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# Exploring Behavioral Responses of Motorists to Risk-Based Charging Mechanisms

Stephen Greaves, Simon Fifer, and Richard Ellison

**This paper reports the behavioral response of motorists in Australia to a variable-rate charging scheme designed to encourage safer driving practices and reduce exposure to crash risk, specifically kilometers driven, nighttime driving, and speeding. The study involved a 5-week before period of Global Positioning System monitoring to establish how motorists drove normally, followed by a 5-week after period of Global Positioning System monitoring in which charges were levied and changes assessed. Incentives were paid to motorists for the difference in the charges between the two 5-week periods. Vehicle kilometers traveled (VKT) was reduced by 10%, although the sample was evenly split into motorists with increasing VKT and those with decreasing VKT. The proportion of distance speeding fell by 4.7%; this finding, when coupled with decreases in VKT, implied a net reduction of more than 40% in kilometers spent speeding. Three-fourths of the participants reduced their speeding. Exit interviews with a cross section of participants highlighted the practical difficulties of reducing kilometers but (more encouragingly) reinforced the potential to reduce speeding.**

Recent estimates suggest that motor vehicle accidents cost the Australian economy around $17 billion a year (*1*). Although both the number of crashes and the crash rates (crashes per kilometer) have been reduced dramatically in the past 30 years, recent statistics show that 1,463 persons were killed on Australian roads in 2008 (*2*). Of more concern, it appears that reductions may have stagnated in recent years, leaving policy makers searching for other options that might lead to significant drops in crash rates. Although engineering-based methods for both roadway infrastructure and vehicles as well as regulation and enforcement will continue to play a critical role in future road safety initiatives, an area of growing interest is the use of kilometer-based financial mechanisms to encourage safer driving practices (*3*). The notion here is that by linking what motorists are charged to both the kilometers they drive and the circumstances under which those kilometers are driven (e.g., nighttime driving, route choice, speeding), motorists will have the incentive to change behavior, and the overall risk and societal costs of accidents will be reduced (*4*).

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In 2009 an experiment was conducted in Sydney, Australia, that aimed to facilitate and detect changes in driving behavior following the imposition of a kilometer-based charging regime focused around safer driving practices (*5*). The charging regime was focused on reducing kilometers, nighttime driving, and speeding, which are acknowledged correlates with increased crash risk (*6*). The experiment encompassed a 10-week field study of 148 Sydney motorists whose driving patterns were monitored by using Global Positioning System (GPS) technology before and after the implementation of a charging regime. Motorists were financially rewarded for any net reductions in vehicle kilometers traveled (VKT), nighttime driving, and speeding in the after period relative to the before period. The main findings of the experiment are reported, with the focus on aggregate-level change in VKT, nighttime driving, and speeding. These quantitative measures of change are supplemented by the findings of exit interviews designed to determine more about the reasons behind the observed changes.

## LITERATURE REVIEW

Efforts to provide a financial incentive for safer on-road driving behavior are most visible through commercial pay-as-you-drive (PAYD) insurance options, in which premiums are differentiated according to kilometers driven and in some cases time, location, and speed (*3*). Technology has facilitated even more sophisticated offerings focused on how a vehicle is being driven, or pay-how-you-drive. For instance, the Co-operative Insurance Company has recently launched a product that offers premium reductions for young drivers based on their braking and acceleration, cornering, speeding, and time of driving (http://www.co-operativebank.co.uk). These behaviors are monitored via a smart box, which transmits the information to a server that computes adjustments to the premiums based accordingly. Although not widely available in Australia as yet, PAYD schemes are available in various forms in the United States, the United Kingdom, and the Netherlands, among other places (*4*). Commercial sensitivities preclude details of how rates are set and although some aggregate indicators of the outcomes of the programs are provided, rarely is information provided on the before-and-after changes in driving. One exception was a recent government-sponsored trial of PAYD insurance in Dallas–Fort Worth, Texas (*7*). Motorists were monitored for 12 months (divided into two 6-month periods) before and after the imposition of a distance-based scheme that rewarded them at US$25 for each 5% reduction in miles driven up to a cap of $350 ($175 per period).

Various academic studies have focused on exploring how variable-rate pricing regimes might affect motorist behavior, largely from the perspective of congestion mitigation (*8, 9*). The closest parallel to the current investigation was a hypothetical investigation of

the effects of various PAYD insurance schemes being proposed for young drivers in the Netherlands (*4*). The approach used was to set a base rate, which in this case was taken as the average insurance premium divided by the annual kilometers driven. The base rate was then adjusted upward by factors (derived from various sources) reflective of higher accident risk, including driving at night versus driving during the day and driving on urban roads versus motorways. The authors concluded that the most aggressive scheme, including obligatory time and road type differentiation, could reduce crashes by over 5%. No published evidence is currently available on how this program changed behavior in reality.

Other studies have looked at specific methods of using financial mechanisms to change behavior, primarily speeding. Mazureck and Van Hattern detail a study in the Netherlands in which motorists were paid to stay within the speed limit and maintain a safe following distance (*10*). Results indicated that speeding was reduced by around 20% based on a reward of €0.04 for every 15 s spent not speeding (€1 = $1.28 in 2006); notably, once the rewards were removed, drivers largely reverted to their original behavior. In a similar study, the Swedish Intelligent Economic Speed Adaptation study involved directly linking incentives to actual speeding behavior. Participants were paid a lump sum bonus, which was reduced by a certain charge for every minute participants drove above the speed limit within the study period (*11*).

## STUDY METHODS

Although full details of the methods discussed here are provided by Greaves et al. (*5*) and by Greaves and Fifer (*6*), the process is briefly described. Motorists were recruited to undertake a 12-week study of driving in Sydney involving both a GPS and online survey component for which they would receive a gift card worth AU$30 (AU$1 = $0.90 in 2009). There was no mention of the potential to make money through changes in driving at the recruitment phase because it might have influenced both the decision to participate and the driving behavior of those who did participate. The study, approved by University of Sydney ethics in 2009, encompassed five phases: a 5-week before period of GPS monitoring (GPS Before), establishment of the charging regime, a stated-choice survey completed at the end of the GPS Before phase (SC Before), a 5-week after period of GPS monitoring (GPS After), and a stated-choice survey completed at the end of the SC After phase (Figure 1). To cross-check the VKT coming from the GPS device, three odometer readings were also taken at installation, after the GPS Before phase, and at the completion of the GPS After phase. Motorists also completed a survey capturing facets of personality, risk aversion, and behavior before the GPS monitoring began (*12*). Finally, exit interviews were completed to gather participant reaction to the survey itself as well as provide further evidence on whether any observed changes in behavior were due to the charges or other factors.

**TABLE 1 Final Charging Rates Used in GPS After Phase (*6*)**

| Age Group | Daytime ($) | | Nighttime ($) | |
|---|---|---|---|---|
| | Nonspeeding | Speeding | Nonspeeding | Speeding |
| 17–30 | 0.20 | 0.60 | 0.80 | 2.40 |
| 31–65 | 0.15 | 0.45 | 0.60 | 1.20 |

The purpose of the 5-week before period of GPS monitoring was to establish a detailed profile of driving routines and patterns. A website was developed enabling participants to view their travel and add trip-specific information (e.g., who was driving, trip purpose) via a Google map–style interface developed by the project team. Concurrent with this period was the development of the charging regime (Table 1), which was based on scientific considerations (crash-cost and crash-risk analysis) as well as pragmatic ones (easily understandable, sufficient to encourage a change in behavior, within the project budget) (*6*). The information collected in the before period was combined with the charging regime to establish a starting budget for each motorist that reflected the combined effects of their kilometers driven, nighttime driving, and speeding. Motorists were then informed that they could make money on the basis of reductions in these measures relative to the before period. A further 5-week period of GPS monitoring (the GPS After phase) followed to detect any changes made; participants were notified daily through the website how they were faring against the budget. At the end of the trial, participants received a financial payment corresponding to the money they had left (participants going over the budget were not obliged to pay).

To give a sense of what these rates could mean in terms of potential payouts to participants and the project budget, a sensitivity analysis was conducted according to assumed changes in VKT, nighttime driving, and speeding over the 5-week after period (Table 2). The basis for these assumptions was evidence collected from various voluntary travel behavior change interventions conducted in Australia and in-depth interviews conducted with pilot participants for this project. These computations were based on the before-period driving of the 125 participants who qualified for the charging phase of the experiment. Starting budgets (charges incurred in the before period) ranged from $25 to $915, reflecting the heterogeneity of driving habits of motorists in the study. Under the various hypothesized behavioral changes, average incentives ranged from $21 for women 31 to 65 years of age to $119 for women 17 to 30 years of age, with a maximum project liability of just under $10,000.

## RECRUITMENT AND SAMPLE DETAILS

Participants were recruited through an online panel according to strict criteria that reflected the main aims of the study as well as practicalities about using the GPS equipment. In terms of the main

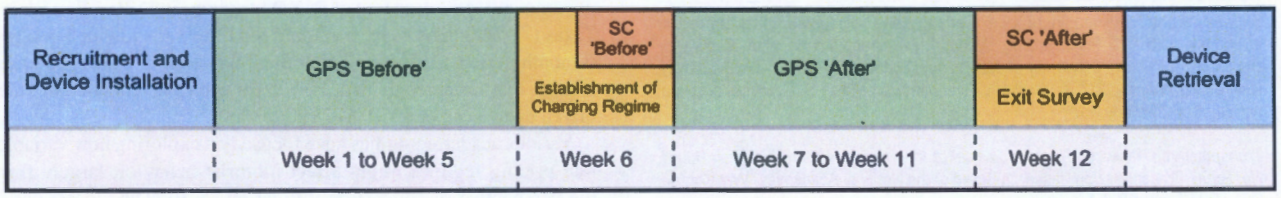


FIGURE 1 Study overview.

**TABLE 2 Behavioral Change Scenarios and Projected Incentives**

| Category | Starting Budget[a] | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 |
|---|---|---|---|---|---|
| Reduction (%) | | | | | |
| VKT | na | 5 | 8 | 12 | 15 |
| Night driving | na | 10 | 15 | 15 | 20 |
| Speeding | na | 15 | 25 | 35 | 45 |
| Males, age 17–30 | | | | | |
| Average ($) | 355 | 41 | 64 | 87 | 108 |
| Range ($) | 85–630 | 9–84 | 14–131 | 19–171 | 24–210 |
| Females, age 17–30 | | | | | |
| Average ($) | 405 | 45 | 71 | 96 | 119 |
| Range ($) | 105–815 | 6–111 | 9–175 | 13–234 | 17–290 |
| Males, age 31–65 | | | | | |
| Average ($) | 315 | 32 | 50 | 68 | 85 |
| Range ($) | 30–870 | 3–116 | 5–182 | 7–241 | 9–301 |
| Females, age 31–65 | | | | | |
| Average ($) | 233 | 21 | 33 | 45 | 56 |
| Range ($) | 25–915 | 1–56 | 2–87 | 3–116 | 4–145 |
| Projected incentive payout ($) | 35,950 | 3,708 | 5,831 | 7,895 | 9,855 |

NOTE: na = not applicable.
[a]Reflects combined effects of kilometers driven, nighttime driving, and speeding from the before period multiplied by the relevant rates in Table 1.

aims of the study, only participants with a valid license from one-car households were recruited, and they needed to be the primary driver and drive more than 2 days a week on average. In terms of practicalities, cars needed a working cigarette lighter that did not stay on when the engine was turned off and drain the battery (a problem for a small proportion of high-end vehicles in Australia) and were parked off-street at night. Unfortunately, the parking criterion was imposed following the pilot study when two devices were lost in the first week because they were in vehicles that were parked on the street and were stolen. (These were the only two devices out of 150 that were lost in the entire study.)

The original sample included 148 motorists, of which 119 were given the charging regime (the target group) and 29 were not (the control group). Of the 148 participants who started the experiment, 125 completed all phases with 116/119 (97%) of target participants and 9/29 (31%) of control participants complying, respectively. Twelve dropped out because of loss of interest or fatigue (all in the control group), whereas two target group participants and four control group participants had incomplete prompted-recall data for the comparison time periods. Intuitively, the opportunity to make money should have kept the target participants interested; unfortunately, some control participants lost interest and motivation as the study extended well past the original 12 weeks because of delays in recruitment and the time required for the stated-choice component of the work.

In terms of other issues, despite alerting screeners about the need for constant power from cigarette lighters, three participants were still lost from the study because of this problem. Another two participants dropped out stating computer issues, meaning that they could not access the website. Because of the higher-than-anticipated loss of sample, those participants with eligible before data were invited back for a further 5-week phase of charging (Phase 2), which ran from February 22, 2010, to March 28, 2010. This phase resulted in another 17 participants in the target sample giving a net total of 133 (116 + 17) for further consideration.

These 133 participants were then subjected to several data quality checks to verify to the maximum extent possible that the changes were genuine. This procedure resulted in the removal of 29 participants because of irreconcilable differences between the GPS-based VKT estimates and the odometer-based VKT readings (15 participants) and those taking extended holidays in the after period (14 participants). Two of those taking holidays were invited back, so a final usable sample of 106 participants was left for further analysis. Although this final number (particularly of young men) may seem low, it must be stressed that it is reflective of the number of vehicles included in the sample, not the number of drivers. The issue here is that 54/106 vehicles were in fact driven by more than one participant over the study period with a total pool of drivers of 181. Although this number captures the reality of what would happen if, say, a scheme of this nature were implemented, it is important to interpret results in this light.

The final sample breakdown was as follows:

- Original target sample + Phase 2 sample, 133;
- Extended holiday in before or after period, 14;
- Irreconcilable differences in VKT, 15;
- Final vehicle sample for before and after analysis, 106;
- Demographics of study participants:
  - Men, 17 to 30 years of age, 5;
  - Men, 31 to 45 years of age, 19;
  - Men, 46 to 65 years of age, 20;
  - Women, 17 to 30 years of age, 21;
  - Women, 31 to 45 years of age, 24; and
  - Women, 46 to 65 years of age, 17;
- Vehicles with multiple drivers, 54; and
- Total drivers in sample: 181.

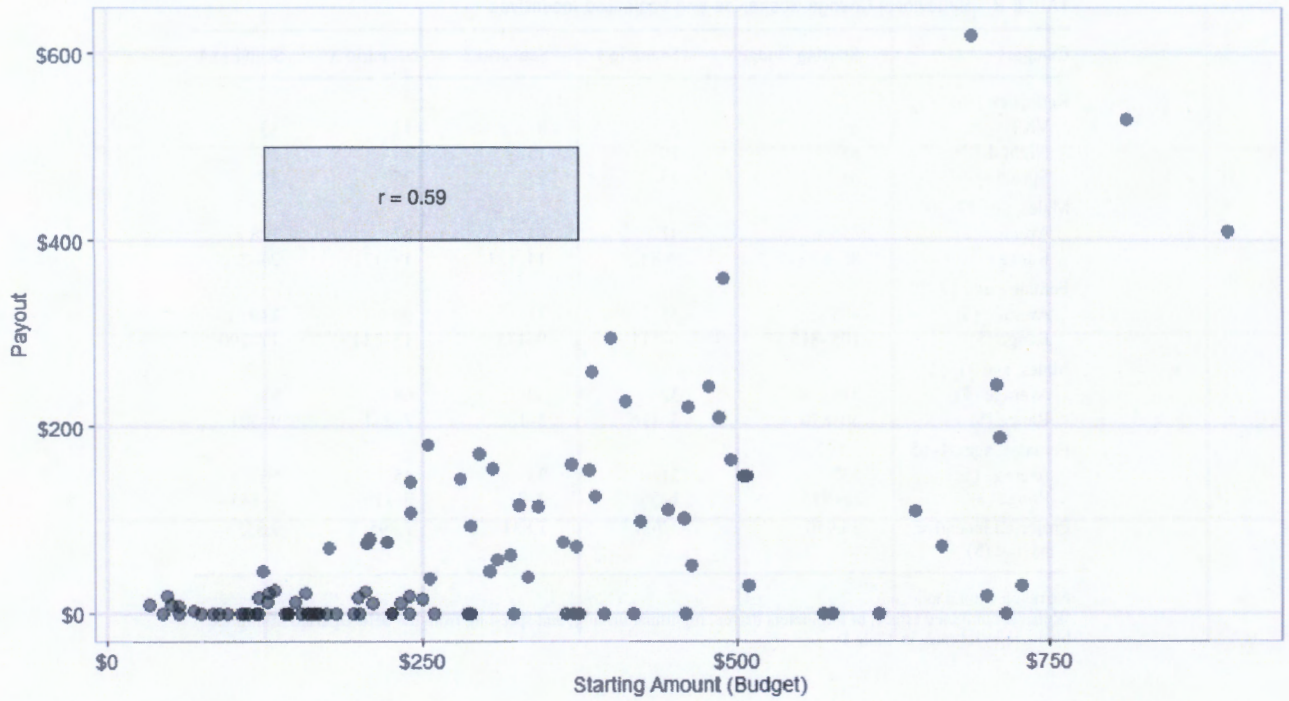


FIGURE 2 Comparison of starting amount and final payout by participant.

## RESULTS

### Aggregate Comparisons

Of the 106 participants and vehicles who qualified for the before-and-after comparison, 65 (61%) made money, and 41 (39%) did not and received no money (as stated earlier, they did not have to pay back the additional amount). For those making money, payouts ranged from $2 to $619 with an average payout of $116 (median payout was $77). A pertinent question is whether the amount of the starting budget had any influence on the propensity of change, since logic might suggest that someone would be more motivated by making several hundred dollars than a few dollars. When viewed overall, the answer appears to be yes, with those making money starting with an average budget of $350 compared with $240 for those not making money. However, the correlation between starting amount and final payout ($r = 0.59$) suggests that this use of averages may not be telling the full story. This suggestion is confirmed by Figure 2, which suggests considerable intraparticipant variability with some participants on very high starting amounts making little or no money. The implications here are that participants appear varied in both their capability and their willingness to make changes for financial rewards computed from their actual driving.

Table 3 provides the overall changes in key travel characteristics across the sampling period. The 95% confidence limit was constructed by using the approach advocated by Stopher and Greaves for assessing the significance of changes in behavior from panel data (*13*). VKT was reduced by 113.7 km or 3.2 km/day, an average reduction of 9.8%. However, the sample was evenly split by those who increased their VKT and those who decreased VKT.

TABLE 3 Overall Change in Travel Characteristics Between 5-Week Before and After Periods

| Sample Behavior | Before | After | Change | 95% Confidence Interval of the Change | Percent of Sample Reducing |
|---|---|---|---|---|---|
| Average VKT | 1,164.3 | 1,050.5 | –113.7 (–9.8%) ($p = .02$)[a] | –160.0 (–14%) to –84.8 (–6%) | 50 |
| Nighttime VKT | 120.5 (10.4%) | 121.7 (11.6%) | 1.2 (1.0%) ($p = .91$) | –10.0 (–8%) to 12.4 (10%) | 50 |
| Speeding VKT | 155.0 (13.3%) | 90.2 (8.6%) | –64.8 (–41.8%) ($p = .00$) | –76.9 (–50%) to –52.8 (–34%) | 75 |
| Trips | 142.2 | 129.8 | –12.4 (–8.7%) ($p = .00$) | –16.7 (–12%) to –8.1 (–6%) | 61 |
| Travel time (min) | 36:15:58 | 32:45:46 | –03:30:12 (–9.7%) ($p = .02$) | –04:57:31 (–14%) to –02:02:53 (–6%) | 47 |

NOTE: Number of sample participants = 106.
[a]Paired sample *t*-test.

**TABLE 4 Change in VKT by Trip Purpose**

| VKT Purpose | Before | After | Change | 95% Confidence Interval of the Change | Percent of Sample Reducing |
|---|---|---|---|---|---|
| Work and work related | 324.4 | 290.3 | −34.0 (−10.5%) ($p$ = .16) | −58.1 (−18%) to −10.0 (−3%) | 50[a] |
| Shopping and personal business | 214.5 | 216.7 | 2.2 (1%) ($p$ = .87) | −10.9 (−5%) to 15.3 (7%) | 54 |
| Social–recreational | 293.1 | 241.5 | −51.6 (−17.6%) ($p$ = .02) | −72.8 (−25%) to −30.3 (−10%) | 60 |

NOTE: Number of participants = 106.
[a]Twelve participants recorded no work VKT in either the before or after phases, so this computation was based on the 94 participants who did.

Nighttime kilometers increased marginally in the after period but the changes were not statistically significant ($p$ = 0.91), although half the sample reduced their nighttime VKT. The number of kilometers spent speeding decreased by 64.8 km (1.9 km/day) with three-fourths of the sample reducing their speeding. Overall the proportion of distance speeding fell by 4.7%, which, coupled with the decrease in VKT, meant that the proportion of kilometers spent speeding in the after period fell by 41.8%. The number of trips also fell, from 142.2 (4.1 trips/day) to 129.8 trips (3.7 trips/day), a reduction of 8.7%. Finally, the average time spent driving fell from around 62 min/day to 56 min/day, a drop of 9.7%.

### *VKT by Trip Purpose*

Analysis of the changes in VKT by trip purpose (Table 4) shows that for work and work-related trips, VKT was reduced by 10.5%, although this value was not significant at the 95% confidence level. Half the sample reduced their work VKT, similar to the pattern for overall VKT. Shopping and personal business VKT marginally increased (not significant), and social and recreational VKT decreased by 17.6% (significant at the 95% confidence level). The results suggest not surprisingly that, overall, participants had the most flexibility in reducing travel that might be considered more discretionary. Perhaps more surprising is the lack of flexibility for shopping and personal business; this finding suggests that, overall, participants were unwilling or unable to change these patterns.

### *Money Makers*

Analysis of the results for the 65 participants who made money shows, as expected, more marked changes in VKT and speeding as well as a substantial and statistically significant decrease in nighttime driving (Table 5). VKT decreased by around 26% with 82% of the sample reducing, and the distance spent speeding decreased by around 62%, with 92% reducing.

### *Not Money Makers*

Focusing on the 41 participants who did not make money, Table 6 shows that overall there was a 25% increase in VKT and all increased their VKT in the after period. Nighttime driving also increased substantially for this group. Speeding decreased marginally, although the change was statistically insignificant. Though almost half the sample reduced their speeding VKT, this finding suggests that perhaps simply being made aware that speeding was being monitored was in itself an important factor affecting behavior.

## Disaggregate Comparisons

Although the aggregate-level comparisons indicate overall change across the sample, evidently there is considerable heterogeneity within the sample. It is also not clear from the evidence thus far why people might or might not have changed behavior and to what extent this change was due to the financial mechanisms. In this section of the results a more disaggregate approach is taken toward changes in the key parameters—VKT, speeding, and nighttime driving—by considering both the numerical evidence and the qualitative evidence from the exit interviews.

### *Vehicle Kilometers Traveled*

Changes in VKT by participant are shown in Figure 3; by way of interpretation, those changes falling to the right of the line reduced VKT, and those to the left of the line increased VKT. The results reinforce the earlier findings that although there is an even split in terms of those who increased or decreased VKT, those decreasing VKT did so by a substantially larger amount. To focus on the largest reductions in VKT, the participant with the biggest net reduction—from 2,590 km in the before period to 294 km in the after period—clearly aroused the suspicion of the research team. Follow-up interviews revealed that the participant (who drove a considerable distance to work in

**TABLE 5 Overall Change in VKT, Nighttime Driving, and Speeding Between 5-Week Before and After Periods**

| Participant | Before | After | Change | 95% Confidence Interval of the Change | Percent of Sample Reducing |
|---|---|---|---|---|---|
| VKT | 1288.3 | 951.0 | −337 (−26.2%) ($p$ = .00) | −395.9 (−31%) to −278.5 (−22%) | 82 |
| Nighttime VKT | 148.1 (11.5%) | 110.3 (11.6%) | −37.8 (−25.5%) ($p$ = .00) | −47.7 (−32%) to −27.9 (−19%) | 66 |
| Speeding VKT | 168.7 (13.1%) | 64.4 (6.8%) | −104.3 (−61.8%) ($p$ = .00) | −121.1 (−72%) to −87.5 (−52%) | 92 |

NOTE: Number of participants = 65. Those who made money only.

TABLE 6 Overall Change in VKT, Nighttime Driving, and Speeding Between 5-Week Before and After Periods

| Participant | Before | After | Change | 95% Confidence Interval of the Change | Percent of Sample Reducing |
|---|---|---|---|---|---|
| Average VKT | 967.6 | 1208.2 | 241 (24.9%) ($p$ = .00) | 214.0 (22%) to 267.1 (28%) | 0 |
| Nighttime VKT | 76.9 (7.9%) | 139.9 (11.6%) | 63.0 (82.0%) ($p$ = .00) | 43.4 (56%) to 82.7 (108%) | 24 |
| Speeding VKT | 133.4 (13.8%) | 131.1 (10.9%) | −2.2 (−1.7%) ($p$ = .83) | −12.7 (−9%) to 8.2 (6%) | 46 |

NOTE: Number of participants = 41. Those who did not make money only.

western Sydney) had entered into an informal carpooling agreement with a neighbor in which they agreed to use the neighbor's car for the majority of the 5-week after period and split the difference. The participant with the second-largest reduction (2,520 km in the before period to 446 km in the after period) explained that this change was largely due to the fact that in the before period the car was shared with her daughter, who drove a lot for work. During the after period, the daughter purchased her own car and stopped driving the participant's car. Ideally, a second GPS device would have been installed in the daughter's car, but clearly this was not possible.

Responses in the exit interviews gave some sense of changes in personal circumstances that might have affected driving during the study period. Ten percent of participants indicated a major change in personal circumstances in the before period, 20% in the interim period, and 25% in the after period. Among the reasons provided were giving birth, being hospitalized for some reason, death or serious illness in the family, moving house, changing jobs, and someone else using the car more (or less). Whatever the precise reason, the issue is that even within a relatively short time period (3 months), a significant number of participants faced events that affected driving above and beyond the imposition of the charging regime.

To gain more insight on this issue, participants were also asked, "During the charging phase did you reduce (*a*) work-related driving, (*b*) social and recreational driving, and (*c*) shopping and personal business driving to earn a financial reward and to what extent would you reduce them if the reward was increased?" The results are shown in Figure 4.

In terms of work-related travel, more than 80% of participants said they did not reduce work-related driving because of the money; the graph suggests that the incentive needed to be substantially higher to see a meaningful change. This finding does not seem to support what was found in the observational data, where there was a substantial reduction in work-related VKT and a roughly 50:50 split in terms of those reducing. The results for social and recreational trips are more aligned with what was seen in the GPS data; this finding reinforced the notion that participants generally have more latitude and flexibility to change discretionary travel. The shopping and personal business graphs mirrored the social and recreational

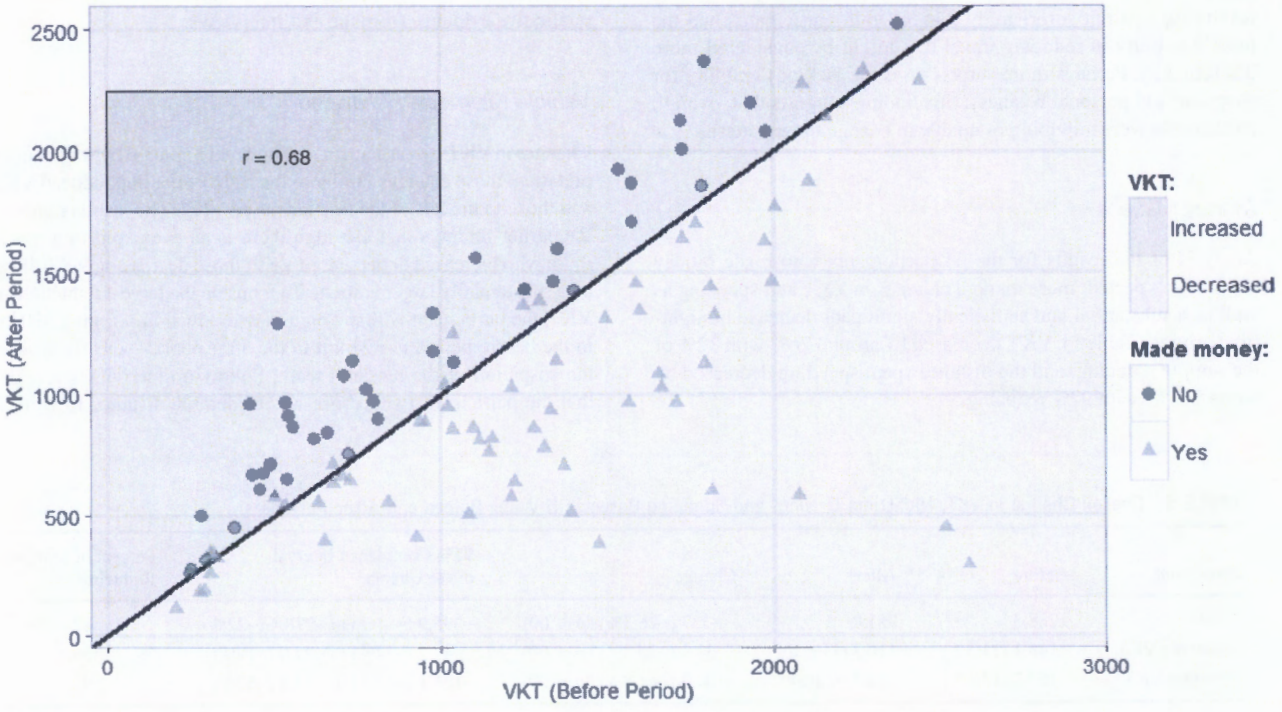


FIGURE 3 Changes in VKT in before and after periods.

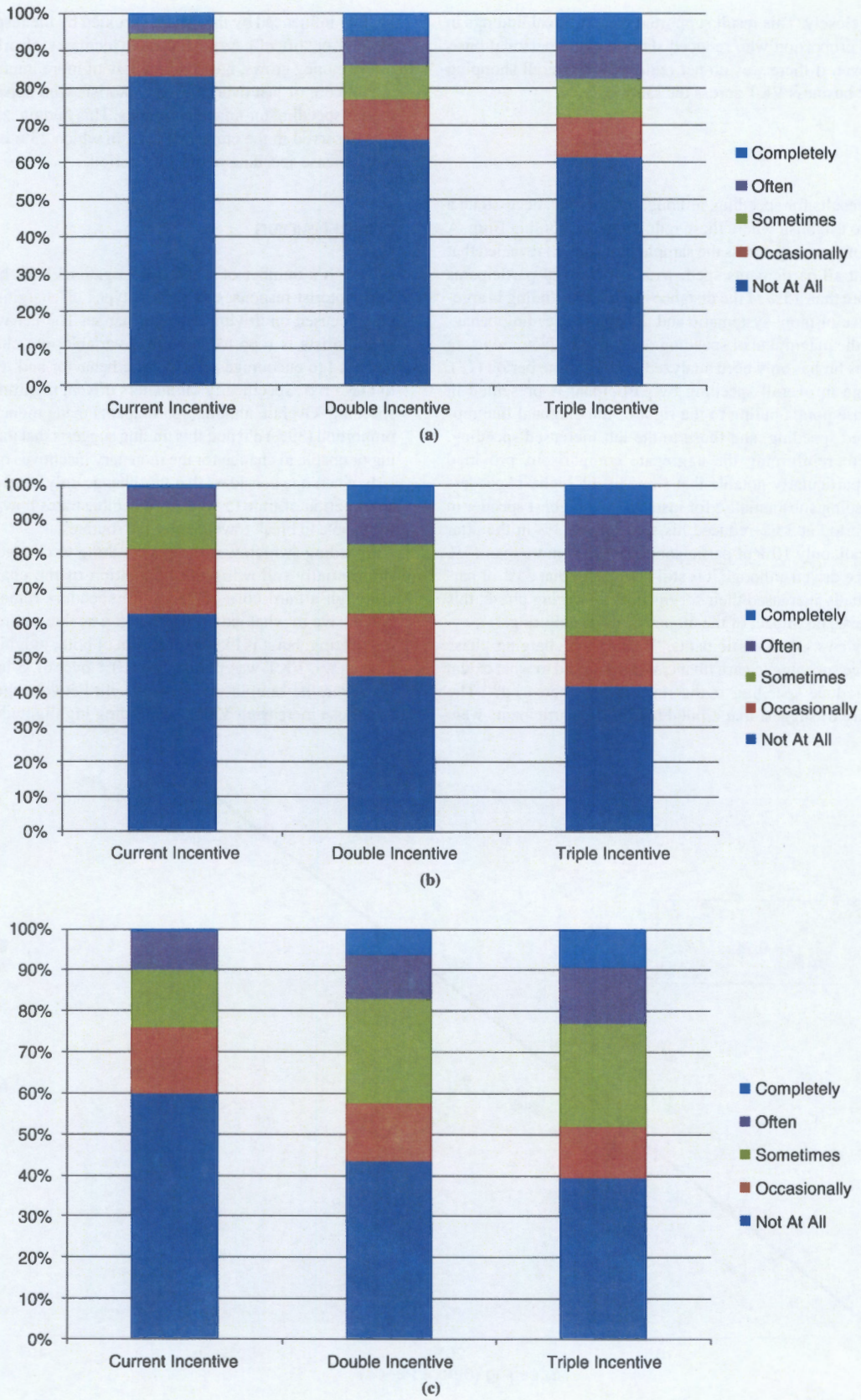


FIGURE 4 Exit interview responses to question about motivation for reduction in (*a*) work-related driving, (*b*) social and recreational driving, and (*c*) shopping and personal business driving.

trends more closely. This result supported the empirical findings in terms of the proportion who reduced shopping and personal business VKT, even if there was no net reduction in overall shopping and personal business VKT across the sample.

### *Speeding*

The overall results for speeding, although impressive, necessitate a closer look to establish where these reductions are coming from. A distribution of speeding across the sample (not shown) revealed that at some point all participants sped, with one-third of participants speeding more than 15% of the distance driven; this finding is arguably indicative of more systematic and deliberate speeding behavior. Clearly, the magnitude of speeding must also be factored in, an issue that thus far has only been analyzed for the before period (*12*).

The change in overall speeding by participant is presented in Figure 5; those points falling to the right of the diagonal line represent reduced speeding, and those to the left increased speeding. In addition to reinforcing the aggregate comparisons provided earlier, it is particularly notable that some of the highest speeders reduced speeding substantially; for instance, the highest speeder in the before period at 35% reduced his speeding to 3% in the after period. Overall, only 10% of participants now sped more than 15% of the distance driven although it is still of concern that 25% of participants actually increased their speeds in the charging phase; this finding suggests no impact of the money or the monitoring.

Exit interviews asked participants, "During the charging phase did you reduce speeding to earn financial rewards and to what extent would you reduce speeding if the reward was increased?" The results (Figure 6) suggest that around half of the participants were heavily influenced by the charge (proxied by the response of "completely" or "often"). As the incentive increases, clearly the influence of the money grows, but it is arguably of more interest that there is a hard core of just over 20% of motorists who apparently will not reduce speeding for financial reasons. This finding is similar to what was observed in the empirical data, in which 23% of motorists did not decrease speeding in the after period.

## CONCLUSIONS

Although a number of recent investigations have been conducted into motorist responses to various types of charging regimes, few have focused on driving behavior per se. The behavioral response of motorists is reported here to a variable-rate charging scheme designed to encourage safer driving behavior and reduce exposure to crash risk, specifically kilometers driven, nighttime driving, and speeding. Overall, although participants made money, a substantial proportion (39%) did not; this finding suggests that they were unwilling or unable to change for the monetary incentives offered. Particularly when one considers that this change only involved a relatively short period of time (5 weeks), it demonstrates how difficult it was for people to break travel habits and routines.

Speeding (which was the easiest thing to change) was reduced substantially following the imposition of the charging scheme, although a hard core of perennial speeders remained. It is not conclusive to what extent this result was due to the money or the monitoring, but it is likely a function of both, judging from the exit interviews. VKT was reduced by 10% overall, a large reduction. However, the sample was equally split between those decreasing and those increasing VKT; this finding highlighted the variability

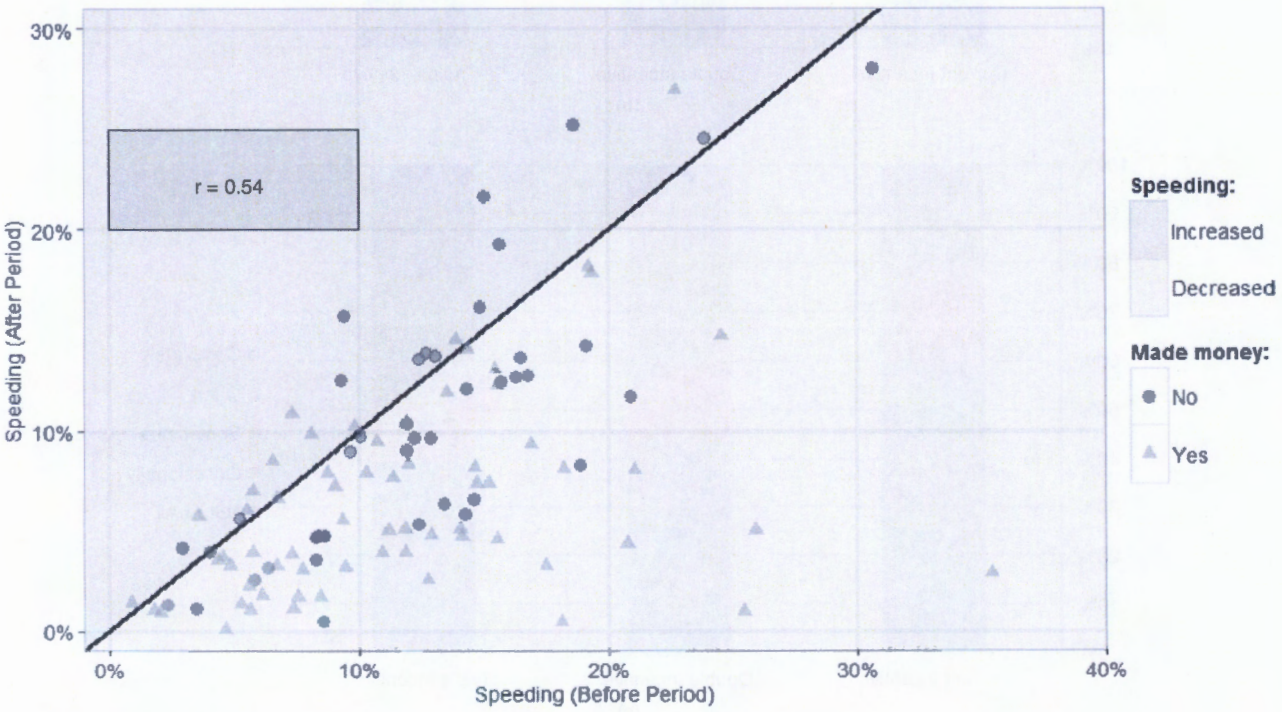


FIGURE 5 Changes in speeding in before and after periods.

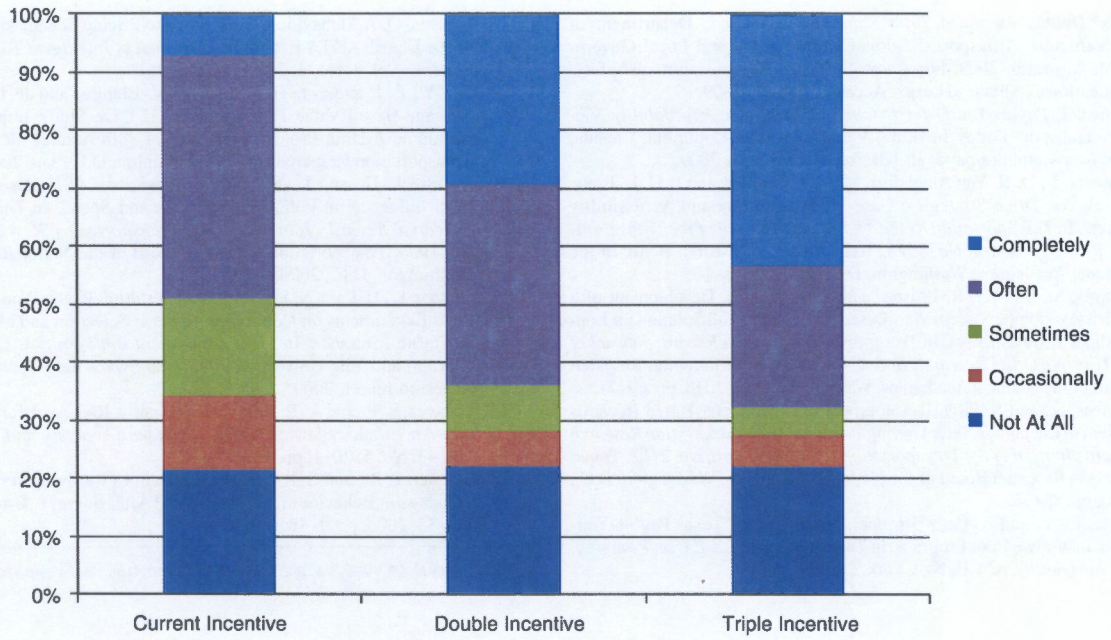


FIGURE 6 Exit interview responses to question about incentives.

in comparative driving measures and for many participants the difficulties involved in reducing car dependency, an assertion again corroborated by the exit interviews.

Clearly, as with any study of this nature, there are caveats relating to the sample (size, composition, representativeness, etc.), the technology, and how to definitively establish causality between the charging regime and intervention and observed behavioral change. To address these issues, the nature of the study (appealed to some and not to others), the fact that it was an opt-in study, and the available survey budget all had ramifications for the sample. It is also acknowledged that the study may have attracted more risk-averse drivers in general (on the basis of an average risk aversion score of 3.73 out of 5 for participants in which the higher score is for the more risk adverse). These points are true for all studies of this nature and as long as one is candid about how the results should be interpreted and used, this practice is accepted.

In the current effort, the purpose was to administer a sophisticated pilot study to identify if there was enough evidence of behavioral change to warrant further studies of this nature, and the authors argue that there is. In terms of the technology, the main issue with in-vehicle monitoring is to minimize or eliminate the potential for drivers to inadvertently or deliberately tamper with the setup. It is the authors' opinion that although perfect driver compliance may not be achievable, improvements can be made. For instance, a device with the same capability as the one used here has recently been developed that plugs into the onboard diagnostic port out of the sight of the driver. Other touted options include installing the device in the engine management system; in the current study, as well as being substantially more expensive, this option was prohibited under university ethics and is also not foolproof against tampering.

The issue of establishing causality between the fiscal intervention and behavior change is clearly imperative. In this study, it was attempted to incorporate both quantitative and qualitative evidence to establish this causality. The control group, despite suffering from a general loss of interest, did demonstrate the importance per se of the financial intervention in keeping people interested given that no one from the target group dropped out in the after period. The exit surveys were a useful addition to the study that enabled exploration of some of the "why" questions behind behavioral changes. Arguably, given the complex patterns of household driving, individual-level analysis is required to further understand the reasons for the nature of the changes within each household, something which is currently under way.

Despite the aforementioned limitations, this study serves as a useful pilot that should be used as a reference for future studies exploring issues of this nature. Furthermore, it has been demonstrated that it appears possible to significantly change aggregate behaviors (particularly speeding) of a segment of the motoring public through financial leverages based on rewarding better behavior. Such a notion is being taken up through the previously discussed Pay-How-You-Drive products being increasingly offered through the commercial insurance sector. Although undoubted challenges remain, GPS technology opens up the possibility for developing greater equity in charging systems that reflect not just the kilometers driven but when, where, and how they are driven.

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