An Economic Analysis of Removing Older Vehicles from the Perth Fleet

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Abstract

Increasing the turnover of vehicles has been suggested under Perth's Air Quality Management Plan in order to reduce mobile-source emissions. This paper examines the options available to encourage greater vehicle retirement in Perth. The main focus of the paper is the incentive to scrap older vehicles through scrappage programs. The likely success of such a program is assessed by simulating it in Perth. Using this methodology, the estimated participation rates in the program can be obtained in order to determine the likely effectiveness of such a program in Perth.

1.0 Introduction

In the 12 months leading up to 31 October 2005, Western Australians travelled a total of 21.5 billion kilometres in their motor vehicles, consuming 2.9 gigalitres of fuel and producing an estimated 193.3 kilotonnes of pollutants and greenhouse gas emissions[1]. This is an alarming fact, considering the number of vehicles on the road is set to increase steadily into the future while the amount of pollutants in the air continues to rise. The remedy to this situation has already sparked worldwide debate, with efforts such as the Kyoto Protocol and US carbon trading scheme. In 2000, the 30-year Perth Air Quality Management Plan (AQMP) was introduced in an attempt to maintain and improve Perth's air quality.

The AQMP implementation strategy highlights old cars as a major source of tailpipe emissions. This is because older vehicles emit a disproportionately larger amount of pollutants than newer vehicles due to their poorer engine conditions and less stringent manufacturing standards. This is a particular problem in WA which has a large proportion of older vehicles in the Perth fleet. The average age of WA vehicles is 11 years, compared to the Australian average of 10.5 years, 9 years for the US and 5.9 years for the UK.

2.0 Measures to Increase Vehicle Turnover

The measures used to increase vehicle turnover generally fall into two broad categories – those that target older vehicles directly through voluntary accelerated vehicle retirement (VAVR) programs, and those that target them indirectly. The latter are not aimed specifically at older vehicles but tend to target them indirectly through the characteristics of this class of vehicles.

2.1 Voluntary accelerated vehicle retirement

VAVR entails the exchange of cash or non-cash rewards for the scrapping of an older vehicle. Non-cash rewards can include travel passes and contributions towards the purchase of a new

[1] Sources: Australian Bureau of Statistics (ABS) Survey of Motor Vehicle Use (May 2005), Sinclair Knight Merz (SKM) Perth Airshed Diffuse Emissions Study (2004/2005)

vehicle. In this way, older, more polluting vehicles can be retired earlier than they otherwise would have been, thus reducing the potential emissions from these vehicles. Rewards may be offered for simply retiring the vehicle and this is known as cash-for-retirement. However, to avoid the replacement of scraped vehicles with others that are equally as old, cash-for-replacement programs offer non-cash rewards which encourage the use of newer vehicles or more environmentally friendly means of transportation.

The first major VAVR program was carried out in 1990 by oil producer Unocal (now Chevron). The company sponsored the South Coast Recycled Auto Project (SCRAP) program in Los Angeles, whereby owners of cars manufactured before 1971 were offered USD700 to scrap their vehicles. Unocal used the emissions reductions to offset their own emissions, thereby complying with regulatory requirements at the time. In 1992, US Generating Company initiated a similar vehicle retirement program in Delaware. The British Columbia Scrap-It program in Canada is an example of a cash-for-replacement program that targets pre-1993 cars, with rewards that include between CAD500 and CAD1000 toward a new vehicle, up to CAD500 toward a bicycle, CAD750 toward carpooling, or public transport passes. Most recently, the New Zealand Ministry of Transport launched a pilot VAVR program in May 2007, offering NZD400 worth of bus and rail passes for the scrapping of unwarranted vehicles in Auckland.

VAVR programs appear to be a cost-effective tool for reducing vehicle emissions. Analyses on previous VAVR programs generally report cost-effectiveness (cost per tonne of emissions reduced) of USD3000-3800 per tonne of photochemical smog[2]. There are, however, qualifications to the effectiveness of VAVR programs. Firstly the success of a VAVR program depends on the vehicle replacement decisions of the participants. Cash-for-replacement programs ensure the vehicles are replaced with newer ones or other more fuel-efficient means of transport. However, these programs are generally more expensive to administer. Another point to note is the decreasing cost-effectiveness of VAVR programs over time. That is, as more vehicles are retired, an ever increasing reward amount is required to attract each additional participant to the program. Cost-effectiveness also decreases as higher incentives are offered, even though more vehicles are scrapped. In addition to this, the time limit of a VAVR program is also crucial. Lengthy VAVR programs tend to decrease the effectiveness of the program, as owners of older vehicles have an incentive to hold on to their vehicles to ensure a minimum purchase value for them later on. However, this may be reduced by setting a public ceiling on the number of vehicles and moving rapidly towards this goal.

2.2 Indirect targeting of older vehicles

A common approach to removing older vehicles from operation is emissions-based regulation. These measures target all vehicles, but older vehicles are affected disproportionately as they are associated with higher tailpipe emissions. The most prevalent form of emissions-based controls is mandatory emission testing which requires vehicles to satisfy a certain minimum emissions standard in order to remain in operation. In Australia, emission testing has only been carried out on a voluntary basis through pilot programs. Another emissions-based alternative is the imposition of emission taxes or charges. This would increase the running costs of older vehicles, forcing a larger proportion of them to be retired. Tradable emission permits have also been highlighted as a possible solution.

[2] The values are based on research into VAVR programs in California (Hahn, 1995 and Report to the California Legislature, 2004), the Delaware vehicle retirement program (Alberini, 1996) and evaluations of the British Columbian Scrap-It program (Clean Air Initiative for Asian Cities, The World Bank and Asian Development Bank, no date).

Substitutes-based incentives entail increasing the attractiveness of alternatives to older vehicles. One option is to decrease the cost of purchasing newer vehicles. Tax credits on the purchase of hybrid vehicles are already available in the US, but there are currently no tax incentives to purchase these vehicles in Australia. However, various other measures exist that reduce the cost of purchasing these vehicles, including interest-only loans on car purchases and reduced stamp duty, which has been effective in WA since July 2007. The improvement of alternate means of transport is also likely to reduce the demand for older vehicles. Countries such as Singapore, Japan and England, have both extensive and well-established public transport systems, and tend to have lower estimated average vehicle ages.

There is a vast array of alternatives that may be used to increase the turnover of vehicles. VAVR programs represent a balance of these alternatives as they target older vehicles directly by offering compensation to the owners of these vehicles, thereby resulting in a more equitable solution. Although there are qualifications to the effectiveness of VAVR programs, the programs may be enhanced by the introduction of other measures mentioned above. For example, improvements in the public transport system would likely result in increased participation in cash-for-replacement programs where transport passes are offered as a reward for vehicle scrappage. The effectiveness of VAVR programs is discussed further in the following section.

3.0 Simulation of VAVR in Perth

In this section the work of Alberini *et al.* (1995) is used to simulate a hypothetical VAVR program in Perth. In doing this, the resulting participation rates if such a program were to be implemented in Perth can be estimated.

3.1 Explanation of the model

Alberini *et al.*'s (1995) theoretical model is based on several comparisons of streams of costs and benefits associated with car ownership under alternative scenarios, within a continuous time framework. The analytical solutions are used only to guide the empirical framework, rather than to provide equations that can be directly estimated. The schematic overview of their model provided here offers the same general guide to the empirical framework. The model draws upon consumer maximising behaviour. A consumer's willingness-to-accept (WTA) a scrappage offer is given by the difference between the net present value of rejecting the offer and the net present value of accepting it. Offers higher than the WTA are accepted, and those below it rejected.

Using survey results from the Delaware Scrappage Program, Alberini *et al.* (1995) estimate the WTA function as log $WTA_i = x_{i\_} + \__i$; where x_i is a vector of predictors and $\__i$ is a disturbance term. x_i includes variables pertaining to the net benefits of vehicle ownership as well as the current age of the vehicle and the residual ownership time of the vehicle. These are assumed to be linearly related to log WTA. Log WTA is also assumed to follow a normal distribution.

3.2 Data and methodology

The model estimated by Alberini *et al.* (1995) is used to simulate a hypothetical scrap program in WA. The parameters derived using the Delaware buy-back program are applied to WA data in order to estimate the WTA of the would-be participants. In doing so, the appropriate offer required to meet a target level of participation in the program can be obtained, and the likely success of such a program can be assessed. Various offer amounts can also be tested and the resulting participation rates used to produce a vehicle scrappage supply schedule.

Alberini *et al.* (1995) find four significant explanatory variables for log WTA. The restricted model below uses these explanatory variables plus a constant term. To increase the accuracy of

the simulation results as applied to the current time period, the Alberini *et al.* (1995) model is also adjusted for inflation using annual US consumer price index (CPI) inflation values[3].

$$\widehat{\log \text{WTA}} = \underset{(20.78)^{[4]}}{6.7903} + \underset{(6.90)}{0.1996}\,res\_life + \underset{(5.85)}{0.0005}\,wvalue - \underset{(-4.70)}{0.4144}\,condn - \underset{(-1.84)}{0.0006}\,spend$$

$$\hat{\sigma} = 0.5266$$

where *res_life* is the remaining number of years the vehicle would have been held onto had it not been scrapped, *wvalue* is the blue book value of the vehicle, *condn* is a dummy variable with a value of one for a vehicle in excellent or good condition and zero for a vehicle in fair or poor condition, and *spend* is the anticipated expenses to keep the vehicle running for another year[5].

This study uses two benchmarks as the target age for scrappage. The first targets vehicles manufactured in 1986 and earlier, 1986 marking the introduction of catalytic converters and the gradual phasing out of leaded petrol in motor vehicles. The second benchmark targets pre-1993 model vehicles (15 years and older). In order to simplify the analysis the class of vehicles targeted for the scrappage program is also reduced to include passenger vehicles only.

The mean residual life is assumed to be three years in this analysis. The condition of the target vehicles is assumed to be fair or poor, resulting in a value of zero for the dummy variable. This is reasonable as the condition of the vehicle is likely to deteriorate with age, and so the likelihood of a 1986 vehicle being in good condition, on average, is low. The blue book is similar to the red book in Australia, which reports the range of values for both trade-in and private resale of used cars. Red book ranges were obtained for a variety of cars, including the Holden Astra, Ford Laser and Toyota Corolla in the small-to-medium car (four cylinders) category, and Holden Commodore, Ford Falcon and Mitsubishi Magna in the large car (six cylinders) category. For 1986 vehicles, the average red book value is AUD 1335. For vehicles in the 1992 vintage, large cars have a mean red book value of AUD 2075 whereas small-to-medium cars have a mean value of AUD 1636.

To obtain the anticipated expenses associated with keeping the vehicle running for another year, a survey was conducted involving local WA car mechanics. Of the 50 mechanics that were contacted, responses were obtained from 16 mechanics. The average disbursements associated with 1986 vehicles is AUD 958, whereas for 1992 vehicles the anticipated disbursements are, on average, lower at AUD 843 for small-to-medium cars and AUD 916 for large cars.

The above data are applied to the Alberini *et al.* (1995) model for 1986 vehicles, small-to-medium 1992 vehicles, and large 1992 vehicles. 1992 vehicles are expected to produce higher values for WTA than 1986 vehicles as they tend to have higher red book values as well as lower maintenance and repair costs. The WTA for larger cars is also anticipated to be higher than that of smaller cars. The results are then used to estimate the participation rates with different offers. Assuming a normal distribution of log WTA,

$$\text{Expected participation rate} = \Phi\left(\frac{\log(offer) - \bar{x}\hat{\alpha}}{\hat{\sigma}}\right)$$

[3] At the time of writing, US consumer prices have increased by 50.75 per cent since 1992, the year that the survey was carried out (International Monetary Fund (IMF) World Economic Outlook Database, April 2007).
[4] The t-statistic is calculated assuming the same standard error and a level shift in the coefficient.
[5] The Blue Book is an online service that provides information on new and used cars. The blue book value reflects a combination of trade-in, suggested retail and private party values of these cars.

where $\bar{x}$ describes the average values of the regressors, _ is the vector of parameters that index the distribution and _ is the cumulative density function of the standard normal. Various offers are then tested to obtain the supply schedule. Around the world, offer amounts vary according to the scrap program and range from USD 400 to USD 2000 (Dill, 2001). The simulation tests offers ranging from AUD 400 to AUD 1000 in a cash-for-retirement program only.

3.3 Results

The average WTA obtained and expected participation rates from the simulation are presented in Table 3.1. The WTA values obtained are larger than the replacement cost (or red book value) of vehicles in the same category, which is indicative of the high values placed on the vehicles. As anticipated, the WTA for 1992 vehicles is higher than the WTA for 1986 vehicles. The average WTA value for large cars is also higher than that of small-to-medium cars.

In addition to this, the average WTA is lower than that obtained by Alberini *et al.* (1995), which reports an average WTA value equivalent to AUD 2,334 after adjusting for inflation and the exchange rate. This is reflected by the higher participation rates obtained. This is partly explained by the older vintage targeted in this study. The Alberini *et al.* (1995) analysis examines vehicles 12 years and older at the time of the research. This group of vehicles is likely to command higher WTA values than the older age groups examined in this study. Another reason for this may also be the existence of "waivered" vehicles in the Delaware program. These vehicles are targeted as high-polluters and are unlikely to pass the compulsory Inspection and Maintenance Program. The vehicles are waivered from inspection if the owners spend up to USD 75 on emissions repair (Alberini *et al*, 1995). The option of procuring a waiver thus reduces the incentive to participate in VAVR programs for owners of these vehicles.

TABLE 3.1 Predicted Rate of Participation in a VAVR Program

Offer AUD	1986 All sizes	1992 All sizes	1992 Large	1992 Small-to-medium
400	0.0028	0.0008	0.0005	0.0012
500	0.0095	0.0031	0.0022	0.0044
600	0.0227	0.0085	0.0062	0.0114
700	0.0438	0.0181	0.0137	0.0236
800	0.0728	0.0328	0.0254	0.0418
900	0.1091	0.0528	0.0419	0.0659
1,000	0.1512	0.0781	0.0631	0.0956
$\bar{x}\hat{a}$	7.4508	7.6545	7.7129	7.5960
WTA	AUD 1,721.19	AUD 2,110.02	AUD 2,237.11	AUD 1,990.16

The table highlights the decreasing cost-effectiveness of the VAVR program, as each additional participant requires a marginally higher offer. This makes the program extremely costly to implement for high participation rates. However, there exists a trade-off between a short-term high-participation program and a long-term lower-participation program. While the former involves large outlays at the start of the program, the latter is affected by decreasing cost-effectiveness over time, changing WTA and lower participation rates resulting from the guaranteed minimum purchase value for old vehicles in the future.

4.0 Conclusion

Overall, the simulation appears to produce some promising results. This is especially true in light of the favourable comparison between the results obtained in this study and those from the Delaware vehicle buy-back program, a program which is deemed to have been successful by the prevailing literature. The question remains whether a VAVR program is truly a viable option in WA, or even if the retirement of older vehicles should indeed be used as a means of improving air quality. It has already been seen that obtaining a high participation rate would make the VAVR program very costly to administer. With limited funds, the high opportunity cost of implementing a VAVR program leaves much to be desired. This high cost, however, may be justified by the possible benefits flowing from such a program. These include health benefits, reduced congestion and increased vehicle safety from fewer breakdowns, and the stimulation of car sales. In addition to this, the increased supply of recyclable scrap metal makes VAVR programs attractive to metal and steel producers, which may represent an avenue for funding. It should be noted that the inclusion of other measures such as mandatory emissions testing and public transport improvements would lower the WTA, which would in turn increase the participation rates and make the VAVR program less costly. Some combination of the above is therefore recommended to ensure the success of the program.

5.0 References

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