that vehicles less than 18 months old can be represented by vehicles between 18–36 months old. A

central tenet of this paper is that the 18–36 month old vehicles have different VKT characteristics to the 0–18 month vehicles. We would expect the 18–36 month old vehicles, to have lower average VKT than the 0–18 month old vehicles. This is demonstrated in figures 5.3 and 5.4. Therefore the 18–36 month vehicles should not be relied upon to represent the activity of the 0–18 month old vehicles. [22]

Figure 5.3 consists of two curves. The first is unweighted data, pooled across the six survey years 1998–2003. The second curve is an exponential curve fitted to the unweighted pooled data. The nonlinear fit, which was tested on pooled data, was considerably more powerful than linear fits, which were also tested.

5.3 National average travel by age of vehicle, private passenger cars, pooled SMVU data for 1998–2003



Source: ABS (2003 SMVU unit record data)

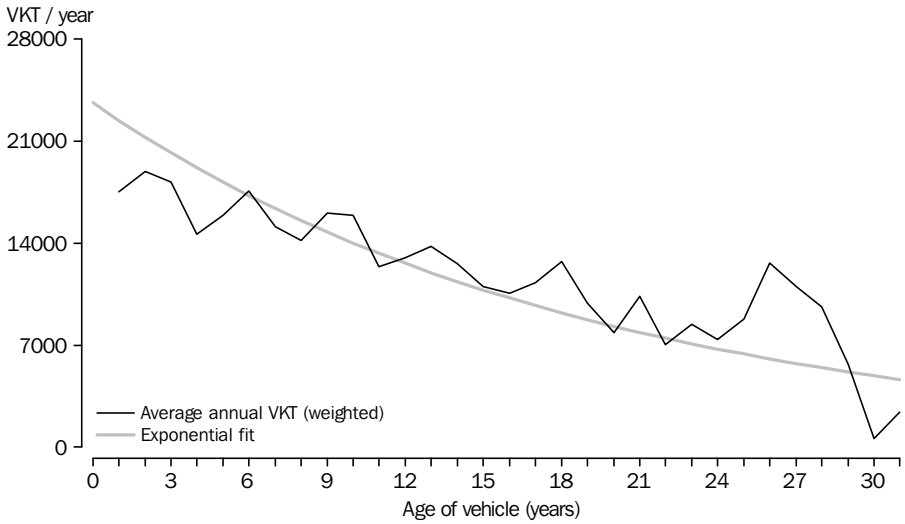
Those years that included vehicle 'top-ups' tend to have average VKT results for passenger vehicles up to one year old of between 25 000 to 30 000 km per annum. This roughly accords with an exponential model, based on SMVU data which was pooled over the 1998–2003 period. However, survey years lacking top-ups apply considerably lower average VKT values in calculating new vehicle contribution. For example, in the 1998 survey, an average VKT for approximately two year old vehicles was used for the NVP factor. National average VKT for two year old passenger cars in the 1998 SMVU data (i.e. the weighted average annual travel across all States for sampled vehicles manufactured in 1996) is about 17 500 km. This value is below expected new passenger vehicle utilisation, as indicated in figure 5.3. Moreover this value appears to have been influenced by a single low use vehicle in Victoria. For

22 The authors note that the ABS has identified the underlying NVP issues that are presented in this section. Further, the ABS has scheduled investigations into identifying the impact and if necessary, a cost effective solution for addressing this coverage issue.

2003, the one year old vehicles, with average VKT of 17 500 km per annum, and two year old vehicles, with average VKT of 18 900 km, accounted for most of the NVP calculation. These values are below likely average use by new vehicles, as indicated by the exponential fit in figure 5.3 (the former value is significantly influenced by a single low-use record in New South Wales).

Figure 5.4 shows the average VKT (weighted) by age of vehicle for passenger vehicles in the 2003 SMVU, compared with an exponential fitted curve (based on unweighted pooled data). The graph illustrates the potential implications of using sample information from one and two year old vehicles for the 2003 NVP adjustment. The average VKT of one year old vehicles in 2003 was 17 500 km per annum, and 18 900 km per annum for two year old vehicles, which is significantly less than the average VKT implied by the exponential fit (approximately 24 000 km per annum for cars aged up to one year old). [23]

5.4 Sample-weighted average vehicle kilometres travelled, by vehicle age – Passenger vehicles



Source: ABS (2003 SMVU unit record data)

5.1.2 NVP factor and variability at the State/Territory level

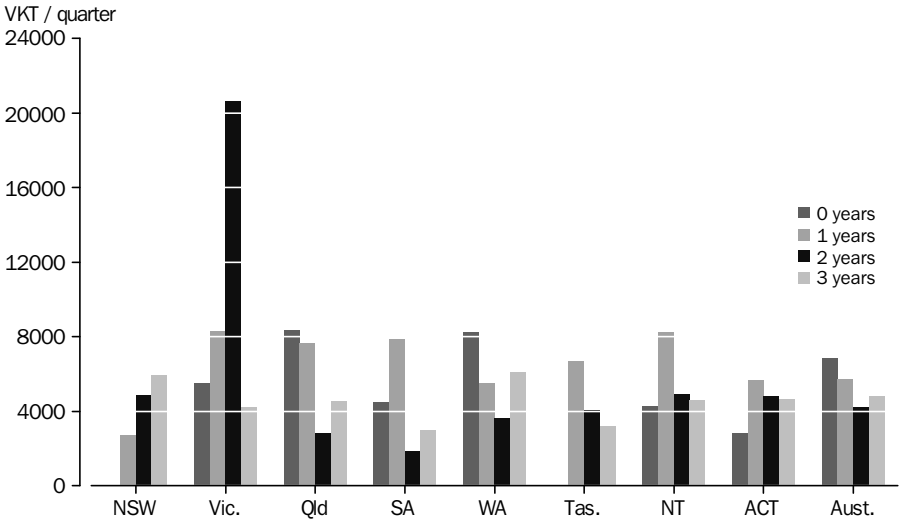
The impact on average VKT estimates at the State/Territory level, resulting from the coverage/NVP issue, is more pronounced due to the smaller sample sizes at this level of stratification. The newer vehicles present in the sample have very high sample weights and in some strata, only a handful of newly registered vehicles are available to provide VKT information for the NVP calculation. If any of those few records happens to display considerable variance from the mean, then the entire State/Territory average VKT may show variation from the previous year once the new vehicle factor is

23 The ABS cautions against emphasising the end point of models, since this range is generally where models perform least well.

applied. This variability should be accounted for by the standard error of the annual level estimate for the respective State/Territory.

Table A.1 (Appendix A) shows the sample weighted average VKT estimates by State/Territory for passenger vehicles aged up to three years. Sometimes a handful (or none), of the newest registered vehicles, are available to provide VKT information for the NVP calculation. [24] For example, in the 1998 and 1999 SMVUs there are no vehicles under two years and in all but Tasmania in 1998, there are more than five vehicles sampled in each jurisdiction for each vehicle age cohort. In the 2000, 2001 and 2002 SMVUs newer vehicles are present in the sample, however, because of the small sample size the average VKT is highly variable. Given that new vehicle sales represent seven per cent of all vehicles in the vehicle stock, it is essential that these newer vehicle VKT estimates be as accurate as possible, if the fleet aggregate utilisation estimates are to be reliable. [25]

5.5 Sample-weighted average vehicle kilometres travelled, by State/Territory – Passenger vehicles aged 0–3 years in the 2000 SMVU



Source: ABS (2003 SMVU unit record data)

Figure 5.5 demonstrates that the small and irregular sample of newest vehicles contributing to the NVP, is impacting on variability of average VKT by State/Territory for vehicles less than three years of age. Combining the information in Table A.1 with Table 5.5, we can see that on occasion, low and varied representation of newest vehicles in the State/Territory sample, has resulted in VKT movements that are not

24 We are defining newly registered vehicles here as less than 18 months old. A minimum of six vehicles must contribute to the NVP in any strata and therefore a minimum of 12 vehicles must have contributed to the NVP class for any single State/Territory in the 2001–2003 surveys (a minimum of six for the capital city geographic region and a minimum of six for the 'Rest of State/Territory' region).

25 The authors note that the ABS has increased the sample size of vehicles expected to contribute to the NVP class for the 2006 SMVU.

coherent. For example, in New South Wales in 2000, there were no zero year age passenger vehicles in the sample, one year vehicles had an average utilisation of 2 700 km per quarter (approximately 10 800 km per year) and the total weight for these vehicles comprised 13 per cent of the passenger vehicles in New South Wales. Two and three year old vehicles had a quarterly average VKT of 4970 km (19 880 km per annum) and 5 930 km (23 720 km per annum) and accounted for nine per cent of the vehicle fleet. These figures explain much of the apparent ten per cent drop in the SMVU estimates of VKT by New South Wales registered vehicles in 2000.

By contrast, in Victoria the quarterly average VKT of zero year vehicles in 2000 was 5500 km (22 000 km per annum), 8 300 km for one year old vehicles (33 200 km per annum), 20 650 km (82 600 km per annum) for two year old vehicles and 4 200 km (16 800 km per annum) for three year old vehicles. The zero and one year old vehicles account for 13 per cent of the final weights for passenger vehicles in Victoria, while the two and three year old vehicles account for four per cent of the final weights. It is unlikely that these Victorian results are reflecting underlying travel characteristics of the sample. This result is likely to be due to the characteristics of a single non-representative two year old vehicle, rather than variability attributable to the NVP factor. However, this example highlights the sensitivity of average VKT to low sample numbers of newly registered vehicles. [26]

5.2 Nil-use vehicles

5.2.1 Nil-use vehicles and false nil-use reporting

The SMVU essentially involves four independently sampled quarterly surveys, which are aggregated to produce an annual estimate. A provider reports nil-use when they do not utilise the registered vehicle during the three month quarterly survey period. The SMVU does not produce separate estimates of the number of nil-use vehicles, however, a number of SMVU estimates contain contribution of vehicles that reported nil-use for the quarterly survey period. Thus the extent of nil-use reporting has the potential to impact on SMVU average VKT estimates. Should false nil-use reporting occur, then this would also impact on level estimates for VKT.

Some sampled vehicles may be used during the annual registration period, but may not be used during the quarterly survey period. In such instances, the survey will not be a good measure of the extent of nil-use on an annual basis. However, any downward impact on annual average VKT is likely to be compensated by sampled vehicles which undertook relatively high VKT during the same three month period. [27]

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26 Due to the nature of random sampling, the distances travelled by vehicles of specific age groups may vary from year to year. This is the reason why minimum sample sizes, of new vehicles that contribute to the NVP factor, is such a crucial issue.

27 Reducing the sample reference period from 12 months to three months has the effect of increasing the number

Further, any quarterly survey will include some vehicles that were not used in previous quarters, but were in fact used during the quarterly reference period.

The potential exists for some data providers to report false nil-use, to avoid the effort required to accurately report SMVU data items. This is despite ABS efforts to individually verify each case of reported nil-use and the fact that ABS survey questions are tested to ensure comprehensibility and appropriate provider burden. It is not possible to determine conclusively that false nil-use reporting is occurring, therefore measuring the impact on SMVU estimates is exceedingly problematic. A discussion on nil-use can therefore only really cover plausibility, or comparison with comparable data sources. International comparisons are difficult due to comparability of data items and collection methodologies. Moreover, the determining characteristics of false nil-use reporting and true nil-use activity may be unique to different regions, rendering validity comparisons not meaningful.

5.2.2 Evidence on nil-use

Since the SMVU does not publish an estimate of the number of nil-use reporting vehicles, this investigation has used survey data to create an average quarterly nil-use estimate by multiplying the reported nil-use records by their survey weight. The average quarterly estimate of nil-use for passenger vehicles was in the order of 3–5% for the 1998–2003 SMVU years. Data from pre-1998 SMVUs indicate that the extent of annual nil-use is in the order of 1–2%. An additional comparability issue arises when comparing the average quarterly nil-use estimate with an annual estimate. It is statistically feasible for an average quarterly estimate of nil-use of 3–5%, to be consistent with an annual nil-use estimate of 1–2%. This was not covered within the scope of this investigation. We feel the issue of nil-use reporting is worthy of consideration and further investigation.

5.2.3 Odometer response analysis

Analysis of SMVU odometer responses was undertaken to identify any relationship between the reporting of nil-use and odometer response. Table 5.6 shows the sample size for each survey year, delineated by provider response category (odometer reading group). Table 5.7 shows the relative proportions of each response category for each year. The 'both readings' category are vehicle owners who provide an initial odometer reading on the survey pre-advice form, in addition to a final odometer reading on the follow-up survey form. These vehicle owners also provided an estimate of VKT during the three month reference period. The 'single reading'

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of vehicles that report extreme values. In a random sample, these extreme values include both low VKT (including nil-use) and high VKT. This doesn't cause a bias, as both extremes are equally likely in a randomly selected sample and will balance each other. The impact on the final estimate will be reflected within the relative standard error.

category includes those providers who only provided one odometer reading and the VKT estimate. The 'no reading' category includes those providers who only provided an estimate of VKT during the three month reference period and no odometer reading.

5.6 Number of sample responses by Odometer response group – Passenger vehicles

	Odometer response group			
Survey year	*No reading*	*Single reading*	*Both readings*	*Total*
1998	266	371	1 689	2 326
1999	178	303	1 532	2 013
2000	124	292	1 626	2 042
2001	115	313	1 716	2 144
2002	168	312	1 630	2 110
2003	121	401	1 517	2 039

Source: ABS (SMVU unit record data).

The proportion of nil-use responses was significantly higher among the 'no reading' respondents than among the 'both readings' respondents.[28] The 'no reading' group however, are comprised of older vehicles on average than the 'both readings' groups. Most of the responses provide both odometer readings, ranging from 72.6 per cent (in 1998) and 80 per cent (in 2001). The share of 'no reading' responses has varied in different samples, with the lowest proportion around six per cent in each of the 2000, 2001 and 2003 surveys.

5.7 Share of sample responses by Odometer response group – Passenger vehicles

	Odometer response group			
Survey year	*No reading*	*Single reading*	*Both readings*	*Total*
1998	11.4%	16.0%	72.6%	100%
1999	8.8%	15.1%	76.1%	100%
2000	6.1%	14.3%	79.6%	100%
2001	5.4%	14.6%	80.0%	100%
2002	8.0%	14.8%	77.3%	100%
2003	5.9%	19.7%	74.4%	100%

Source: ABS (SMVU unit record data).

28 Vehicle average VKT also differed significantly depending on the odometer response, the 'both readings' category displaying higher average VKT than the 'no reading' and 'single reading' categories.

Sample responses by odometer group

The proportion of nil-use vehicles varies quite significantly with the odometer response. Table 5.8 shows the share of nil-use sample responses by odometer response group for passenger vehicles. For vehicles supplying both odometer readings, the proportion of nil-use vehicles has varied between 3.9 per cent in 1998 and 1.7 per cent in 2001. However, for the 'no reading' groups the proportion of nil-use responses is not less than 13.7 per cent, in 2000, and as high as 25.8 per cent in 1999.

The 'no reading' group form between 5.4 and 11.4 per cent of the total passenger vehicle sample. The number of nil-use reporting vehicles that did not provide any odometer response is between 44 and 65 over the six year period. These vehicles represented 1.5 and 3.0 per cent of the respective total passenger vehicles sampled.

The proportion of nil-use for all passenger vehicles is generally between four and six per cent of the SMVU sample, which corresponds to 3–5% of final weighted estimates of the number of total passenger vehicles.

5.8 Proportion of nil-use sample responses (unweighted) by Odometer response group – Passenger vehicles

	Odometer response group			
Survey year	*No reading*	*Single reading*	*Both readings*	*Total*
1998	16.9%	4.6%	3.9%	5.5%
1999	25.8%	6.9%	3.5%	6.0%
2000	13.7%	8.9%	2.5%	4.1%
2001	24.3%	9.9%	1.7%	4.1%
2002	14.9%	8.0%	2.1%	4.0%
2003	17.4%	10.5%	1.9%	4.5%

Source: ABS (SMVU unit record data).

Vehicle age and odometer response

Regression analysis undertaken on pooled SMVU data, indicates that older vehicles are more likely to report nil-use than newer vehicles. Table 5.9 shows that the average age of the 'both readings' response vehicles is around 10 years in each of the six surveys. In contrast, the average vehicle age for 'no reading' is on average 5.5 years older, or equivalent to 1.5 times the average age of 'both readings' response vehicles.

5.9 Average vehicle age (years) by Odometer response group – Passenger vehicles

	Odometer response group		
Survey year	No readings	Both readings	Total
1998	14.6	10.3	10.9
1999	15.3	10.1	10.8
2000	17.1	9.7	10.3
2001	17.2	9.4	10.3
2002	13.9	9.9	10.3
2003	14.0	9.4	10.0

Source: ABS (SMVU unit record data).

The nil-use relationships, in terms of vehicle age and odometer category, are logically consistent, in that the reported nil-use in the 'no reading' response group might be expected to be higher than the reported nil-use in the 'both readings' response group. This is due to the older vehicle age structure of the 'no reading' category. However, despite the older age of vehicles in the 'no reading' group, a binomial logit analysis of nil-use response, with respect to vehicle age, State/Territory of registration and survey quarter, suggests that the reported number of nil-use vehicles in the 'no reading' response group is over-represented (see below in 'Nil-use regression analysis').

5.2.4 Nil-use regression analysis

A binomial logit model was used to estimate the probability of a nil-use response to vehicle age, State/Territory of registration and cycle quarter. Dummy variables for odometer response category ($dNoOD_i$, $dSingleOD_i$) were also included. Separate estimates were derived for each vehicle type.

The model has the form:

$$\Pr\left(VKT_i > 0\right) = \frac{e^{z_i}}{1+e^{z_i}} \qquad (1)$$

where

$$z_i = \beta_0 + \beta_1 Age + \beta_2 SMVU_i + \sum_j \delta_j dState_j + \gamma_1 dNoOD_i + \gamma_2 SingleOD_i$$

Unfortunately, there are few other variables present in the SMVU unit record data that would help explain the level of reported nil-use.

Table 5.10 shows the logit model results for passenger vehicles. Vehicle age is a significant factor in the level of nil-use, but State/Territory and SMVU cycle quarter are not statistically significant. The *NoOD* and *SingleOD* dummy variables are all

statistically significant, suggesting there is some other factor not explained by vehicle age or jurisdiction that results in higher reported nil-use among 'no reading' and 'single reading' response vehicles.

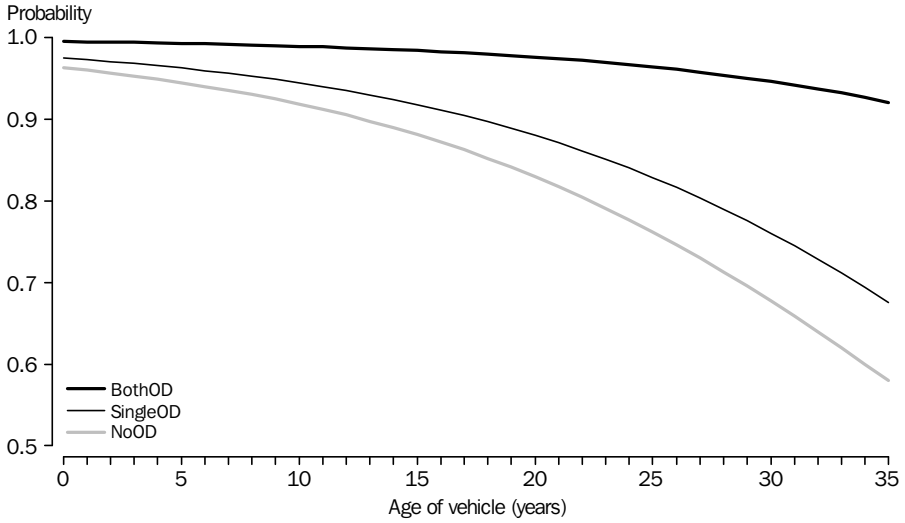
5.10 Logit model results of Nil-use – Passenger vehicles

Variable	*Estimate*	*Std. error*	*z-value*	*Pr(> |z|)*
Intercept	5.397	0.521	10.37	0.000 ***
Age	–0.084	0.012	–7.31	0.000 ***
SMVU quarter	0.111	0.103	1.09	0.278
dVic	–0.776	0.476	–1.63	0.103
dQld	–0.781	0.512	–1.53	0.127
dSA	–0.908	0.487	–1.87	0.062 *
dWA	–0.610	0.508	–1.20	0.230
dTas	–0.290	0.528	–0.55	0.583
dNT	–0.394	0.545	–0.72	0.470
dACT	–0.761	0.512	–1.49	0.137
dNoOD	–2.131	0.326	–6.53	0.000 ***
dSingleOD	–1.718	0.259	–6.63	0.000 ***

Summary statistics:
Null deviance: 749.90 on 2038 degrees of freedom
Residual deviance: 600.68 on 2027 degrees of freedom
AIC: 624.68

Source: ABS (SMVU unit record data) and investigation modelling.
Note: Significance codes: 0.001–0.01: '***', 0.01–0.05: '**', 0.05–0.1: '*'

5.11 Predicted probability of non-zero use, by vehicle age – Passenger vehicles



Source: ABS (2003 SMVU unit record data) and BTRE estimates.

Figure 5.11 illustrates the probability of a passenger vehicle recording non-zero use by vehicle age for each of the three odometer response groups.

Those vehicles not supplying both odometer readings are more likely to record nil-use, independent of vehicle age.

5.3 Average petrol consumption

The analysis on the SMVU unit record response data also investigated the average passenger car petrol consumption rates reported by survey respondents, in order to gauge whether this has any impact on the SMVU estimates of total petrol consumption. The ABS reports that the fuel consumption rate is the single survey item requiring the highest rate of imputation.

The analysis focussed on major vehicle types found in the on-road fleet (e.g. Ford Falcons, Lasers, Holden Commodores and Barinas, Toyota Camrys and Corollas Mitsubishi Magnas etc.) and compared the reported average petrol consumption rate with rated (test cycle) petrol consumption for each vehicle class. While there is some variability in response, and clustering at specific round values (e.g. 10L/100km and 20L/100km). For all major vehicle classes chosen, the average petrol consumption rate was typically 10–20% higher than rated (test cycle) petrol consumption, which is consistent with higher observed petrol consumption rates in on-road use.

The results suggest that petrol consumption rate responses are unlikely to be a major factor in the observed disparity between total petrol sales and SMVU petrol consumption estimates. Despite this conclusion, we did not investigate the sensitivity of the final petrol consumption estimate, to small changes in reported average petrol consumption. Given that a considerable portion of the sample report rounded values for average petrol consumption, the potential for this type of non-sampling error ton the impact on total petrol consumption estimates, is worthy of further investigation.

5.4 Summary

The regression analysis presented in this section was undertaken using unweighted average VKT. The ABS generally cautions users against analysis on unweighted data, as unweighted data may not be representative of the population of interest. However, we believe in this instance, that the outcome of the results on weighted data would lead to similar conclusions as presented in this section. The primary objective of the analysis was to identify if the current survey methodology is adequately accounting for the distance travelled by newest vehicles in the population. Although the authors believe this impact may be to reduce the SMVU VKT estimate by between 1–4%, we acknowledge that more rigorous analysis is required to confirm the conclusions presented. We note that the ABS has independently identified that the NVP methodology may not be adequately compensating for the lack of coverage of newest vehicles in the population and will be undertaking further investigations into the methodology.

The analysis suggests that the small sample sizes for newer vehicles in combination with the sample weighting process, may be contributing to the observed variation in VKT estimates at the State/Territory level. [29]

It is difficult to obtain conclusive evidence on the existence of false nil-use reporting, because there are valid reasons why a registered passenger vehicle may not be used during one of the four quarterly reference periods, that annual SMVU estimates are compiled from. However, the proportion of nil-use vehicles among the 'no reading' group appears high (between 14 and 26 per cent over the 1998–2003 surveys), even after allowing for their older age structure. We believe this issue warrants further investigation. [30]

29 The NVP analysis in this paper has been undertaken on 1998–2003 SMVU data. Note that the SMVU sample design includes vehicle age stratification from the 2004 and subsequent surveys. We anticipate that changes to the stratification for SMVU 2006 will remove most of the data issues surrounding variability of the factor, but not the basic lack of coverage of newest vehicles within the SMVU sample.

30 The authors note that the ABS has scheduled investigations into identifying the validity of nil-use reporting. More conclusive evidence on the extent on nil-use reporting and the likely impact of false reporting, may emerge from these investigations.

6. RECONCILIATION OF SMVU AND TPS ESTIMATES

This section combines the conclusions relating to scope factors, discussed in Section 4, and the coverage factors, discussed in Section 5, into a single coherent view of the disparity between SMVU petrol consumption estimates and petrol sales data. To do this we have developed quantifiable parameters associated with the impact of the NVP and nil-use issues that were presented in Section 5.

It should be emphasised that the true impact upon petrol consumption estimates, attributable to the NVP and nil-use issues (via impact on VKT) are not yet known. The purpose of this exercise is to identify how much of the disparity, is accounted for by this investigation. This is important because any remaining disparity indicates that there may be additional factors not considered, or the identified magnitude of one or more of the factors identified in Sections 4 and 5, are not accurate.

6.1 Reconciling disparity for scope factors

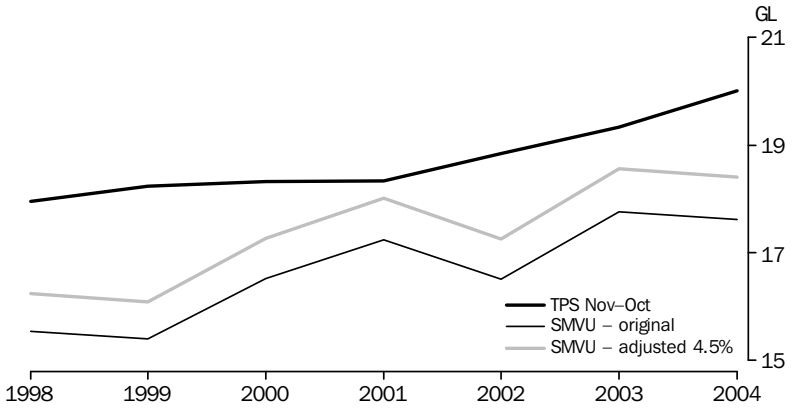
The background discussion highlighted that the disparity between TPS and SMVU petrol estimates was of the order of 5–15% between 1991 and 2003. Part of this disparity will be due to off-road use of petrol engines (such as by lawnmowers, outboard engines, trail bikes and personal generators) and use by vehicles out-of-scope of the SMVU (such as defence, diplomatic and unregistered vehicles). Section 4 presented population-based estimates that suggest off-road petrol usage is likely to account for 2.5–3.8% of SMVU petrol consumption, while petrol use by out-of-scope vehicles is likely to account for another 0.6–1.6% of SMVU petrol consumption (see table 6.1). Therefore, up to 49% of the average disparity is attributable to out-of-scope vehicles and off-road usage.

6.1 Summary of assumed scope difference between TPS and SMVU consumption estimates

	Megalitres	*% SMVU estimate*	*% average disparity*	*% 2003 disparity*
Average petrol sales, 1998-2004	19,581			
Average petrol consumption, 1998-2004	17,618			
Average disparity, 1998-2004	1,963			
Disparity, 2003	1,115			
Disparity attributable to:				
Scope factors	541 – 952	3.1 – 5.4%	27.6 – 48.5%	48.5 – 85.4%
Coverage factors	355 – 710	2.0 – 4.0%	18.1 – 36.2%	31.9 – 63.7%
Total	896 – 1,662	5.1 – 9.4%	45.7 – 84.7%	80.4 – 149.1%

Figure 6.2 shows the TPS series and SMVU petrol consumption estimates increased by 4.5 per cent, to account for the scope and off-road factors that were identified in Section 4. As can be seen, the scope differences account for approximately 40% of the disparity between the two series. [31]

6.2 Total petrol sales and SMVU petrol consumption (adjusted 4.5 per cent to account for scope), Gigalitres



Source: DITR, ABS SMVU and BTRE estimates

6.2 Reconciling disparity for coverage factors

After allowing for scope and off-road use factors, approximately 60% of the disparity still remains. The remaining disparity implies that the SMVU has underestimated either the average VKT for petrol vehicles or their average rate of petrol consumption (or a combination of both factors) for each of the surveys since 1991. Distribution of average petrol consumption by vehicle type was assessed and deemed to be within expected parameters (approximately 20 per cent higher than petrol consumption rated by the manufacturer). [32] Therefore we think it unlikely that reported petrol consumption rates are a major cause of the disparity.

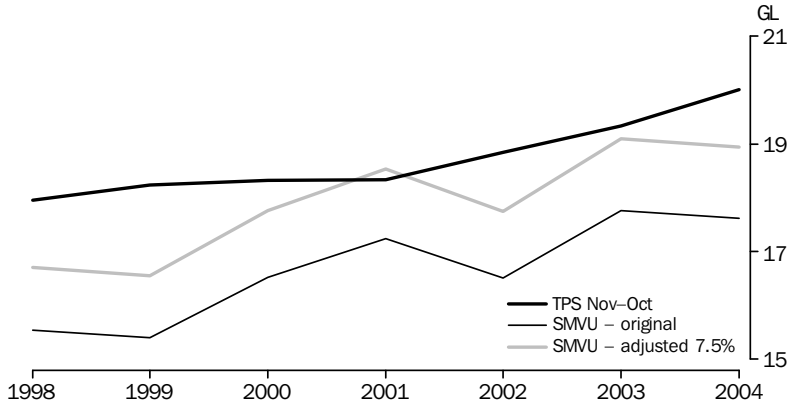
The conclusions in Section 5 identified the potential for VKT to be underestimated by 1–4% of VKT because newest vehicles (which travel the furthest distances on average) are not adequately covered in the survey. Further, the NVP factor is not adequately able to account for newest vehicle travel characteristics. The section also identified the potential for misreporting of nil-use, particularly in the 'no reading' response category. No conclusions as to the likely impact upon VKT were made, however for analytical purposes, let us assume that this impact is in the order of one per cent of VKT.

31 The ABS anticipates the volatility of the SMVU series to moderate as a result of enhanced vehicle age stratification and resulting refinements to the NVP methodology, which come into effect in for the 2006 survey.

32 The difference is attributable to engine wear, traffic congestion, engine idle, variation in vehicle load and throttle usage, which are not factored into manufacturers test conditions.

Figure 6.3 shows the TPS petrol sales series and SMVU petrol consumption, which has been shifted by four and a half per cent for scope factors, and three per cent for NVP and nil-use. With this scenario, equating petrol sales (TPS) with petrol consumption (SMVU), is far more plausible than was indicated by the original series in figure 6.1, however, a small gap remains between the two series.

6.3 Total petrol sales and SMVU petrol consumption (adjusted 7.5 per cent to account for scope, NVP and Nil-use), Gigalitres



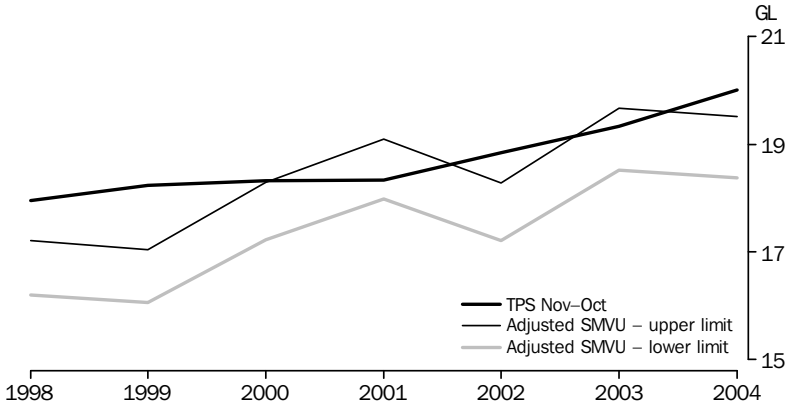
Source: DITR, ABS SMVU and BTRE estimates

6.3 Miscellaneous petrol loss factors and measurement uncertainty associated with Total Petrol Sales

It is difficult to assess the uncertainty levels associated with the data on total petrol sales. Factors such as measurement error and reporting error may introduce an element of uncertainty with the TPS series, however, the extent of these factors is unknown. In addition, spillage and displacement loss (Farrington, 1988) and storage loss, will introduce an element of uncertainty with regard to the size of the disparity between the two series. These combined factors may be in the order of 1–2% of TPS, however, we have not factored this into the calculation of the disparity, due to the relative small and unknown magnitude of volumes.

The relative standard errors associated with the 2002–2004 SMVU petrol consumption estimates is approximately three per cent (the mid point of the 2-4% range for the combined NVP and nil-use factors). It is perfectly reasonable to apply this error to the SMVU petrol consumption estimate in Figure 6.3, which was adjusted upwards by seven and a half per cent for scope and coverage factors. Figure 6.4 illustrates the TPS series with the upper and lower confidence intervals associated with the adjusted SMVU series. After applying the upper and lower confidence intervals to the adjusted SMVU series, the resulting correlation indicates that any remaining disparity between the two series, is approximately accounted for by the measured error of the SMVU.

6.4 Total petrol sales and upper and lower confidence intervals associated with SMVU petrol consumption (adjusted 7.5 per cent to account for scope, NVP and Nil-use), Gigalitres



Source: DITR, ABS SMVU and BTRE estimates

6.4 Impact of changing socio-economic and environmental factors on the disparity between the SMVU and Total Petrol Sales

This investigation into the differences in scope has focused on the 1998–2003 time period, due to lack of data availability for the pre-1998 time periods. Anecdotal evidence suggests that the extent of the differences in scope have changed over the survey lifetime, as supply and demand factors have impacted on household nondiscretionary expenditure.

The following demand side factors have arguably increased the disparity over time:

- Nondiscretionary expenditure on recreation has increased from 8.81 per cent of average weekly household expenditure in 1988–89 (*Household Expenditure Survey – Australia*, ABS cat. no. 6535.0) to 12.76 per cent in 2003–04. Petrol engine marine and freshwater vessels are included within household expenditure on recreation; and
- population demographic characteristics have changed with an increase in population density in coastal regions, arguably increasing the use of recreational vessels (in relative terms the price of these activities has also dropped over time).

The following supply side factors have arguably increased the disparity over time:

- Tariff reductions have reduced the relative price of imported machinery (vessels, boats, motorcycles, lawn mowing equipment);
- Technological innovation has resulted in a greater proportion of petrol powered engines (outboard marine engines, utility engines, etc.) entering the market, compared to diesel powered engines; and

- Technological innovation has also resulted in new petrol powered products such as personal water craft entering the market.

The combined supply and demand factors suggest higher demand and use of petrol powered engines in the late 1990s and 2000s, compared to Farrington's 1985 analysis.

6.5 Reconciling the apparent divergence from Total Petrol Sales after 1991

It is reasonable to presume that the factors causing the scope difference identified in the 1998–2003 time period, were also evident prior to this period. Therefore it is incongruent that the two series tracked well prior to 1991 (see figure 3.1) but not after this period. Much of the data presented in Sections 4 and 5 are not available for the pre-1998 time period, therefore it is not possible to repeat this analysis for earlier time periods. Nevertheless, we need to reconcile the fact that the disparity associated with the post-1998 time series, is not evident in the pre-1991 time series. We believe this can be accounted for by three main factors:

1. change in supply and demand factors over time, as discussed immediately above;
2. changes in the methodology applied to the SMVU collection processes (treatment of nil-use, NVP factors, deregistered vehicles); and
3. changes in provider response to modified question design methodology, such as recall bias and rounding on survey forms.

We do not have the ability to confirm the extent of recall bias associated with the earlier surveys, or its impact on VKT and petrol use estimates. However ABS methodological investigations conducted at the time, indicated the potential for recall bias to significantly influence SMVU estimates.

Another potential scenario is that scope impacts were present during the pre-1991 series and they have increased during the 1990's, due to changing socio-economic and demographic factors.

7. CONCLUSIONS

The disparity between SMVU and TPS during the 1998–2003 time period varies between 5–15% of TPS. A significant portion of the disparity is attributable to scope differences between the two collections and coverage factors of the SMVU. Ascertaining how much of the disparity is accounted for by differences in scope and under coverage is not straightforward because the SMVU series is subject to volatility and therefore the magnitude of the disparity varies between years.

The SMVU does not include petrol consumption by unregistered, off-road, defence, diplomatic and consular vehicles. Nor does the survey account for petrol use by marine vessels, pleasure craft (jet skis), lawnmowers and petrol-fuelled machinery. We estimate that petrol use by these vehicles and machinery accounts for approximately 40% of the average disparity between the SMVU and TPS.

The main coverage issue impacting on the SMVU is attributable to the time lag between the survey frame creation date and the reference period. This lag dramatically reduces the number of newly registered vehicles in the 1998–2003 SMVU samples. Since total petrol consumption is the product of distance travelled and average reported petrol consumption, this contributes to the disparity between TPS and SMVU. In addition to the impact on the disparity between SMVU and TPS, the small and varied sample sizes of newly registered vehicles contributes to observed variability in VKT estimates at the State/Territory level.

The conclusions on reported nil-use are less certain than for the NVP analysis. However, the extent of nil-use reported by some categories of data providers is not consistent with the age distribution of vehicles in these categories. We estimate that the impact on petrol use attributable to the NVP and nil-use coverage factors accounts for approximately 30% of the average disparity between the SMVU and TPS

Scope and coverage factors appear to account for all of the disparity in years where the disparity is relatively low, such as 2001 and 2003. However, scope and coverage are only likely to account for approximately two thirds of the disparity in years where the disparity is relatively high, such as in 2002 and 2004.

There are a variety of possible explanations for the remaining unexplained disparity. For example, petrol use in industries such as agriculture, manufacturing or mining, have not been estimated by this investigation, and may account for a small part of the remaining disparity. Another possibility is that petrol use by out-of-scope and off-road engines is actually somewhat higher than estimated by this investigation. Yet another possibility is that aggregate petrol consumption estimates are sensitive to minor changes in reported average petrol consumption, causing non-sampling error that has not been fully investigated in this analysis (especially considering that rounding of response values for SMVU petrol use questions are quite prevalent). It should also be borne in mind that since the SMVU is a sample survey, the size of such a disparity would be expected to change from year to year simply through random variation..

REFERENCES

Australian Bureau of Statistics (2005) *Australian Demographic Statistics*, cat. no. 3103.0, ABS, Canberra.

—— (1998–2004) *Motor Vehicle Census, Australia*, cat. no. 9309.0, ABS, Canberra.

—— (2000–2001) *New Motor Vehicle Registrations, Australia*, cat. no. 9301, ABS, Canberra.

—— (1976–2004) *Survey of Motor Vehicle Use, Australia*, cat. no. 9208.0, ABS, Canberra.

Department of Industry Tourism and Resources (2001–2003) *Energy Use in Commonwealth Operations*, DITR, Canberra.

—— (1971–2004) *Australian Petroleum Statistics*, DITR, Canberra.

Farrington. V. (1988) *Air Emission Inventories (1985) for the Australian Capital Cities*, Australian Environment Council Report No. 22.

Federal Chamber of Automotive Industries (2005) *Vehicle Sales*, Data sourced from <www.fcai.com.au> in June 2005.

Maritime Safety Queensland (2003) *Recreational Boating Survey Report, 2003*, Brisbane.

New South Wales Auditor General (2003) *Dealing with Unlicensed and Unregistered Driving*, Sydney.

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APPENDIXES

A. AVERAGE VEHICLE KILOMETRES TRAVELLED, BY STATE/ TERRITORY

A.1 Sample-weighted average VKT, by State/Territory – Passenger vehicles aged 0–3 years

	Age of vehicle			
	0 years	*1 year*	*2 years*	*3 years*
New South Wales				
1998	na	na	4 582.3	3 920.8
1999	na	na	4 776.7	4 933.7
2000	na	2 698.0	4 867.7 *	5 934.5
2001	5 319.4 *	4 433.9	3 657.5	6 746.3
2002	na	5 054.1	3 957.4	3 808.6
2003	na	3 058.0 *	4 773.1	4 071.6
Victoria				
1998	na	na	4 175.2	4 671.4
1999	na	na	4 180.8	4 953.5
2000	5 503.3 *	8 303.9	20 642.0 *	4 209.3
2001	na	6 129.2	6 059.4 *	170.6
2002	na	5 734.3	5 632.9	4 236.9
2003	na	3 721.4 *	4 829.8	6 099.9
Queensland				
1998	na	na	3 742.5	3 652.4
1999	na	na	5 723.2	4 795.7
2000	8 327.7 *	7 646.6	2 863.8 *	4 567.8
2001	10 813.0 *	5 263.3	6 170.8	12 499.0
2002	1 495.0 *	5 324.6	4 777.9	4 775.6
2003	na	4 024.5 *	4 632.3	3 590.2
South Australia				
1998	na	na	2 657.8	3 528.7
1999	na	na	4 979.4	4 651.9
2000	4 540.8 *	7 892.4 *	1 873.9	3 003.1
2001	na	5 405.0	5 805.5 *	na
2002	na	4 453.4 *	5 013.2	3 650.9
2003	na	5 680.0 *	4 021.6	3 499.1
Western Australia				
1998	na	na	5 686.0	5 634.9
1999	na	na	2 591.4	4 564.6
2000	8 253.1 *	5 548.6 *	3 615.4 *	6 093.6
2001	na	5 063.3 *	5 091.6 *	7 746.8 *
2002	na	5 801.9	3 862.0	4 340.1
2003	na	6 817.0 *	5 041.7	5 295.9

A.1 Sample-weighted average VKT by State/Territory – Passenger vehicles aged 0–3 years (continued)

	Age of vehicle			
	0 years	*1 year*	*2 years*	*3 years*
Tasmania				
1998	na	na	5 379.1 *	3 311.0
1999	na	na	5 763.9	3 430.5
2000	na	6 666.5	4 080.7	3 213.1
2001	2 723.2 *	4 046.2	5 188.3	4 034.2
2002	na	5 577.5	4 760.3	5 030.8
2003	na	25 140.0 *	5 291.9	4 108.6
Northern Territory				
1998	na	na	4 015.5	3 575.6
1999	na	na	5 415.0	5 770.9
2000	4 265.9 *	8 244.0 *	4 934.0	4 593.4
2001	10 478.0 *	4 317.4	4 844.3	5 311.2
2002	na	5 922.4	4 680.7	3 992.8
2003	na	3 350.9 *	4 660.5	3 306.0
Australian Capital Territory				
1998	na	na	5 264.8	5 634.1
1999	na	na	6 659.9	4 387.1
2000	2 874.6 *	5 714.9	4 796.1	4 666.7
2001	6 205.7 *	3 848.3	4 105.7	4 470.0
2002	na	5 718.2	4 354.4	3 905.5
2003	na	3 132.8 *	4 002.1	4 826.9
Australia				
1998	na	na	4 375.9	4 223.5
1999	na	na	4 654.6	4 822.3
2000	6 840.3	5 745.2	4 196.9	4 805.3
2001	7 519.9	5 251.7	4 949.5	5 015.9
2002	1 495.0	5 405.5	4 592.0	4 162.9
2003	na	4 382.0	4 729.6	4 544.6

Source: ABS (SMVU unit record data) and BTRE estimates.

* Number of vehicles contributing to the calculation is less than six.

na nil or rounded to zero (including null cells)

B. DESCRIPTION OF FRAME LAG AND THEORY OF NVP

The SMVU frame is generally created seven months prior to the start of the reference period. This creates a frame lag which has the potential to adversely affect sample coverage of the survey. The frame would be 'out of date' by 19 months, at the end of the reference period, if corrective measures were not implemented to counter the lag. Therefore the survey frame does not fully cover the youngest vehicles in the population. The ABS refers to this frame deficiency as a frame, or population 'coverage' problem. This means a portion of the units of interest are subject to reduced availability for selection. Figure 5.1 illustrates the SMVU reference period and the associated frame lag.

The purpose of the new vehicle provision (NVP) factor is to readjust, or correct, the survey frame for changes (registration of new vehicles) which occur to the frame during the survey reference period. The NVP calculation is essentially a mean value for vehicle kilometres travelled (VKT) by the newest vehicles in the sample, which is used to estimate for the number of new vehicles which enter the fleet population after the frame snapshot and before the end of the reference period. Mean VKT is obtained from newest vehicles within the SMVU sample, therefore the representative nature of the adjustment is maintained. The numbers of new vehicle registrations is obtained from the respective State/Territory motor vehicle registries.

The benefit of the NVP approach, compared to a modelling solution, is that any changes which occur to the population over time, will be reflected within the NVP factor. We know that newest vehicles within the fleet (0–24 months old) tend to have high VKT characteristics, therefore it is very important that these characteristics are captured within SMVU estimates. The coverage problem is therefore overcome, if the population characteristics of the newest vehicles captured within the sample, are representative of newly registered vehicles. However, the evidence presented in Section 4, suggests that the sample vehicles are not fully representative of the population characteristics of newly registered vehicles.

The coverage issue was improved when new registration information, from the New Motor Vehicle Registrations (NMVR) collection, allowed for direct sampling of this portion of the population. Updated frame information for new vehicle registrations was available in the 2000, 2001 and 2002 SMVUs. The NMVR collection enabled the ABS to 'top-up' the SMVU sample with a secondary sample of newly registered vehicles, thus alleviating the frame lag problem. The NMVR collection is no longer available, therefore the SMVU is reliant upon the NVP factor, to account for newly registered vehicles.

Data issues associated with current NVP treatment

Due to the stratification of pre-2004 SMVUs, sample designers were not able to control for the number of newest vehicles which contribute to the NVP calculation. The minimum requirement for feeding vehicle characteristic information into the NVP factor is a sample size of six. The NVP calculation algorithm searched the stratum sample for one year old vehicles first, then two year old vehicles, etc., until the minimum sample size of six is reached. Therefore the information feeding into the NVP may be coming from vehicles that are up to three years old, which is problematic since the average VKT of three year old vehicles is considerably less than for a one year old vehicle.

C. LIST OF GOVERNMENT DEPARTMENTS AND AGENCIES WHICH PROVIDED DATA TO THE INVESTIGATION

Australian Bureau of Agriculture and Resource Economics

Australian Federal Police

Department of Defence

Department of Foreign Affairs and Trade

Department of Industry Tourism and Resources

Department of Infrastructure, Victoria

Department of Infrastructure Energy and Resources, Tasmania

Department of Marine Safety, Tasmania

Department of Planning and Infrastructure, Western Australia

Department of Planning and Infrastructure, Northern Territory

Department of Transport, Queensland

Department of Transport, South Australia

New South Wales Police Department

New South Wales Road Traffic Authority

Queensland Police Department

South Australian Police Department

Tasmanian Police Department

Victorian Police Department

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