

# The differential impact of CO<sub>2</sub> penalties, CO<sub>2</sub> incentives and information policies on consumer behaviour when purchasing a new motor vehicle

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## ***Abstract***

The main purpose of this experimental study was to determine the differential impact that a CO<sub>2</sub> penalty, a CO<sub>2</sub> incentive and information regarding the future fuel costs of a motor vehicle will have on South African consumers' behaviour when they choose new motor vehicles. The results of the experiment did not find any statistically significant proof that either a CO<sub>2</sub> penalty or a CO<sub>2</sub> incentive is likely to influence consumers to purchase more fuel-efficient motor vehicles. An information policy that provides consumers with the estimated future fuel costs of motor vehicles also has no meaningful influence. The combination of the information policy with either a CO<sub>2</sub> penalty or CO<sub>2</sub> incentive also has no meaningful influence. Finally, this study provides statistical evidence that the importance of the fuel economy of a motor vehicle and the consumer's attitude regarding the protection of the environment can both have a meaningful influence on a consumer's choice of motor vehicle.

**Key words:** CO<sub>2</sub> penalty, CO<sub>2</sub> incentive, consumer behaviour, future fuel costs, motor vehicle

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## 1. INTRODUCTION

*'If you think the economy is more important than the environment, try holding your breath while counting your money'* (McPherson, 2009).

South Africa is a carbon-intensive economy that generates the majority of its electricity with coal-fired power plants. A number of studies have been carried out to measure the effect of carbon taxes and emissions trading on the South African economy and the environment. Devarajan et al. (2009, p. 2) explored the potential impact of a carbon tax on South Africa's economy. Due to the complexity of South Africa's developing economy, Devarajan et al. (2011, p. 1) conducted a further study in 2011 using a disaggregated computable general equilibrium model of the South African economy to simulate a range of tax policies to reduce CO<sub>2</sub> emissions by 15%. Devarajan et al. (2011, p. 4) concluded that the welfare costs of a carbon tax in a developing country such as South Africa depend more on other distortions such as the labour market than on South Africa's own carbon emissions.

A study evaluating the socioeconomic consequences of introducing carbon taxes in South Africa found that, ignoring all benefits, the tax will reduce national welfare (Alton et al., 2014, pp. 351-352). Despite this, South Africa enacted its Carbon Tax Act on 1 June 2019 which will assist the country in meeting its commitments to reduce carbon emissions.

Apart from a carbon tax, many countries levy a CO<sub>2</sub> emissions tax on motor vehicles as a measure to reduce the CO<sub>2</sub> emissions of new motor vehicles sold. Alternatively, some countries have recently commenced using rebates or incentives to promote the sale of low-emission motor vehicles (Verboven, 2014, p. 389). A combination of a CO<sub>2</sub> penalty and a CO<sub>2</sub> incentive, referred to as a feebate policy, is also used to promote the sales of low emission vehicles (Verboven, 2014, p. 390). The feebate policy introduced in France in 2008 resulted in a substantial shift towards the sale of low CO<sub>2</sub> emission motor vehicles (D'Haultfoeuille, Givord & Boutin, 2014, p. 473).

The impact of CO<sub>2</sub> emissions tax on consumer behaviour when a new motor vehicle is purchased has been widely researched in many of the major economies of the world. Klein (2014, p. 38) argues that a CO<sub>2</sub> emissions tax is a very important measure to reduce the CO<sub>2</sub> intensity of a country's motor vehicle fleet. Gerlagh et al. (2018, p. 115) confirmed that an acquisition tax, such as a CO<sub>2</sub> emission tax, has in fact solicited the purchase of new vehicles that emit lower CO<sub>2</sub> emissions. The majority of research on CO<sub>2</sub> emissions tax, CO<sub>2</sub> incentives and feebate policies found that these interventions were effective in promoting the sale of low CO<sub>2</sub> emission motor vehicles.

Even though CO<sub>2</sub> emissions on motor vehicles are not the largest contributor of the greenhouse gas emissions in South Africa, emissions tax is one of the policies used with the aim of reducing greenhouse gas emissions. In September 2010, South Africa joined the effort to reduce CO<sub>2</sub> emissions on new motor vehicles sold by introducing a CO<sub>2</sub> tax (hereinafter referred to as a CO<sub>2</sub> levy). According to the South African Revenue Service (SARS), the objective of the CO<sub>2</sub> levy 'is to influence the composition of South Africa's vehicle fleet to become more energy efficient and environmentally friendly'.<sup>1</sup> South

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<sup>1</sup> See SARS, 'Motor vehicle CO<sub>2</sub> emissions', <https://www.sars.gov.za/ClientSegments/Customs-Excise/Excise/Environmental-Levy-Products/Pages/Motor%20vehicle%20CO2%20emission.aspx> (accessed 19 July 2015).

Africa has not introduced CO<sub>2</sub> incentives for the purchase of new motor vehicles emitting lower CO<sub>2</sub> emissions.

The purpose of this study was, first, to measure whether a consumer's choice of motor vehicle in South Africa is more likely to be influenced by a CO<sub>2</sub> incentive or by a CO<sub>2</sub> levy and, second, to measure the impact of an information policy by focusing on the level of transparency that exists regarding future fuel costs when a motor vehicle is chosen, and how this affected the prospective buyers' behaviour. Finally, the effect of a CO<sub>2</sub> incentive or a CO<sub>2</sub> penalty combined with an information policy on consumer behaviour was measured. The purpose of this study leads to the formulation of the following two research objectives that guided this study:

- to determine the differential impact of a CO<sub>2</sub> penalty or a CO<sub>2</sub> incentive on consumers' behaviour in South Africa when a new motor vehicle is chosen.
- to determine the differential impact of an information policy manipulating the transparency in respect of future fuel costs on South African consumers' behaviour when a new motor vehicle is chosen.

To meet these research objectives, this behaviour study has an experimental design.<sup>2</sup> CO<sub>2</sub> incentives, CO<sub>2</sub> levies and information policies were manipulated as treatment conditions and gave rise to six experiments to determine the respective differential impact on consumers' behaviour when purchasing a new motor vehicle. A quantitative research methodology was applied to design this experiment.

Section 2 presents the literature review that formed the basis for four theoretical frameworks which were used to formulate six hypotheses. Section 3 describes the design of the experiment to test the six hypotheses. A brief discussion of the research methodology and the assumptions and limitations used is followed by the data analysis and results of the experiment in section 4. The conclusion and recommendations for future research are discussed in section 5.

## 2. RELATED PRIOR LITERATURE AND DEVELOPMENT OF HYPOTHESES

Research analysing the effectiveness of the South African CO<sub>2</sub> levy concluded that there is no clear evidence that the introduction of the CO<sub>2</sub> levy has led to consumers purchasing motor vehicles emitting lower CO<sub>2</sub> emissions (Barnard, 2014, p. 54; Ackerman, 2014, p. 91; Nienaber & Barnard, 2018, p. 151). In fact, the sale of certain high-emission vehicles continued to rise after September 2010 and outperformed the sales of vehicles with lower emissions (Carrim, 2014, p. 58). The study by Barnard (2014, p. 54) concluded that consumers were not even aware of the CO<sub>2</sub> levy or of the CO<sub>2</sub> emissions emitted by their new motor vehicles and that the introduction of the CO<sub>2</sub> levy in South Africa did not change or influence the behaviour of consumers who purchase new motor vehicles. The findings of these studies indicate that the current CO<sub>2</sub> levy is not meeting its objective of rendering South Africa's vehicle fleet more efficient and environmentally friendly. It is possible that the current CO<sub>2</sub> levy is too low in

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<sup>2</sup> This study is a laboratory-designed experiment that exposes participants to a contrived (artificial) environment where they need to choose a motor vehicle (Model A or Model B). Due to the study being a laboratory-designed experiment, it is regarded as a quantitative study. The experiment is further a causal study that measured whether the CO<sub>2</sub> penalty or CO<sub>2</sub> incentive had an effect on the choice of motor vehicle, i.e. how many participants chose Model A and how many participants chose Model B.

relation to the cost of the new motor vehicles purchased by consumers to have a material impact on the total price. South Africa should also consider whether a CO<sub>2</sub> incentive would be more effective than a CO<sub>2</sub> levy in changing consumers' behaviour when choosing a new motor vehicle. In particular, countries such as Sweden and the Netherlands have successfully used rebates (incentives) to reduce the purchase price and promote the ownership of low-emission vehicles (Huse & Lucinda, 2014, p. F417; Peters et al., 2008, p. 1355). To date, no studies have been conducted in South Africa to determine whether a CO<sub>2</sub> incentive is more likely to change consumers' choice of motor vehicle than a CO<sub>2</sub> levy.

A CO<sub>2</sub> incentive received can be regarded as a gain and CO<sub>2</sub> penalty or levy paid can be regarded as a loss. Nosenzo et al. (2014, p. 636) studied the effect of bonuses (gains) versus fines (losses) in inspection games and found that bonuses are less effective in encouraging compliance. The effectiveness of fines can be explained by loss aversion, as individuals want to avoid the emotion of loss. If these findings by Nosenzo et al. are also true for CO<sub>2</sub> penalties and CO<sub>2</sub> incentives, it is expected that a CO<sub>2</sub> penalty (loss) will have a stronger effect on consumers' behaviour than a CO<sub>2</sub> incentive (gain).

The prospect theory explains that people are loss averse and that losses appear larger than gains (Kahneman, 2011, p. 284). Loss aversion is based on the concept that the fear of losing, for example, ZAR 1,000 is more intense than the hope of gaining ZAR 1,000. The loss aversion ratio has been estimated in several experiments to be in the range of 1.5 to 2.5 (Kahneman, 2011, p. 284). Based on this loss aversion ratio, a loss of ZAR 1,000 would be balanced out by a gain of ZAR 1,500 to 2,500. It is therefore expected that consumers will be loss averse and would want to avoid paying a CO<sub>2</sub> levy. The literature review on CO<sub>2</sub> levies, CO<sub>2</sub> incentives and the prospect theory were used to develop the first theoretical framework:

Theoretical framework 1: The dependent variable, i.e. the consumer's choice of motor vehicle, is influenced by the following independent variable: whether a CO<sub>2</sub> penalty is imposed or a CO<sub>2</sub> incentive granted.

The literature review indicated that a CO<sub>2</sub> incentive and a CO<sub>2</sub> penalty both have the potential to change consumer behaviour when choosing a new motor vehicle (Huse & Lucinda, 2014, p. F417, Gerlagh et al., 2018, p. 122). Consumers are expected to be drawn towards motor vehicles for which a CO<sub>2</sub> incentive is granted because they will feel that they are being rewarded for their decisions. Consumers are also expected to avoid purchasing motor vehicles that are subject to a CO<sub>2</sub> penalty as they want to avoid the emotion of loss and being punished for their decisions. However, the expectation is that a CO<sub>2</sub> penalty will have a stronger influence on consumer behaviour than a CO<sub>2</sub> incentive. The following three directional hypotheses were derived from theoretical framework 1:

*H1: The granting of a CO<sub>2</sub> incentive will influence a consumer to choose a more fuel-efficient new motor vehicle.*

*H2: Charging a CO<sub>2</sub> penalty will influence a consumer to choose a more fuel-efficient new motor vehicle.*

*H3: Charging a CO<sub>2</sub> penalty will have a stronger influence than a CO<sub>2</sub> incentive on a consumer's decision to choose a more fuel-efficient new motor vehicle.*

Another reason why the CO<sub>2</sub> levy is not effective in changing South African consumers' behaviour is the information considered by the consumer. Gerlagh et al. (2018, p. 122) suggest that consumers suffer from near-sightedness when they purchase new motor vehicles and tend to underestimate or ignore the future costs of driving those vehicles. Gerlagh et al. (2018, p. 123) maintain that the adoption of a subtle fiscal policy that prompts consumers to consider information detailing the future cost of driving a particular motor vehicle can be successful in reducing their near-sightedness. Limited research has been conducted to determine the extent to which South African consumers' behaviour is influenced by an information policy that prompts them to consider the future fuel costs of the motor vehicles they wish to purchase. The question regarding the possible effect of such a policy still has to be answered. In addition, the question on whether an information policy will increase the effectiveness of either a CO<sub>2</sub> penalty or a CO<sub>2</sub> incentive in changing consumer behaviour when choosing a new motor vehicle must be answered.

As discussed, Gerlagh et al. (2018, p. 122) considered near-sightedness as one of the main reasons why a CO<sub>2</sub> levy is more effective than future usage taxes and fuel costs in influencing consumers' behaviour. It is also possible that consumers give little weight to the actual future fuel costs because of limited information or the complexity of the available information which requires the consumers to do further calculations (Greene, 2010, p. 608). Rational decision making of consumers is often replaced by bounded rationality which is generally accepted to apply when a consumer purchases a motor vehicle (Coad, de Haan & Woersdorfer 2009, p. 2079). Bounded rationality suggests that consumers' rational behaviour is compromised by time limitations, the type of information available and their cognitive abilities (Greene, 2010, p. 608).

Barnard (2014, p. 54) found that South African consumers are neither aware of the CO<sub>2</sub> tax currently levied, nor of the CO<sub>2</sub> emissions emitted by their new motor vehicles. Gerlagh et al. (2018, p. 106) argue that the effectiveness of car taxes can depend on the adoption of subtle policy features. If subtle information policies require consumers to consider certain information before the final purchase decision is made, such as comparing the future fuel costs of the different engine capacity of the preferred motor vehicle model, they might change their behaviour when choosing a model. This change in consumer behaviour could then be ascribed to the subtle information policy that reduced the bounded rationality of consumers, as the policy enables them to make a fair assessment of all the relevant information and make a more rational decision. The mentioned studies on consumer near-sightedness, bounded rationality and information policies were used to develop the second theoretical framework for this study:

Theoretical framework 2: The dependent variable, i.e. the consumers' behaviour when choosing a new motor vehicle, will be affected by the independent variable, which is the provision of an information policy that provides a high level of transparency regarding the future fuel cost of driving a particular motor vehicle.

It is expected that the provision of information regarding the future fuel cost of driving a motor vehicle will influence the behaviour of near-sighted consumers and those that suffer from bounded rationality when choosing a new motor vehicle. The second theoretical framework was used to formulate the fourth hypothesis, which is directional in nature:

*H4: An information policy that provides a high level of transparency regarding the future fuel cost of driving a particular motor vehicle will influence a consumer to choose a more fuel-efficient new motor vehicle.*

According to Stern (1999, p. 461), when information policies and financial incentives (such as a CO<sub>2</sub> incentive) are combined, the effect on consumer behaviour may be stronger than when each policy is applied in isolation. It is therefore expected that the combination of these two policies will have a stronger effect on consumer behaviour than when each policy is applied on its own.

When H1 and H4 are tested together, the effect of providing information about future fuel costs in terms of an information policy will be tested in conjunction with the effect of a financial policy that offers a CO<sub>2</sub> incentive (the 'carrot'). Based on Stern's (1999, p. 461) findings, it is expected that when consumers are provided with more information regarding the future fuel costs of driving a motor vehicle, the CO<sub>2</sub> incentive and the information policy will have a synergistic effect on consumer behaviour and that consumers will show a stronger preference for fuel-efficient motor vehicles. As a result, a third theoretical framework is derived from testing H1 and H4 in combination:

Theoretical framework 3: Consumers' behaviour when choosing a new motor vehicle (dependent variable) is impacted by two independent variables: a financial policy (a CO<sub>2</sub> incentive) and an information policy (more information on the future fuel costs of driving a motor vehicle).

The fifth hypothesis is a directional hypothesis as the third theoretical framework supports a positive relationship between the two independent variables, being an information policy and a financial policy (a CO<sub>2</sub> incentive), and the dependent variable, being consumers' behaviour when choosing a new motor vehicle. The fifth hypothesis is as follows:

*H5: The combination of a CO<sub>2</sub> incentive with an information policy (a high level of transparency regarding the future fuel costs of driving the motor vehicle) is more likely to result in an increase in the consumer's preference for a fuel-efficient new motor vehicle than would a CO<sub>2</sub> incentive without an information policy (a low level of transparency regarding future fuel costs).*

When H2 and H4 are tested in combination, the effect of providing information on the future fuel costs by way of an information policy, will be tested in conjunction with a financial policy that charges a CO<sub>2</sub> penalty (the 'stick'). Stern (1999, p.461) did not attempt to determine whether the combination of an information policy with a financial policy that charges a penalty will also have a synergistic effect on consumer behaviour. As argued above, due to bounded rationality, consumers might not take the time to carefully consider all the available information on the motor vehicle they plan to purchase, which could include estimating the future fuel costs. Greene (2010, p. 613) suggests that the provision of accurate additional information about the actual future fuel savings that consumers are likely to realise can increase the importance of those future fuel savings in the case of consumers who are loss averse. In addition, the loss aversion theory normally makes the CO<sub>2</sub> penalty appear larger than it actually is. If the consumers are given more information regarding the actual total cost of a motor vehicle, including the future fuel costs, the CO<sub>2</sub> penalty will be seen in perspective with the other costs of the vehicle, which will reduce the loss aversion ratio applied to the CO<sub>2</sub> penalty. As a result, the CO<sub>2</sub> penalty will no longer appear to be larger than it really is and should

become less effective. These studies on loss aversion, consumer near-sightedness and bounded rationality are now used to develop the fourth theoretical framework for this study, which is derived from testing H2 and H4 in combination:

Theoretical framework 4: Consumers' behaviour when choosing a new motor vehicle (dependent variable) is impacted by two independent variables: financial policies (a CO<sub>2</sub> penalty) and information policies (more information regarding the future fuel costs of driving a particular motor vehicle).

The sixth hypothesis is a directional hypothesis as the fourth theoretical framework supports an inverse relationship between the two independent variables, being an information policy and a financial policy, and the dependent variable, being consumers' behaviour when choosing a new motor vehicle. The sixth hypothesis is as follows:

*H6: The combination of a CO<sub>2</sub> penalty and an information policy (a high level of transparency regarding the future fuel costs of driving the motor vehicle) is more likely to result in a decrease in consumer preference for a fuel-efficient new motor vehicle than a CO<sub>2</sub> penalty without an information policy (a low level of transparency regarding future fuel costs).*

The six hypotheses formulated above were tested by means of an experiment that will be discussed in section 3.

### 3. RESEARCH METHODOLOGY

To test the six hypotheses, an experiment was designed with a basic scenario that required participants to choose between two motor vehicles of the same make, namely Model A and Model B. This basic scenario of choosing between Model A and Model B was also employed in an experiment conducted by Morrow and Rupert (2015, pp. 47-54) in the United States. The experiment of Morrow and Rupert measured the effect of the conformity of federal tax incentives and state tax incentives on the decision of a consumer when choosing between a traditional or hybrid motor vehicle.

The six hypotheses were used to design treatment conditions which are summarised in Table 1. The treatment conditions include either a CO<sub>2</sub> penalty or a CO<sub>2</sub> incentive and either a higher or a lower level of transparency regarding the future fuel costs of the two motor vehicles. These two options for each of the two research objectives led to a 'two-by-two' experimental design, which resulted in the creation of four different treatment groups to test the two research objectives. An additional treatment group and a control group then increased the treatment groups from four to six as set out in Table 1 below.

**Table 1: Treatment Conditions and Treatment Groups**

Treatment conditions		H1, H2 and H3		
		CO <sub>2</sub> incentive is granted	CO <sub>2</sub> penalty is imposed	No CO <sub>2</sub> penalty and no CO <sub>2</sub> incentive
H4, H5, H6	A low level of transparency regarding future fuel costs	Treatment Group 1	Treatment Group 2	Treatment Group 3 (control group)
	A high level of transparency regarding future fuel costs	Treatment Group 4	Treatment Group 5	Treatment Group 6

### 3.1 Independent variables

The six treatment groups gave rise to six experiments. The treatment conditions in each treatment group were the independent variables of each experiment and are summarised in Table 2 below.

**Table 2: The Six Experiments**

Experiment	Treatment group	Independent variables
Experiment 1	Treatment Group 1	CO <sub>2</sub> incentive Low level of transparency regarding future fuel costs
Experiment 2	Treatment Group 2	CO <sub>2</sub> penalty Low level of transparency regarding future fuel costs
Experiment 3	Treatment Group 3 (control group)	No CO <sub>2</sub> incentive and no CO <sub>2</sub> penalty Low level of transparency regarding future fuel costs
Experiment 4	Treatment Group 4	CO <sub>2</sub> incentive High level of transparency regarding future fuel costs
Experiment 5	Treatment Group 5	CO <sub>2</sub> penalty High level of transparency regarding future fuel costs
Experiment 6	Treatment Group 6	No CO <sub>2</sub> incentive and no CO <sub>2</sub> penalty High level of transparency regarding future fuel costs

### 3.2 Basic scenario

Participants were randomly allocated to participate in only one of the six experiments. Participants in all six experiments were presented with the basic scenario of purchasing a new motor vehicle. They were informed that they had already decided to purchase a new motor vehicle and had also decided on the make and model of the new motor vehicle they wanted to purchase. The only decision that remained was to choose between two engine versions of this motor vehicle, being Model A and Model B. Lane and Potter (2007, p. 1085) argued that fuel consumption provides a useful marketing tool for promoting low-emission motor vehicles and is a more effective marketing tool than a motor vehicle's 'green' credentials. The study conducted by Coad et al. (2009, p. 2079) found that consumers did not fully understand the meaning of the energy label or 'green' credentials, which suggests that consumers are not well informed about environmental issues. Based on the findings of the two studies, the participants were not provided with information on either the CO<sub>2</sub> emissions of these two models, or their 'green' credentials. The only information given to the participants related to the fuel consumption of the two models.

The basic scenario was designed to ensure that all the characteristics of the two motor vehicles, such as power, style and handling, reliability, safety, insurance premiums, financing options and motor plans were identical. The participants were informed that they would drive 20,000 kilometres per year for five years and that the two models would be equal in value at the end of five years. Model A had a fuel consumption of 6.5 litres per 100 kilometres and the fuel consumption of Model B was 4.7 litres per 100 kilometres. The total cost of the two models was made up of the purchase price, the CO<sub>2</sub> penalty or CO<sub>2</sub> incentive and the future fuel costs for a period of five years. The total costs of Model A and Model B were designed to be exactly the same. It could therefore be expected that the choice of model would not depend on total costs, but rather on how the total costs were made up.

For purposes of calculating the CO<sub>2</sub> penalty and CO<sub>2</sub> incentive, it was assumed that Model A emits 157 grams of CO<sub>2</sub> per kilometre and Model B emits 119 grams of CO<sub>2</sub> per kilometre. Based on the legislation on CO<sub>2</sub> levies imposed on motor vehicles in South Africa applicable at the time of the study, the CO<sub>2</sub> levy that was payable on Model A, amounted to ZAR 3,700 (at time of writing, increased to ZAR 4,070 which is still approximately 1% of the value of the Model A vehicle as referred to below: South African Revenue Service, 2019). Since Model B's CO<sub>2</sub> emissions were below the approved emissions level of 120 grams per kilometre, it was not subject to a CO<sub>2</sub> levy.<sup>3</sup> Carrim (2014, p. 58), Barnard (2014, p. 54) and Ackerman (2014, p. 91) found that the then CO<sub>2</sub> levy in South Africa had not changed consumer behaviour, and it can be argued that the reason for this is that levy is too low to make an impact. In this experiment, the CO<sub>2</sub> penalty was therefore increased from ZAR 3,700 to ZAR 10,500, which meant that the CO<sub>2</sub> penalty or CO<sub>2</sub> incentive used in the experiment represented approximately 3% instead of approximately 1% of the purchase price of the motor vehicle. The CO<sub>2</sub> penalty and CO<sub>2</sub> incentive used in the six different experiments were both set at ZAR 10,500. Even though the theory of loss aversion argues that a loss of ZAR 10,500 is more painful than a gain of ZAR 10,500 is favourable, the penalty and incentive were both tested at ZAR 10,500 to ensure that any differences in the responses to the penalty and incentive would not be influenced by the difference between the amounts.

The basic scenario for Experiments 1, 2 and 3, presented a lower level of transparency regarding the future fuel costs of Model A and Model B. The participants were provided with the average fuel consumption per 100 kilometres for both models and the total kilometres that would be travelled each year for a period of five years. The participants were also given the projected cost of fuel per litre for the next five years to enable them to calculate the future fuel costs per model.

- In Experiment 1, the participants were informed that although Model B cost more than Model A, it was more fuel efficient and therefore qualified for a CO<sub>2</sub> incentive or discount of ZAR 10,500 for which Model A did not qualify. The total cost of each of the two models, including the purchase price, the CO<sub>2</sub> incentive and the correctly calculated future fuel cost, was exactly the same and amounted to ZAR 350,497.
- In Experiment 2, the participants were informed that only Model A, which cost less and was less fuel efficient than Model B, was subject to a CO<sub>2</sub> penalty of ZAR 10,500. The total cost of each of the two models included the purchase price, the CO<sub>2</sub> penalty and the correctly calculated future fuel cost, and was exactly the same at ZAR 350,497.
- In Experiment 3, the two models were subject to neither a CO<sub>2</sub> incentive nor a CO<sub>2</sub> penalty. The total cost of each model included only the purchase price and the correctly calculated future fuel cost and amounted to ZAR 350,497. Once again, the costs of Model A and Model B were exactly the same.

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<sup>3</sup> See SARS, 'Environmental Levy on Carbon Dioxide (CO<sub>2</sub>) Emissions Of Motor Vehicles', <http://www.sars.gov.za/Legal/Primary-Legislation/Pages/Schedules-to-the-Customs-and-Excise-Act.aspx> (accessed on 11 August 2016).

The basic scenario for Experiments 4, 5 and 6 presented a higher level of transparency regarding the future fuel costs of Model A and Model B. The participants were again provided with the average fuel consumption of both models per 100 kilometres and the total distance in kilometres travelled each year. Instead of providing participants with the fuel cost per litre for the next five years as had been done in Experiments 1, 2 and 3, the participants were given the estimated future fuel costs for five years for both models and were advised that the estimated future fuel costs were based on the assumption that a distance of 100,000 kilometres would be travelled in the next five years and that the costs had been calculated correctly.

- In Experiment 4, as in Experiment 1, the participants were informed that Model B, which was more expensive but also more fuel efficient than Model A, qualified for a CO<sub>2</sub> incentive of ZAR 10,500, for which Model A did not qualify. The total cost of each model, which included the purchase price, the CO<sub>2</sub> incentive and the future fuel cost, amounted to ZAR 350,497. The participants were also provided with an additional table summarising the total cost of each of the two models. The purpose of this additional table was to highlight each cost element and the fact that the total cost for each of the two models was exactly the same.
- In Experiment 5, which was similar to Experiment 2, the participants were informed that only Model A, which cost less but was less fuel efficient than Model B, was subject to a CO<sub>2</sub> penalty of ZAR 10,500. The total cost of each model, which included the purchase price, the CO<sub>2</sub> penalty and the future fuel cost, amounted to ZAR 350,497. The participants were again given an additional table summarising the total cost of each of the two models with the purpose of highlighting each cost element and the fact that the total cost of each of the two models was exactly the same.
- In Experiment 6, as in Experiment 3, the two models were not subject to either a CO<sub>2</sub> incentive or a CO<sub>2</sub> penalty. The total cost of each model included only the purchase price and the future fuel cost and amounted to ZAR 350,497. The participants were again given an additional table containing summaries of the total cost of each car in order to highlight each cost element and the fact that vehicles cost exactly the same.

As stated above, the participants in Experiments 1, 2 and 3 were given the total number of kilometres driven over a period of five years, the average fuel consumption and the cost of fuel per litre for the next five years. They therefore had the information, but could decide for themselves whether they wanted to calculate the future fuel costs and consider it when choosing a vehicle. The participants in Experiments 4, 5 and 6 were given the future fuel costs for Model A and Model B, which were ZAR 70,497 and ZAR 50,975 respectively. The calculation of the fuel costs ignored the time value of money and is set out in Table 3 below.

**Table 3: Calculation of the Future Fuel Costs for Five Years for Model A and Model B**

	<b>Model A</b>	<b>Model B</b>
Total kilometres driven in five years	100,000 km	100,000 km
Average fuel consumption	6.5 litres/100 km	4.7 litres/100 km
Litres required for 100 000 km	6,500 litres	4,700 litres
Cost of fuel per litre	ZAR 10.85	ZAR 10.85
Future fuel cost over five years	ZAR 70,497	ZAR 50,975

Table 4 shows the composition of the total cost of ZAR 350,497 for Model A and Model B for all six experiments. The composition of the total cost for Experiments 1 and 4 was the same as both experiments included a CO<sub>2</sub> incentive. For Experiments 2 and 5 the composition was also the same as both experiments included a CO<sub>2</sub> penalty. The composition of the total cost for Experiments 3 and 6 is also the same as both experiments include neither a CO<sub>2</sub> incentive nor a CO<sub>2</sub> penalty.

**Table 4: The Total Cost for Model A and Model B for the Six Experiments**

	<b>Experiments 1 and 4</b>	
	<b>Model A</b>	<b>Model B</b>
Purchase price (including VAT)	ZAR 280,000	ZAR 310,022
CO <sub>2</sub> incentive on Model B	-	(ZAR 10,500)
Future fuel costs over five years	ZAR 70,497	ZAR 50,975
Total cost	ZAR 350,497	ZAR 350,497
	<b>Experiments 2 and 5</b>	
	<b>Model A</b>	<b>Model B</b>
Purchase price (including VAT)	ZAR 269,500	ZAR 299,522
CO <sub>2</sub> penalty on Model A	ZAR 10,500	-
Future fuel costs over five years	ZAR 70,497	ZAR 50,975
Total cost	ZAR 350,497	ZAR 350,497
	<b>Experiments 3 and 6</b>	
	<b>Model A</b>	<b>Model B</b>
Purchase price (including VAT)	ZAR 280,000	ZAR 299,522
Future fuel costs over five years	ZAR 70,497	ZAR 50,975
Total cost	ZAR 350,497	ZAR 350,497

### 3.3 Dependent Variables

The participants in all six experiments were required to choose between Model A and Model B after reading the information provided on these two models. The choice between Model A and Model B was the primary dependent variable, which was similar to the primary dependent variable in the experiment conducted by Morrow and Rupert (2014, p. 52). The scale used by Morrow and Rupert to measure a participant's preference for Model A or Model B was adjusted to be an unbalanced six-point itemised semantic differential scale and ranged from (1) 'I will definitely choose Model A' to (6) 'I will definitely choose Model B'. An unbalanced scale was used to ensure that the participant chose between Model A and Model B and did not remain undecided.

After choosing between Model A and Model B, the participants were also required to respond to questions that measured the impact of the CO<sub>2</sub> incentive or the CO<sub>2</sub> penalty on their choice of model.

- In Experiments 1 and 4, the participants were asked four additional questions, which were the secondary dependent variables. These four questions were similar to the questions asked by Morrow and Rupert in their experiment (Morrow & Rupert, 2015, p. 52). The first three questions related to the CO<sub>2</sub> incentive that had been granted on Model B. The participants were first asked how important the CO<sub>2</sub> incentive of ZAR 10,500 on Model B was considered to be when a choice had to be made between the two models. The Likert scale used by Morrow and Rupert was adjusted to obtain an unbalanced five-point differential semantic rating scale that ranged from (1) 'Not important at all' to (5) 'Of extreme importance'. The midpoint of the scale read 'Of moderate importance' and not 'Neither important nor unimportant'. The second and third questions were of a general nature. The second question required the participants to indicate how likely they thought it was that a CO<sub>2</sub> incentive of ZAR 10,500 offered on Model B would change a consumer's behaviour when choosing a new motor vehicle. An unbalanced five-point differential semantic rating scale was used that ranged from (1) 'Unlikely' to (5) 'Definitely'. Third, the participants were asked how fair they thought it was to grant a CO<sub>2</sub> incentive of ZAR 10,500 on Model B to influence a consumer's choice of motor vehicle. An unbalanced six-point differential semantic rating scale was used that ranged from (1) 'Very unfair' to (6) 'Very fair'. The final question focused on the model chosen by the participant. It required participants to quantify what the difference in total price in ZAR between Model A and Model B would have to be to convince consumers to change their minds and choose the other model.
- The four questions and scales used in Experiments 2 and 5 were similar to the questions in Experiments 1 and 4, except that they related to a CO<sub>2</sub> penalty and not to a CO<sub>2</sub> incentive. First, the participants were asked how important the CO<sub>2</sub> penalty of ZAR 10,500 on Model A was when choosing between the two models; second, how likely the participants thought it was that the CO<sub>2</sub> penalty of ZAR 10,500 charged on Model A would change a consumer's behaviour when choosing a new motor vehicle, and third, how fair they thought it was to impose a CO<sub>2</sub> penalty of ZAR 10,500 on Model B in order to influence a consumer's choice of motor vehicle. The final question again focused on the models chosen by the participants and required them to quantify the difference in total price between Model A and Model B that would convince them to choose the other model.
- In Experiments 3 and 6, the participants had to choose between Model A and Model B when neither a CO<sub>2</sub> incentive nor CO<sub>2</sub> penalty was applicable to either model. Even though neither of the models was subject to a CO<sub>2</sub> incentive or a CO<sub>2</sub> penalty, participants were asked four general questions about a CO<sub>2</sub> incentive and a CO<sub>2</sub> penalty. The questions were similar to the second and third questions asked in Experiments 1, 2, 4 and 5. The participants were asked how likely they thought it was that a CO<sub>2</sub> penalty of ZAR 10,500 charged on Model A only would change a consumer's choice of motor vehicle; second, how likely they thought it was that a CO<sub>2</sub> incentive or discount of ZAR 10,500 granted on Model B only would change a consumer's choice of motor vehicle; third, how fair they thought

it was to impose a CO<sub>2</sub> penalty of ZAR 10,500 on Model B in order to influence a consumer's choice of motor vehicle, and fourth, how fair the participants thought it was to grant a CO<sub>2</sub> incentive of ZAR 10,500 on Model B in order to influence a consumer's choice of motor vehicle. For the first and third questions, an unbalanced five-point differential semantic rating scale ranging from (1) 'Unlikely' to (5) 'Definitely' was used. For the second and fourth questions, an unbalanced six-point differential semantic rating scale ranging from (1) 'Very unfair' to (6) 'Very fair' was used. The amount of ZAR 10,500 used for the CO<sub>2</sub> incentive and the CO<sub>2</sub> penalty in Experiments 1, 2, 4 and 5 was also used in the four questions in Experiments 3 and 6 to ensure that the results obtained from these questions would be comparable for all six experiments.

### 3.4 Manipulation check questions and background questions

After the participants had completed the experiment, they were requested to answer 18 short questions. These questions were included to measure and control other factors that might influence a consumer's choice of motor vehicle. For example, a consumer's age, gender, income and opinion about protecting the environment may influence their choice of motor vehicle.

Questions 1, 2 and 3 were the manipulation check questions and Questions 4 to 18 were the background questions. Questions 4 to 18 were the same for all six experiments.

The answers to Question 1 and Question 2 had to be correct in order for the questionnaire to be valid.

#### 3.4.1 *Question 1: manipulation check question for the CO<sub>2</sub> incentive and the CO<sub>2</sub> penalty*

For Experiments 1 and 4, the manipulation check question was a statement and participants had to indicate whether it was true or false. The statement read as follows: 'In this experiment in which I took part, I was granted a CO<sub>2</sub> incentive on one of the two models'. The objective of this question was to determine whether the participants realised that one of the two models had been granted a CO<sub>2</sub> incentive. For Experiments 2 and 5, the manipulation check question was the same as for Experiments 1 and 4 above, except that the statement referred to a CO<sub>2</sub> penalty and not to a CO<sub>2</sub> incentive. The objective of this question was to determine whether the participant realised that a CO<sub>2</sub> penalty was being charged on one of the two models. For Experiments 3 and 6, no CO<sub>2</sub> penalty or CO<sub>2</sub> incentive applied. The manipulation check question required the participants to respond 'true' or 'false' to the statement that Model A and Model B were both not subject to CO<sub>2</sub> penalties or CO<sub>2</sub> incentives or discounts. The objective of this question was to determine whether the participants were aware of the fact that neither one of the two models was subject to CO<sub>2</sub> penalties or CO<sub>2</sub> incentives.

#### 3.4.2 *Question 2: manipulation check question for the level of transparency regarding the future fuel costs of Model A and Model B*

For Experiments 1, 2 and 3, the manipulation check question was a statement and participants had to indicate whether it was true or false. The statement read as follows: 'In this experiment in which I took part, I was given sufficient information to calculate the future fuel costs of Model A and Model B'. The objective of this question was to determine whether the participants were aware that they had been given sufficient information to calculate the future fuel costs of Model A and Model B. For Experiments 4, 5 and 6, the manipulation check question was also a statement to which participants

had to respond by indicating whether they considered it to be true or false. The statement read as follows: 'In this experiment in which I took part, I was given the future fuel costs of Model A and Model B'. The objective of this question was to determine whether the participants were aware that they had been given the future fuel costs of Model A and Model B.

As Question 3, the participants in all six experiments were also asked whether or not they took the future fuel costs into account when choosing between the two models by choosing either 'Yes' or 'No'. This question was not a pure manipulation check question, but was included to determine whether the manipulation of the level of transparency regarding the future fuel costs was influencing a participant to consider the future fuel costs when choosing between Model A and Model B. The objective of this question was to measure whether the participants in Experiments 4, 5 and 6 had given more consideration to the fuel costs than those who participated in Experiments 1, 2 and 3.

### 3.4.3 Questions 4 to 18: background questions

Questions 4 to 18 were the background questions of which questions 4, 5 and 6 were control variables. The personal information gathered in questions 4, 5 and 6 related to the participant's age, gender and income and was used to describe the sample characteristics.<sup>4</sup> The background questions also included questions designed to measure the environmental morale and tax morale of the participants. For ease of reference, the results of the background questions are given below as the background questions are discussed.

Question 4, an open question, asked participants to state their age by writing it down in years. Question 5 asked the participants to indicate their gender by selecting 'male' or 'female'. The third control variable was income and in Question 6 they had to indicate whether their annual incomes before deductions were less than ZAR 670,000, between ZAR 670,001 and 1.3 million or more than ZAR 1.3 million.

As indicated in Table 5, 73.04% of the participants were between 25 and 44 years of age as 44.78% of the participants were aged between 25 and 34 years and 28.26% between 35 and 44 years. With regard to gender, males (48.70%) and females (51.30%) were evenly balanced. The annual income before deductions of 69.13% of the participants was less than ZAR 670,000 and 26.52% earned more than ZAR 670,000 and up to ZAR 1.3 million per year. Only 3.05% of the participants were in the top income group and earned more than ZAR 1.3 million per year.

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<sup>4</sup> The potential impact of socioeconomic factors on the consumers' choice of motor vehicle was controlled in this experiment with the inclusion of background questions. As a result, the socioeconomic factors were treated as control variables and randomised out to ensure the choice of motor vehicle was not influenced by these factors.

**Table 5: Frequency of Demographic Information**

<b>Demographic information</b>	<i>N</i>	<b>% of sample</b>
<b>Age</b>		
19 – 24 years	20	8.70%
25 – 34 years	103	44.78%
35 – 44 years	65	28.26%
45 – 54 years	21	9.13%
Older than 55 years	21	9.13%
	230	100.00%
<b>Gender</b>		
Male	112	48.70%
Female	118	51.30%
	230	100.00%
<b>Annual income before deductions</b>		
ZAR 0 – ZAR 670,000	159	69.13%
ZAR 670,001 – ZAR 1,300 000	61	26.52%
More than ZAR 1,300 000	7	3.05%
No answer	3	1.30%
	230	100.00%

Question 7 asked the participants to indicate whether they drove company vehicles or their own motor vehicles. The assumption was that participants who drove company-owned motor vehicles would be less concerned about the purchase price and the CO<sub>2</sub> penalty or CO<sub>2</sub> incentive as such costs would be borne by their employers. For this reason participants who drove their own motor vehicles were preferred. 95.22% of the participants drove privately-owned motor vehicles.

Question 8 asked the participants to indicate which of the following two statements applied to them: ‘I pay my own fuel cost’ or ‘I can claim my fuel cost for business travel back from my employer’. The objective of this question was to determine whether the participants were fully liable for their own fuel costs or not. This information was important as it was assumed that participants whose fuel costs were paid by their employers would be less concerned about the fuel consumption of their motor vehicles as the cost would not directly impact their personal finances. For this reason participants who paid their own fuel costs were preferred for this study. 77.40% of the participants paid their own fuel costs.

In response to Question 9, the participants had to indicate how likely it was that they would purchase new motor vehicles in the next five years using an unbalanced five-point semantic differential scale from (1) ‘Unlikely’ to (5) ‘Definitely’. This question was also included in Morrow and Rupert’s questionnaire (Rupert, 2016). The objective of this question was to give the researchers an indication of how regularly the participants replaced their motor vehicles. Altogether 73.48% of the participants

selected (3), (4) or (5) on the scale, which indicated that it was likely that they would purchase a new motor vehicle in the next five years.

The participants had to respond to Question 10 by indicating the importance of six vehicle characteristics when purchasing a new motor vehicle, namely the status value of the vehicle, safety, fuel economy, the provision of a comprehensive motor plan, functionality (for example boot space and off-road capability) and engine size. The objective of this question was to determine what the participants regarded as important characteristics when choosing a new motor vehicle as their responses could potentially explain their choice of motor vehicle. The importance attached to fuel economy could explain why a participant would choose either Model A or Model B. The environmental impact of the new motor vehicle did not seem to rank high on the agendas of consumers and they appeared to regard fuel efficiency as a bonus (Coad et al., 2009, p. 2079). It was therefore expected that consumers who indicated that fuel economy was not important would have shown a stronger preference for Model A, which was less fuel efficient. In other words, it was expected that consumers who indicated that fuel economy was important when choosing a new motor vehicle would prefer the more fuel-efficient Model B. The safety of the motor vehicle was indicated as the most important factor with a mean score of 4.47, followed by fuel economy (4.20) and the availability of a comprehensive motor plan (4.00).

Questions 11 and 12, which were also asked in Morrow and Rupert's questionnaire (Rupert, 2016), were included to measure the environmental morale of the participants. A scale ranging from (1) 'Strongly agree' to (6) 'Strongly disagree' was used for both questions. Environmental morale is the willingness of people to care for the environment by making decisions that are favourable to the environment. A study conducted by Lane and Potter (2017, p. 1085) in the United Kingdom found that both private and fleet consumers place a low priority on environmental issues when purchasing new vehicles. They also found that consumers use fuel consumption as a proxy for both the environmental impact and the motor vehicle costs. It was therefore expected that consumers with a high environmental morale would be more willing to choose the more fuel-efficient Model B.

Question 11 required the participants to indicate, on a six-point unbalanced Likert scale, how strongly they agreed or disagreed with the following statement: 'I would donate part of my income if I was certain that my money would be used to prevent environmental pollution'. The objective of Question 11 was to measure whether the participants were willing to donate money to help prevent environmental pollution. An empirical study undertaken by Torgler, García-Valiñas and Macintyre (2008, p. 1) in 33 Western and Eastern European countries revealed that women were more inclined than men to want to protect the environment and were more willing to contribute financially to assist efforts in this regard. The gender and age of participants were therefore also taken into account in the analysis of the answers to Question 11. The participants who agreed with the statement represented 63.91% of the participants and 35.65% disagreed. When the opinions of men and women were analysed, 69.49% of women agreed compared to only 58.04% of men.

Question 12 measured the tax morale of the participants combined with their environmental morale and asked participants to indicate, on a six-point unbalanced Likert scale, how strongly they agreed or disagreed with the following statement: 'I would agree to an increase in taxes if the extra tax revenue would be used to repair and prevent environmental pollution'. Tax morale is a taxpayer's intrinsic willingness to pay

tax (Alm & Torgler, 2006, p. 224). The objective of this question was to measure whether the participants would be willing to pay more tax if the tax revenue were earmarked for the repair and prevention of environmental pollution. Individuals respond positively when tax proceeds are directed toward programmes of which they approve (Alm, Jackson & McKee, 1993, p. 285). Daude, Gutiérrez and Melguizo (2013, p. 9) explored the drivers of tax morale worldwide with the emphasis on developing countries and concluded that socioeconomic factors such as age, religion, gender, employment status and level of education have a significant impact on people's levels of tax morale. As the background questions had already asked the participants' age, gender and income, it was possible to analyse their answers to Questions 11 and 12 in relation to their age, gender and income. The responses for Question 12 were similar to those of Question 11 since 63.91% of the participants agreed and 36.09% disagreed. When the opinions of men and women were analysed, both had similar opinions regarding an increase in tax to prevent environmental pollution.

The participants were asked to respond to Question 13 by indicating, on a six-point unbalanced Likert scale, how strongly they agreed or disagreed with the following statement: 'It is the government's responsibility to reduce environmental pollution and it should not cost me any additional money'. This question was included specifically as it was significant in the preliminary analysis of the study conducted by Morrow and Rupert (2015, p. 53). The objective of Question 13 was to determine whether the participants were willing to take responsibility for environmental pollution, or whether they preferred to shift the responsibility and cost of environmental pollution on to the government. 69.57% of the participants agreed with this statement.

The objective of Question 14 was to determine whether participants were willing to shift the blame for environmental pollution onto the motor vehicle manufacturers. They were asked to indicate how strongly they agreed or disagreed with the following statement: 'It is the motor vehicle manufacturer's responsibility to reduce the CO<sub>2</sub> emissions of new motor vehicles'. A six-point unbalanced Likert scale ranging from (1) 'Strongly agree' to (6) 'Strongly disagree' was used. Coad et al. (2009, p. 2083) found that consumers do not feel entirely liable for the environmental damage caused by their high-emission motor vehicles. Consumers generally feel that the responsibility for reducing emissions should fall on the shoulders of the manufacturers, who should improve the fuel efficiency of the motor vehicles they manufacture. Even consumers who care about the environment might therefore continue to purchase high-emissions vehicles as they feel that they are not to blame for driving vehicles that are not environment friendly. The vast majority (96.09%) of the participants agreed with this statement. It is clear from this result that the participants were of the opinion that motor vehicle manufacturers should take responsibility for the reduction of the CO<sub>2</sub> emissions of new motor vehicles.

Questions 15 and 16 were designed to determine how the participants felt about the use of tax incentives and tax penalties outside the motor vehicle industry to encourage or discourage certain activities. A six-point unbalanced Likert scale ranging from (1) 'Strongly agree' to (6) 'Strongly disagree' was used in both questions. Question 15 was based on a question asked by Morrow and Rupert (2014, p. 53), but was adapted to include an example from the South African context. The participants were asked how they felt about the statement: 'Do you agree that the tax system should be used to encourage certain activities, for example to encouraging the installation of solar geysers

by granting tax incentives?'. 92.61% of the participants agreed that tax incentives should be used.

Question 16 asked how the participants felt about the statement: 'Do you agree that the tax system should be used to discourage certain activities, for example the smoking of cigarettes, by charging tax penalties on cigarette sales?'. Only 76.96% of the participants agreed with this statement. When the results for Questions 15 and 16 are compared, more participants agree that tax incentives should be used which was expected as people want to avoid the emotion of loss or being penalised.

Question 17 was also based on a question used by Morrow and Rupert (2014, p. 53), but was adapted to measure the effectiveness of tax incentives and tax penalties in influencing taxpayer behaviour. A six-point itemised semantic differential scale ranging from (1) 'Tax incentives are much more effective' to (6) 'Tax penalties are much more effective' was used. The objective of this question was to measure the participants' opinion regarding the effectiveness of tax incentives and tax penalties in general. 75.65% considered tax incentives to be more effective, compared to only 24.35% who felt that tax penalties were more effective.

The last question, Question 18, was asked to determine whether the participants preferred to have to pay a penalty, or to be rewarded with an incentive for their behaviour. A six-point itemised semantic differential scale ranging from (1) 'I strongly prefer tax penalties' to (6) 'I strongly prefer tax incentives' was used. This was a general question and no reference was made specifically to CO<sub>2</sub> incentives or CO<sub>2</sub> penalties. 82.61% of the participants preferred tax incentives, compared to only 17.39% who preferred tax penalties.

### **3.5 Design of the experiments and questionnaires**

In order to ensure that the experiments and questionnaires adequately tested the hypotheses, Professors Elmar Venter of the University of Pretoria and Timothy Rupert of the Northeastern University's Boston Campus made valuable comments during the design of the different treatment conditions and manipulation check questions. The six questionnaires were also reviewed by Professor Timothy Rupert and Dr. Marthi Pohl, an independent research consultant employed by the Faculty of Economic and Management Sciences at the University of Pretoria.

Even though the experiment was designed to have high internal and external validity, it was a laboratory-designed experiment that was conducted in an artificial setting. The inherent risk of a laboratory-designed experiment is that the participants' responses might differ from what they would have been in a real-life scenario.

### **3.6 Data collection and sampling**

Prior to commencement of the study, the questionnaires were approved by the Research Ethics Committee of the Faculty of Economic and Management Sciences at the University of Pretoria. The unit of analysis was an individual consumer who drives a motor vehicle and the population consisted of motor vehicle drivers living in the city of Pretoria, Gauteng province. We were granted permission by the management of Hi-Q Autowiel (a motor vehicle wheel and tyre fitment centre) in the suburb Menlyn to invite their clients in the waiting area to complete the questionnaire during August 2016 and September 2016. Participation was voluntary without monetary or other rewards. The composition of the sample was determined by the individuals who entered the waiting

area and were willing to complete the questionnaire. In addition to the Hi-Q Autowiel clients, the researcher also approached 10 acquaintances in Pretoria and asked them and nine of their colleagues who drove motor vehicles to complete the questionnaires. The six paper-and-pen-based questionnaires, one for each of the six experiments, were randomly distributed among the participants for completion. As mentioned above, each participant completed only one of the six questionnaires. The questionnaires were completed anonymously and sealed by the participant in an envelope to ensure that sensitive information, such as a person's income, could not be linked to a particular participant. The data obtained was manually captured and analysed as presented in section 4.

#### **4. DATA ANALYSIS**

A quantitative data analysis was performed on the data collected from the six experiments.<sup>5</sup> Descriptive statistics were calculated after which the six hypotheses were tested using statistical techniques. A total of 247 questionnaires were received of which 17 were discarded as invalid or incomplete. The remaining 230 valid questionnaires were used to create the primary data set. The primary data set was then reviewed to ensure that all the data inputs were valid, logical and suitable for further analysis.

First, the data obtained from the background questions (Questions 4-18) were analysed to obtain classification data of the participants of this study. The results of the background questions were provided above under point 3.4. Second, descriptive statistics for the dependent variables were performed where after the six hypotheses were tested using the independent samples *t*-test.

##### **4.1 Descriptive statistics for the dependent variables**

The primary dependent variable in all six experiments was the choice of motor vehicle and the first question on the first form asked participants to choose either one of two models. The scale ranged from (1) 'I will definitely choose Model A' to (6) 'I will definitely choose Model B'. The number of participants in each experiment and the average interval chosen by the participants on this six-point scale are given in Table 6.

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<sup>5</sup> The data analysis is similar to the data analysis performed in the experiment performed by Morrow and Rupert (2014, pp. 54-66).

**Table 6: Analysis of Participants' Choice of Model**

<b>Experiment</b>	<b>Independent variables</b>	<b>N</b>	<b>Mean</b>	<b>Standard deviation</b>
Experiment 1	CO <sub>2</sub> incentive Low level of transparency regarding future fuel costs	37	4.27	1.503
Experiment 2	CO <sub>2</sub> penalty Low level of transparency regarding future fuel costs	38	4.39	1.306
Experiment 3	No CO <sub>2</sub> incentive and no CO <sub>2</sub> penalty Low level of transparency regarding future fuel costs	38	4.18	1.768
Experiment 4	CO <sub>2</sub> incentive High level of transparency regarding future fuel costs	38	4.37	1.567
Experiment 5	CO <sub>2</sub> penalty High level of transparency regarding future fuel costs	42	4.21	1.828
Experiment 6	No CO <sub>2</sub> incentive and no CO <sub>2</sub> penalty High level of transparency regarding future fuel costs	37	4.57	1.501
		230		

For all six experiments, the mean was greater than 4.00, which indicates that the average choice of model in all six experiments was Model B, which cost more than Model A but was more fuel efficient. A comparison between the means and standard deviations of all six experiments in Table 6 revealed that Experiment 6 resulted in the highest average preference for Model B (4.57) and the intervals chosen by the participants in Experiment 6 showed the second lowest variability in the data (1.501).

The frequency of the participants' choices of Model A or Model B for each experiment is given in Table 7. Intervals (1), (2) and (3) on the six-point scale indicate that a participant chose Model A, while intervals (4), (5) and (6) indicate that Model B was chosen. The frequencies of (1) to (3), as well as those of (4) to (6) were added together to calculate the choice of model. When the frequencies of all six experiments were compared, Experiment 2 showed the highest frequency of participants who selected Model B when all six experiments were compared: 32 of the 38 participants in Experiment 2 chose Model B.

**Table 7: Frequency of the Choice of Model per Experiment**

<b>Low transparency</b>	<b>Experiment 1</b>	<b>%</b>	<b>Experiment 2</b>	<b>%</b>	<b>Experiment 3</b>	<b>%</b>
Model A	10	27%	6	16%	12	32%
Model B	27	73%	32	84%	26	68%
	37	100%	38	100%	38	100%
<b>High transparency</b>	<b>Experiment 4</b>	<b>%</b>	<b>Experiment 5</b>	<b>%</b>	<b>Experiment 6</b>	<b>%</b>
Model A	8	21%	14	33%	8	22%
Model B	30	79%	28	67%	29	78%
	38	100%	42	100%	37	100%

Two general observations are made with reference to Tables 6 and 7:

- a comparison of Experiments 1, 2 and 3 in Table 6 shows that the mean of 4.18 calculated for Experiment 3 was lower than the means for the other two experiments, which indicates that the inclusion of both the CO<sub>2</sub> penalty and the CO<sub>2</sub> incentive heightened the participants' preference for the more fuel-efficient Model B. Of the three experiments, Experiment 2 had highest mean (4.39) and the lowest standard deviation (1.306).
- when Experiments 4, 5 and 6 are compared (see Table 6), it can be seen that the mean of 4.59 for Experiment 6 is the highest. This indicates that the participants in Experiment 6, in which no CO<sub>2</sub> penalty or the CO<sub>2</sub> incentive applied, showed the highest average preference for Model B. When the frequency of participants who chose Model B (see Table 7) is compared for Experiments 4, 5 and 6, it can be seen that Experiment 4 had the highest frequency for Model B as 30 (79%) of the 38 participants in this experiment chose Model B.

The participants in Experiments 1 and 4 were asked three questions relating to the CO<sub>2</sub> incentive that was granted on Model B. The average intervals chosen indicated that the CO<sub>2</sub> incentive:

- became more important once the future fuel costs were known;
- the participants thought it was more likely that the CO<sub>2</sub> incentive would change consumers' choice of motor vehicle once they had been informed of the future fuel costs; and
- the participants thought that the CO<sub>2</sub> incentive was more fair once they had been informed of the future fuel costs.

The participants in Experiments 2 and 5 were asked three questions regarding the CO<sub>2</sub> penalty that applied to Model A. The average interval chosen by the participants can be explained as follows:

- the CO<sub>2</sub> penalty became less important once the future fuel costs were known;

- the participants thought that it was slightly more likely that the CO<sub>2</sub> penalty would change a consumer's behaviour once the future fuel costs were known;
- the participants considered the CO<sub>2</sub> penalty to be more fair once they had been informed of the future fuel costs.

A comparison of the means of these three questions of Experiments 1, 2, 4 and 5 indicated that the participants were of the opinion that the CO<sub>2</sub> incentive granted on Model B was fairer than the CO<sub>2</sub> penalty charged on Model A.

## 4.2 Hypotheses testing

The acceptable level of statistical significance for testing the six hypotheses was set at 95% ( $p = 0.05$ ). The independent samples *t*-test was used to test the six hypotheses and to measure whether the mean differences in two populations on one metric variable were equal. The independent samples *t*-test was performed using the Statistical Package for the Social Sciences (SPSS) software and the results are summarised in Table 8.

**Table 8: Results of Independent Samples *t*-Tests**

Hypothesis	Comparison	Mean	Standard deviation	Equal variances assumed	Results of independent samples <i>t</i> -test	Conclusion
H1	Experiment 1 Experiment 3 (control group)	4.27 4.18	1.503 1.768	$p = 0.156$	$t(73) = 0.227, p = 0.821$	H1 <sub>0</sub> cannot be rejected
H2	Experiment 2 Experiment 3 (control group)	4.39 4.18	1.306 1.768	Rejected as $p = 0.008$	$t(68.099) = 0.590, p = 0.557$ (t-test for equal variances not assumed)	H2 <sub>0</sub> cannot be rejected
H3	Experiment 1 Experiment 2	4.27 4.39	1.503 1.306	$p = 0.191$	$t(73) = -0.383, p = 0.703$	H3 <sub>0</sub> cannot be rejected
H4	Experiment 3 Experiment 6	4.18 4.57	1.768 1.501	$p = 0.114$	$t(73) = -1.011, p = 0.315$	H4 <sub>0</sub> cannot be rejected
H5	Experiment 1 Experiment 4	4.27 4.37	1.503 1.567	$p = 0.969$	$t(73) = 0.277, p = 0.783$	H5 <sub>0</sub> cannot be rejected
H6	Experiment 2 Experiment 5	4.39 4.21	1.306 1.828	Rejected as $p = 0.002$	$t(74.142) = -0.511, p = 0.611$ (t-test for equal variances not assumed)	H6 <sub>0</sub> cannot be rejected

Hypotheses H1, H2 and H3 were tested under the low level of transparency regarding the future fuel costs where the participants were given sufficient information to calculate the future fuel costs of Model A and Model B.

To test hypothesis H1, Experiment 1 (a CO<sub>2</sub> incentive was granted) was compared with the control group, Experiment 3 (no CO<sub>2</sub> incentive or CO<sub>2</sub> penalty applied). When the means for Experiments 1 and 3 in Table 8 are compared, the mean for Experiment 1 of 4.27 is slightly higher than the 4.18 mean for Experiment 3, which indicates that the average preference for the more fuel-efficient Model B increased when the CO<sub>2</sub> incentive was granted on Model B. The results of the independent *t*-test indicate that there is no statistically significant difference between the choice of model in Experiments 1 and 3.

To test hypothesis H2, Experiment 2 (a CO<sub>2</sub> penalty was imposed) was compared with the control group, Experiment 3 (no CO<sub>2</sub> incentive or CO<sub>2</sub> penalty applied.) When the means for Experiments 2 and 3 are compared, the mean of 4.39 for Experiment 2 is

slightly higher than the 4.18 for Experiment 3, which indicates that the average preference for the more fuel-efficient Model B increased when the CO<sub>2</sub> penalty was charged on Model A. The results of the independent *t*-test indicate that there is no statistically significant difference between the choice of model in Experiments 2 and 3.

To test hypothesis H3, Experiment 1 (a CO<sub>2</sub> incentive was granted) was compared with Experiment 2 (a CO<sub>2</sub> penalty was charged). When the 4.27 mean for Experiment 1 is compared to the 4.39 mean for Experiment 2, the average interval selected by the participants can be seen to have increased slightly in Experiment 2, which indicates an increase in the preference for Model B. This increase indicates that the CO<sub>2</sub> penalty was slightly more effective than the CO<sub>2</sub> incentive in influencing the participants to choose Model B. The results of the independent *t*-test indicate that there is no statistically significant difference between the choice of model in Experiments 1 and 2.

Hypothesis H4 was tested by comparing Experiments 3 (where sufficient information was given to calculate the future fuel costs) and 6 (where the future fuel costs were given). The average interval chosen increased slightly from 4.18 in Experiment 3 to 4.57 in Experiment 6, which indicates an increase in the preference for Model B. As the future fuel costs were given in Experiment 6, the increase in the mean and the decrease in the standard deviation from 1.768 in Experiment 3 to 1.501 in Experiment 6 indicate that the preference for Model B increased slightly when the future fuel costs were given and the preference was also slightly more concentrated. The results of the independent *t*-test indicate that there is no statistically significant difference between the choice of model in Experiments 3 and 6.

In order to test hypothesis H5, the results of Experiments 1 and 4 were compared to measure the effect of the information policy on the CO<sub>2</sub> incentive. The average interval chosen increased from 4.27 in Experiment 1 to 4.37 in Experiment 4, which indicates a slight increase in preference for Model B. In Experiment 1, the standard deviation increased from 1.503 to 1.567, which indicates that the variability in the data for the choice of model was slightly higher in Experiment 4. The results of the independent *t*-test indicate that there is no statistically significant difference between the choice of model in Experiments 1 and 4.

To test hypothesis H6, the results of Experiments 2 and 5 were compared to measure the effect of the information policy on the CO<sub>2</sub> penalty. The average preference for Model B decreased slightly from 4.39 in Experiment 2 to 4.21 in Experiment 5. The standard deviation increased slightly from 1.306 in Experiment 2 to 1.828 in Experiment 5, which indicates that the variability in the data for the choice of model was slightly higher in Experiment 5. Compared to the low level of transparency in Experiment 2, the high level of transparency of the future fuel costs in Experiment 5 resulted in a lower preference for Model B. As expected, the CO<sub>2</sub> penalty no longer appeared larger than what it actually was, as the costs were clearly set out. The results of the independent *t*-test indicate that there is no statistically significant difference between the choice of model in Experiments 2 and 5.

For all six hypotheses, the results of the independent samples *t*-tests were that the differences in the choice of motor vehicle were not statistically significant and the null hypotheses could thus not be rejected. As a result it appears that neither a CO<sub>2</sub> penalty nor a CO<sub>2</sub> incentive has a meaningful influence on a consumer's decision to choose a more fuel-efficient motor vehicle. Providing a consumer with the estimated future fuel costs of the motor vehicles also does not lead to a meaningful increase in consumers'

preference for a more fuel-efficient motor vehicle. Finally, the combination of an information policy that gives the estimated future fuel costs of motor vehicles with either a CO<sub>2</sub> penalty or a CO<sub>2</sub> incentive also does not result in a meaningful increase in consumers' preference of more fuel-efficient motor vehicles.

### 4.3 Relationships between variables

A meaningful positive correlation was found between the choice of motor vehicle and the importance of fuel economy for the consumer when purchasing a new motor vehicle ( $r = 0.184$ ,  $p = 0.005$ ). The positive relationship indicates that an increase in the importance of the fuel economy explains an increase in the consumer's preference for a more fuel-efficient motor vehicle. However, the correlation is weak as the increase in the importance of fuel economy explains the increase in the choice of a more fuel-efficient motor vehicle to the extent of only 3.39%.

A meaningful negative correlation was found between the choice of motor vehicle and a consumer's environmental morale ( $r = 0.183$ ,  $p = 0.005$ ). The lower a consumer's interest is in protecting the environment (i.e., the more a consumer disagrees with donating his or her income to prevent environmental pollution), the higher his or her preference will be for a motor vehicle that is not fuel efficient. However, this correlation is also weak as the low environmental morale of the consumer explains the consumer's choice of a motor vehicle that is not fuel efficient to the extent of only 3.35%.

The multivariate analysis of variance (MANOVA) found a small but meaningful interaction between the gender and environmental morale of the consumers. The result indicates that 2.5% of the mean difference in gender can be explained by the mean difference in environmental morale which confirms that women are more concerned about the environment than men ( $F(2.202) = 2.586$ ,  $p < 0.1$ , Wilk's  $\Lambda = 0.975$ , partial  $\eta^2 = 0.025$ ).

## 5. CONCLUSION

This experiment was conducted to achieve two research objectives. The first objective was to determine the differential impact of a CO<sub>2</sub> penalty or a CO<sub>2</sub> incentive on consumers' behaviour in South Africa when a new motor vehicle is chosen. The results indicate that neither a CO<sub>2</sub> penalty nor a CO<sub>2</sub> incentive play a meaningful role in a consumer's decision to choose a more fuel-efficient motor vehicle. The second objective was to determine the differential impact of the transparency in respect of future fuel costs on South African consumers' behaviour when a new motor vehicle is chosen. The results found that providing consumers with the estimated future fuel costs of different motor vehicles does not result in any meaningful increase in their preference for more fuel-efficient motor vehicles. The combination of an information policy that gives the estimated future fuel costs of motor vehicles with either a CO<sub>2</sub> penalty or a CO<sub>2</sub> incentive also does not result in a meaningful increase in consumers' preference of more fuel-efficient motor vehicles.

The inferences of this study should be interpreted within the context of a laboratory-designed experiment that was conducted in an artificial setting. A well-designed laboratory experiment will have high internal validity but may lack external validity. The external validity and generalisability of the findings of a laboratory experiment are limited as the real world is more complex than an artificial setting. As a result, the cause-and-effect relationships found in this study may not extend to other more complex

settings (Sekaran & Bougie, 2013, p. 175). Nevertheless, the findings of this study add to the findings of recent studies which concluded that the current CO<sub>2</sub> levy in South Africa is not changing consumers' behaviour when choosing a new motor vehicle (Barnard, 2014, p. 54; Ackerman, 2014, p. 91; Nienaber & Barnard, 2018, p. 151; Carrim, 2014, p. 58).

The contributions of this study are as follows:

- this study is the first to measure the potential impact of a CO<sub>2</sub> incentive on South African consumers when choosing a new motor vehicle;
- in view of the research conducted to measure the impact of an information policy on consumers' choice of motor vehicle, the findings of this study contribute to the existing body of literature in this regard;
- by measuring the extent to which an information policy might impact the effectiveness of the CO<sub>2</sub> penalty or CO<sub>2</sub> incentive, it makes a contribution to the current literature on methods to enhance fiscal tax policies; and
- this study also contributes to the broader literature on behavioural studies that examine how individual behaviour is influenced by a penalty (loss) or reward (gain).

Finally, this study provides statistical evidence of two factors that have a meaningful influence on a consumer's choice of motor vehicle: (1) the importance of the fuel economy of a motor vehicle, and (2) the consumer's environmental morale. Research in this field needs to be continued in order to find an effective way to convince consumers to seriously consider purchasing more fuel-efficient motor vehicles. Otherwise, referring to the quote of McPherson (2011) at the outset of this study, we will have no choice but to hold our collective breath while we count our money.

## 5.1 Future research

The CO<sub>2</sub> penalty and CO<sub>2</sub> incentive used in this study were both calculated as 283% of the CO<sub>2</sub> levy currently charged in South Africa. The experimental design of this study exposed the participants to only a CO<sub>2</sub> penalty or a CO<sub>2</sub> incentive of ZAR 10,500, and the effect of a CO<sub>2</sub> penalty or CO<sub>2</sub> incentive of lesser or greater value was not measured. ZAR 10,500 is approximately 3% of the purchase price of the motor vehicles used in this study. Future research could focus on determining the amount at which a CO<sub>2</sub> penalty or a CO<sub>2</sub> incentive becomes effective in influencing consumers to change their behaviour by choosing a more fuel-efficient motor vehicle.

This experiment required participants to choose between two models of a middle-of-the-range sedan selling at a price of approximately ZAR 300,000, inclusive of value-added tax (VAT). Future research could be undertaken to measure consumers' behaviour when they have to choose between an entry-level motor vehicle and a more expensive motor vehicle.

The experiment conducted in this study exposed the participants to either a CO<sub>2</sub> penalty or a CO<sub>2</sub> incentive, and not to a combination of a CO<sub>2</sub> penalty and a CO<sub>2</sub> incentive in one fiscal policy, charging a CO<sub>2</sub> levy for the higher-emissions motor vehicle and granting a CO<sub>2</sub> incentive for the lower-emissions vehicles. Future research should

explore the potential impact of a so-called ‘feebate’ policy on the behaviour of South African consumers when they choose new motor vehicles.

This study did not consider the role that socioeconomic factors such as culture, tradition and education can have on a consumer’s choice of motor vehicle. In this context, the main goal of a recent study conducted in Slovenia was to determine what kind of motivation consumers needed to consider buying low-emission vehicles. Three different groups of motor vehicle purchasers with different opinions about low-emission vehicles were identified. The first group, which made up 20% of the sample population, were not motivated to purchase low-emission vehicles. The second group (which included 40% of the population sample) showed positive attitudes towards low-emission vehicles, but were not sure about whether they would actually purchase a low-emission vehicle in the future, and the third group (38% of the sample) were planning to buy low-emission vehicles in the near future. The majority (60%) of the population sample was indifferent or neutral towards low-emission vehicles (Zupan et al., 2013, p. 2). This study by Zupan et al. provides evidence that, even though the participants had a positive perception of low-emission vehicles and thus acknowledged the environmental impact of motor vehicles, this would not necessarily influence their choice of motor vehicle. Zupan et al. found that the culture, tradition and education of consumers can also influence their choice of motor vehicle and this may potentially explain why the CO<sub>2</sub> levy currently charged in South Africa is not changing consumer behaviour. Future research is needed to identify the socioeconomic factors that might have the potential to influence consumers to choose fuel-efficient motor vehicles.

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