

# **Addressing Plastic Bags Consumption Crises through Plastic Bag Levy, Retailer Monetary and Non-monetary Interventions in South Africa.**

## ***Abstract***

*This research analyses the impact of a plastic bag levy, and retailer interventions focussing on promotion of reusable bags to reduce plastic bag consumption. For this purpose, tax revenue data for the fiscal years 2008 to 2020 and retail outlet data for March 2018 to February 2020 was used. A descriptive arc price elasticity was estimated from the tax revenue data, while the retail outlet data was analysed by using a panel fixed effects model to evaluate the impact of three treatments on plastic and reusable bag consumption in South Africa. Findings revealed that Treatments 1 (a monetary intervention based on giving reusable bags away for free) and 2 (a non-monetary intervention framed around a plastic-free July campaign) significantly increased reusable bag uptake and reduced plastic bag consumption, while Treatment 3 (a monetary intervention involving a subsidy on reusable bags) increased reusable and plastic bag sales. The findings contribute to the literature on the effectiveness of non-monetary nudges (T2). The latter is more efficient than the monetary incentives (T1 and T3). The results also agree with the literature on the ineffectiveness of subsidies (T3) for the purpose of discouraging the consumption of plastic bags. The results confirmed that plastic bag consumption is habitual in South Africa. Based on these findings, policy recommendations were made that public campaigns and other behavioural nudges should be considered more effective in addressing the consumption of plastic bags than subsidies on reusable bags. In addition, because of the revealed low level of reuse of both plastic and reusable bags, the use of reminders to reuse bags should be considered and researched in order to modify consumer behaviour in South Africa.*

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## 1.0 Introduction

Plastic bags are one of the significant constituents of marine plastic pollution and also contributes to microplastics' build-up in the ocean (UNEP, 2016). The fact that it pollutes the environment has become a matter of serious concern for governments, environmental lobbyists, and NGOs worldwide (Hopewell, Dvorak & Kosior, 2009). This has mounted pressure on retail outlets to discourage the consumption of plastic bags by customers. At payment tills, the purchase of plastic bags has become a habitual behaviour among customers of retail outlets. This prevalent habitual behaviour continues despite the imposed levy and various available alternatives and campaigns to discourage it (Danner, Aarts & de Vries, 2008; Neal et al., 2011). In addition to economic instruments such as taxes, subsidies and provision of deposit-refund systems, several other approaches are under consideration to reduce single-use plastic bags and marine debris in South Africa. The alternative policy responses include nudges and command-and-control measures to steer people towards pro-environmental behaviour (Danner, Aarts & de Vries, 2008; Neal et al., 2011; Ohtomo & Susumu, 2014).

In line with several policy actions to discourage the excessive consumption of plastic bags in South Africa, in 2019 a retailer introduced three different interventions/treatments at various times to increase the uptake of reusable bags and reduce plastic bag consumption. The first treatment (T1) was a reusable bag giveaway in which almost 300,000 customers got free reusable bags valued at R25 (\$1.7) each during April. The second treatment (T2) was the July plastic-free month loaded with nudges, including campaign messages for consumers, store-level campaigns and changes in the default question asked by cashiers. The third treatment (T3), which came in October, was a massive rollout of R5 bags- the cheapest reusable bags available to consumers as an alternative to plastic bags. T3 intervention also includes subsidy of R1 on each R5 reusable bag purchase during October. The primary focus of this research is to investigate the impact of the three interventions rolled out during 2019. In addition, the study aims to estimate the price elasticity of demand for plastic bags and reusable bags.

Pollution from plastic bags has become a crisis globally, with the growing waste problem in cities and oceans. Given the impact of this phenomenon on the food supply chains, terrestrial and marine animals and humans have been increasingly endangered (Adane, Legesse & Muleta, Diriba, 2011; Otsyina et al., 2018). According to a 2015 report, Nigeria and South Africa ranked 9th and 11th respectively among the top 20 countries with the most polluted oceans (Jambeck et al., 2015). These two countries have the largest economies in sub-

Saharan Africa (SSA), in addition to having the largest number of people in the coastal areas (Jambeck et al., 2015). Respectively, they mismanaged 83% and 56% of their wastes in 2010 (Jambeck et al., 2015). However, in South Africa, the government had initiated some policy actions to try and contain the growing waste problem. For example, South Africa was one of the leading developing countries to adopt a plastic bag levy in 2004 (Dikgang, Leiman & Visser, 2012). Unfortunately, though, unlike the case of the developed countries – Norway and Ireland for example – the plastic bag levy only achieved a short-term reduction in plastic bag consumption despite general compliance by retail outlets (Dikgang, Leiman & Visser, 2012).

On one hand, several African countries have adopted policies aimed at containing the plastic pollution problem in their cities and oceans. For example, Kenya, Rwanda and Tanzania adopted a command-and-control policy which criminalizes the production and consumption of single-use plastic bags. Similarly, South Africa and Botswana applied economic instruments such as the imposition of plastic bag levy to discourage the consumption of single-use plastic bags.

The current predicament in South Africa is ineffective government policy in addressing the plastic consumption crisis. Dikgang et al. (2012a, 2012b) revealed that price elasticity remained inelastic and sometimes positive. This indicates the ineffectiveness of a policy after 7 years of general compliance. The aftermath of “the failed policy” was a scientific report that positioned South Africa’s oceans as the 11th most polluted globally (Jambeck et al., 2015). The report added that South Africa mismanaged 56% of its waste with the greater proportion of the waste leaking into the environment (Jambeck et al., 2015).

Against this background, this research will contribute to literature of plastic bag pollution by examining the combination of government intervention through plastic bag levy and private retail effort through designed behavioural interventions (monetary and non-monetary) to reduce plastic bag consumption in South Africa. To the best of knowledge this is first in Africa literature to examine both government and private sector effort toward reduction of plastic bag pollution. Moreso, investigating the effectiveness of nudges as public policy instrument in developing countries where there is less infrastructure for waste management has not received needed attention in the literature. Therefore, this study examines the effectiveness of the plastic bag levy (government intervention) and store-level interventions

in reducing plastic bag consumption in South Africa. With this, the main questions this study attempts to provide answers to include:

- (1) What is the price elasticity of demand for plastic bags and reusable bags?
- (2) What is the cross-price elasticity between plastic bags and reusable?
- (3) What are the immediate impacts of the three treatments, namely the April giveaway (T1), the July plastic-free month (T2) and R5 reusable bag rollout and its subsidy (T3) on the uptake of reusable bags?
- (4) What are the immediate impacts of the three treatments (T1, T2 and T3), namely the April giveaway, July plastic-free month and R5 reusable bag rollout and its subsidy on sales of plastic bags?

In providing an empirical answer to the above questions, tax revenue data for the fiscal years 2008 to 2020 and retail outlet data for March 2018 to February 2020 was used. A descriptive arc price elasticity was estimated from the tax revenue data, while the retail outlet data was analysed by using a panel fixed effects model to evaluate the impact of three treatments on plastic and reusable bag consumption in South Africa. Findings revealed that Treatments 1 (a monetary intervention based on giving reusable bags away for free) and 2 (a non-monetary intervention framed around a plastic-free July campaign) significantly increased reusable bag uptake and reduced plastic bag consumption, while Treatment 3 (a monetary intervention involving a subsidy on reusable bags) increased reusable and plastic bag sales. The findings contribute to the literature on the effectiveness of non-monetary nudges (T2). The latter is more efficient than the monetary incentives (T1 and T3). The results also agree with the literature on the ineffectiveness of subsidies (T3) for the purpose of discouraging the consumption of plastic bags. The results confirmed that plastic bag consumption is habitual in South Africa.

The rest of this paper is structured as follows: The next section reviews the literature. Section 3 provides the detail background for the interventions and stylised facts. Section 4 presents the data and methodology, and Section 5 offers the presentation of results and discussion. Finally, Section 6 concludes with policy implications.

## **2.0 Literature Review**

Plastic bags are sturdy, versatile and low-cost packaging solutions, and are thus ubiquitous today. However, there is growing evidence that the current usage of plastics and their disposal contribute to substantial degradation of the terrestrial environment (Adane, L & Muleta, D, 2011; Otsyina et al., 2018) and marine environment (Barnett et al., 2016; Mellish et al., 2016). This crisis associated with plastic litter has drawn the attention of policymakers from developed, middle-income and developing countries towards the urgency of intervention (Dikgang, Johane, Leiman, Anthony & Visser, Martine, 2012a; Dikgang, Johane, Leiman, Anthony & Visser, Martine, 2012b; He, 2012; Heidbreder et al., 2019; Hopewell, Dvorak & Kosior, 2009; Rivers, Shenstone-Harris & Young, 2017; Zen, Ahamad & Omar, 2013). The peculiar complexity of the problem lies in the involvement of all economic agents, including government, firms (plastic producers and retail outlets) and households. Addressing this type of problem, therefore, must involve the willingness and participation of all stakeholders. This literature review is divided into four parts. Section 2.1 explains the adoption and importance of the economics instrument as a public instrument to discourage consumption of plastic bags. Section 2.2 covers the importance of eco-friendly alternatives when marketed goods pose a danger to the environment. Section 2.3 discusses the concept of nudges as a public policy instrument and the usage of non-pecuniary nudges to enhance pro-environmental behaviour. Lastly, Section 2.4 focuses on the impact and criticism of subsidies as an incentive towards enhancing pro-environmental behaviour.

### **2.1 Effectiveness of the Plastic Bag Levy**

The numerous advantages of plastic include cheapness, versatility and toughness, making plastic bags generally acceptable and thereby an integral part of our daily living. However, there is a rapidly growing awareness that its increasing use and disposal, significantly contributes to the substantial degradation of the terrestrial environment (Adane, Legesse & Muleta, Diriba, 2011; Otsyina et al., 2018) and negatively affects life below terrestrial and ocean waters (Barnett et al., 2016; Mellish et al., 2016). The transformation of plastic litter from a problem to a crisis is drawing the attention of many policymakers from developed, emerging and developing countries towards the urgency of the crisis (Dikgang, Johane, Leiman, Anthony & Visser, Martine, 2012a; Dikgang, Johane, Leiman, Anthony & Visser, Martine, 2012b; He, 2012; Heidbreder et al., 2019; Hopewell, Dvorak & Kosior, 2009; Rivers, Shenstone-Harris & Young, 2017; Zen, Ahamad & Omar, 2013).

Several countries have adopted various policy tools to address the plastic bag pollution crisis. One of the policy tools is command-and-control, which requires adequate situated knowledge to avoid unintended consequences. Kenya, Rwanda, and Tanzania are among African countries that adopted command-and-control policies by outrightly banning plastic bag usage. Conversely, other countries employed economic instruments to address the single-use plastic bag consumption crisis. For example, Norway, Ireland, South Africa, and Botswana adopted a plastic bag levy (Alam, Billah & Yajie, 2018; Ayalon et al., 2009; Convery, McDonnell & Ferreira, 2007; Dikgang, Johane, Leiman, Anthony & Visser, Martine, 2012b; Heidbreder et al., 2019).

Studies show that economic instruments such as taxes, levies, charges or fees often discourage the consumption of plastic bags (Ritch, Brennan & MacLeod, 2009; Saidan et al., 2017; Synthia & Kabir, 2015; Wagner, 2017). These instruments have been deployed to reduce the consumption of plastic bags in both developed (Ayalon et al., 2009; Convery, McDonnell & Ferreira, 2007; Silva et al., 2017) and developing countries (Dikgang, Johane, Leiman, Anthony & Visser, Martine, 2012a; Heidbreder et al., 2019; Jayaraman et al., 2011; Xanthos & Walker, 2017). The advantages of employing economic instruments include cost-effectiveness, incentives for innovation, revenue generation, pro-social reminders and economic efficiency. In addition, several scholars and policymakers seek to understand the long-term effects of the plastic bag levy and its behavioural implications, as many alternatives to the plastic bag are emerging (Dikgang, Johane, Leiman, Anthony & Visser, Martine, 2012a; Dikgang, Johane, Leiman, Anthony & Visser, Martine, 2012b; Heidbreder et al., 2019).

Among the most famous economic instruments that have been used to discourage excessive consumption of plastic is the plastic bag levy. The cost of the levy is borne by the final consumer of the plastic bag and is regarded as the 'polluter pays' principle. The polluter pays principle is usually adopted when a plastic bag levy is imposed. This principle had a track record of being very effective in reducing the single use of plastic bags and encouraged the use of sustainable, eco-friendly alternatives (Convery, McDonnell & Ferreira, 2007; Dikgang, Johane, Leiman, Anthony & Visser, Martine, 2012a; Heidbreder et al., 2019; Schuyler et al., 2018). Numerous scholars adjudged imposition of the levy as the most effective governmental effort to reduce excessive consumption (Alam, Billah & Yajie, 2018; Heidbreder et al., 2019; Schuyler et al., 2018).

Theoretical and empirical evidence supports the notion that the impact of price elasticity increases with time, this explains the time effect of elasticity of demand (Dikgang, Johane, Leiman, Anthony & Visser, Martine, 2012a). It establishes how economic instruments work when introduced to discourage excessive commodity consumption. The price elasticity effect may be minimal, but consumers start to shift towards new options as alternatives come into play. Martinho et al. (2017) showed a simultaneous increase of 61% in reusable bag consumption and a 74% reduction in plastic bag consumption, which confirms the two-directional impact of the plastic bag levy. One of the objectives of this study is to examine the effectiveness of the consistent increase in the plastic levy coupled with the introduction of several alternatives.

## **2.2 Provision of Alternatives to Plastic Bags**

The non-availability of alternatives to plastic bags remains a challenge to many environmentally conscious persons purchasing single-use plastic bags. Affordability to the consumer is another obstacle to consider. The absence of alternatives characterised the introduction of the plastic bag levy in South Africa. Later, retail outlets introduced reusable bags to their consumers with a price range of R15 to R50. It became apparent that many consumers could not afford the alternatives since 40% of the populace comprise non-Ricardian households (i.e. poor households that depend mainly on government grants) (De Vos, Obokoh & Abiola, 2020). The unaffordability of alternatives is likely to result in the perception that socioeconomic status correlates with pro-environmental behaviour. Due to the importance of providing alternatives, a few studies have investigated the effectiveness of alternatives (Clapp & Swanston, 2009; Martinho, Balaia & Pires, 2017; Santos & van der Linden, 2016).

A study conducted in United State of America where a group of students were given reusable water bottles at their matriculation to determine whether it would impact disposable bottle usage. The result was a significant reduction in their use of disposable bottles, and the group also supported a disposable bottle ban in their university (Santos and Linden, 2016).

In another study with Japanese students and reusable bottles, the young people displayed more responsible attributes like willingness to pay for eco-friendly alternatives, environmental consciousness and knowledge about the reduction of the use of plastic bottles, before implementing a water refill system (Heidbreder et al., 2019; Uehara & Ynacay-Nye,

2018). Studies focusing on the United Kingdom showed that numerous interventions in the provision of reusable coffee cups increased both the short-run and long-run usage, while reducing consumption of disposable cups (Martinho, Balaia & Pires, 2017; Santos & van der Linden, 2016). Poortinga & Whitaker (2018) emphasised the complementary effect of combining interventions. Their study reveals that the provision of alternatives coupled with message framing could result in a more significant reduction in plastic consumption. On their part, (Heidbreder et al., 2019) agreed that providing alternatives was a promising approach to reducing plastic waste.

Evidence from the listed studies shows that consumers are more pro-environmentally inclined when provided with alternatives (Clapp & Swanston, 2009; Santos & van der Linden, 2016). The consumption of plastic bottles in the United States of America also revealed enhanced pro-environmental behaviour when provided with cheaper alternatives (Martinho, Balaia & Pires, 2017). However, similar studies, particularly in the African context, have not yet investigated the case of plastic carrier bags. Many studies have focused on monetary nudges such as levies (Martinho, Balaia & Pires, 2017; Silva et al., 2017), but this study include effectiveness of non-monetary nudges to address plastic bags consumption crisis.

### **2.3 Nudges for Enhancing Pro-Environmental Behaviour**

The criticisms against command-and-control regulations brought up the idea of nudges as an alternative intervention. Drawbacks of such regulations (command-and-control) include cost-ineffectiveness, end of pipe solution, stifling of innovation and inefficient and complex implementation. Nudges are intervention instruments designed to amend choice architecture through changes in the environment's physical or informative structure at a particular decision-making corridor to naturally automate behavioural changes (Kallbekken & Sælen, 2013; Lehner, Mont & Heiskanen, 2016; Thaler, Sunstein & Happiness, 2008). Lehner et al. (2016) describe nudges as a collective term for different policy tools under the umbrella of behavioural influencers to change individual choices. The authors classify nudges into four forms of policy tools, namely: (1) simplification and framing of information, (2) changes to the physical environment, (3) changes to the default policy and (4) social norms. The effectiveness of each form is well-documented in the literature (see Lehner, Mont & Heiskanen (2016)).

In this study, nudge interventions in the retail sector include campaign messages, physical display of alternatives, rephrasing of cashier statements and store enhancement to improve

cashier compliance with the designed treatment. This study used all these nudge instruments during the July plastic-free month, classified as a T2 non-monetary intervention. The relevance of such nudges as public policy tools has been well-documented in the literature (Egebark & Ekström, 2016; Freedman & Brochado, 2010; Goldberg & Gunasti, 2007; Lehner, Mont & Heiskanen, 2016). Despite studies on the effectiveness of nudges as an intervention, there is nevertheless a gap in the literature for related studies with reference to Africa generally and South Africa specifically, especially regarding plastic bag consumption.

#### **2.4 Subsidies and Pro-Environmental Behaviour**

Several studies support the provision of subsidies to enhance pro-environmental behaviour and improve the uptake of environmentally friendly goods. Scholarly research has demonstrated this in terms of exploring alternative water sources (Holland et al., 2019; Martínez-Espiñeira, García-Valiñas & Nauges, 2014; Santos & van der Linden, 2016; Vu & Wu, 2020) and clean energy supply (Cheung, Davies & Trück, 2019; Clapp & Swanston, 2009; Dong et al., 2020; Steinhorst & Matthies, 2016; Zhang, Bai & Shang, 2018). However, not many studies have investigated the effectiveness of subsidies in promoting the consumption of eco-friendly bags. Poortinga and Whitaker (2018) argue that subsidies without campaigns or promoting awareness among consumers were less effective. Moreover, there is evidence that having choices available motivate consumers to engage in pro-environmental behaviour (Clapp & Swanston, 2009; Martinho, Balaia & Pires, 2017; Santos & van der Linden, 2016).

Dikgang et al. (2012b) recommended that additional measures are necessary to combat the environmental impact of plastic bags in order to promote environmental consciousness among South African consumers. Many retail outlets are under pressure to reduce the number of plastic bags they supply to customers. The pressure in turn enhances their effort to implement measures to nudge their consumers to become environmentally aware and consume fewer plastic bags. Some of these measures include the production of alternatives e.g., reusable bags, pro-environmental campaigns, and an internal ban on the consumption of plastic bags in some areas. However, such actions should not risk the loss of customers. Several interventions that were implemented by retailers have been detailed in the literature, as indicated earlier. It is important to scientifically evaluate the impact of the interventions, both monetary and non-monetary, to ascertain their policy implications.

The above literature revealed importance of alternatives in promoting pro-environmental behaviour in general. Specifically, the presence of alternatives to plastic carrier bags which was not available during the plastic bag ban in 2004. This would have a significant effect in changing the narrative about effectiveness of plastic bag levy. Moreso, the introduction of affordable alternatives and several nudges instrument can influence the consumers behaviour as revealed in the literature. Therefore, this reveals the imperative to estimate price elasticity of demand and cross elasticity of demand in recent years of plastic bags market in South Africa. Moreso, to investigate the effectiveness of monetary and non-monetary intervention in reducing plastic bags consumption in South Africa.

### **3.0 Background of the Interventions**

In 2019, a retailer introduced three significant interventions to reduce the sale of plastic bags and increase the uptake of reusable bags. The retailer's name is not mentioned due to a non-disclosure agreement and to avoid revealing the retailer strategies to competitors in the market. The retailer has nationally represented in all the provinces and metros with 20% of the total plastic bag sales in South Africa.

#### **a. Promotion of Reusable Bags Through Giveaway Intervention, April 2019**

This promotion was launched between 8 and 22 April 2019 as an integral part of the retailer's Easter campaign by which customers could win reusable bags daily. The winning customers were randomly selected to win one of the five different promotional reusable bags. The selection involved multiple winners per store per day, although the number of winners varied according to store format. In addition, a criterion was that a consumer should spend a minimum of R50. The promotion, however, excluded the retailer's mobile application users, self-service kiosks, retailers' employees and self-service tills. In addition, a winner received a 1% discount on his/her total purchase, which was an internal control to trigger the pop-up message announcing the winner of a reusable bag. The price-redeeming process included signing a Consumer Protection Act (CPA) form/waiver establishing an agreement that a photograph may be displayed on the retailer's social media pages and other platforms to advertise the bags. This was regarded as a giveaway treatment (T1-Monetary) making use of a lottery system and benefitting almost 300,000 shoppers.

In line with the literature on the provision of alternatives to single-use plastic products (Heidbreder et al., 2019; Poortinga & Whitaker, 2018; Santos & van der Linden, 2016; Uehara & Ynacay-Nye, 2018), one of the objectives of this study was to investigate the

impact of the retailer giveaway intervention, regarded as Treatment 1 (T1-monetary), on the uptake of reusable bags and consumption of plastic bags.

### **b. July Plastic-Free Month**

As part of global initiatives to eradicate single-use plastic bags, 3 July 2019 was declared International Plastic Bag-free Day with specific focus on the reduction of the use of single-use plastic bags. Retail outlets had both internal and external pressure to partake in that campaign. The challenge ran throughout July 2019 with the retailer implementing non-monetary treatments. The interventions implemented by the retailer are categorised into three nudges (as explained in (Lehner, Mont & Heiskanen, 2016):

#### **i. Campaign messages for consumers**

The first of the three nudges was a campaign to forbid the retail outlets to sell plastic bags during that month and was announced on their consumer and retail outlet websites before implementation. Also, messages with similar content were sent to consumers.

#### **ii. Store-level campaign:**

This was a structure put in place during the intervention. It included a display of campaign posters with phrases like *“Help us not to sell plastic bags”* and the provision of alternatives to plastic bags in fancy frames, displayed close to the cashier at checkout points.

#### **iii. Changes to cashier default question**

This nudge tool changed the default cashier question, *“Do you want a plastic bag?”*, to *“Do you have a recyclable bag?”*, pointing the attention of customers to the reusable bags, displayed in shelf frames, from which they could choose. These efforts were intensified by an inter-store competition which was referred to as an ‘inter-store challenge’ to mark the International Plastic Bag-Free Day. There was a call on all stores to strongly persuade the customers not to buy plastic bags with the promise of national recognition. It is worth mentioning that retail outlets recorded 19 outstanding stores of which the proportion of plastic bag sales were less than 3% of the total bags sold. This implies that more than 97% of the consumers either bought reusable bags or brought their own bags for the Plastic Bag-Free Day.

Australia was the first country to launch a plastic-free month challenge before it became a global challenge. This later gave birth to a global community with 120 million participants in 177 countries in 2018. The challenge was to avoid, as much as possible, single-use plastics which included single-use plastic packaging or carriers, cutlery, coffee cups and bottled drinks, among others, to achieve the plastic-free goal.

Several literature reviews exist on the effectiveness of public campaigns, changes in default settings, increasing awareness and promoting the willingness of consumers to become environmentally conscious (Chib et al., 2009; Heidebreder et al., 2019; Latinopoulos, Mentis & Bithas, 2018; Veiga et al., 2016; Xanthos & Walker, 2017; Zen, Ahamad & Omar, 2013). These reviews provided a framework for our analysis in studying the impact of interventions carried out by this South African retailer.

### **c. October Roll-Out of R4 Budget Bags**

After a successful trial at the beginning of the year, the R4 reusable bag was launched in October 2019. One million pieces of reusable pet bags were produced as an alternative to plastic bags and other more expensive reusable bags. This new, affordable bag was made from green Polyethylene Terephthalate and its purpose was to become an affordable alternative to retail plastic bags for all income groups. Jay, (2019) reported that the reusable bag (R4) carried a load of between 16kg to 18.4kg. The report also extolled the initiative as an innovative way of enhancing waste reduction, job creation and encouraging pro-environmental behaviour, given that the bag was the cheapest reusable bag available. The production required approximately two polymers of 500ml green Polyethylene Terephthalate (PET) for one bag. This PET was collected from two primary sources: municipal recycling programmes and an informal waste collection workforce of 75,000 collectors who earned a living from selling their PET bottles to recycling depots.

The Jay, (2019) report further showed that the bag could be re-entered into the same recycling cycle at the end of its life. This meant that when the bags eventually wear out, customers could take them to the stores and have them replaced at no charge. The reason for the use of green PET bottles was that these bottles tended to be left out of the recycling process due to short demand. Collectors tended to get a higher price for clear bottles (as this fibre was used more widely), so they were more likely to leave a coloured bottle behind unless they had space to transport it. The price (R5) at the rollout stage required a ninefold use of the R5 bag to make up for the difference in the cost of purchasing one standard 24-litre plastic bag (60c). The subsidy of R1 reduces the price to R4 which was actual price consumer paid during the month of intervention.

It is thus important to study the uptake of this affordable bag to determine the sustainability of the business, given the waves of its impact, such as waste reduction, job creation and increased pro-environmental behaviour by the consumer.

### **3.1 Stylised Facts on Retailer Interventions and the Elasticity of the Plastic Bag Levy**

This section investigates the elasticity of the levy on plastic carrier bags using tax data. It also analyses and describes trends in the sale of plastic shopping and reusable bags using retail outlet data. It is imperative to show trends in sales of plastic and reusable bags to observe the impact of the intervention graphically and also seasonal effects on carrier bag sales. Also, to affirm through the tax data estimation of elasticity the nationally representative of the retail outlet data.

Table 1 shows the degree of responsiveness of the consumption of plastic carrier bags to changes in the levy imposed by the government, covering the period from 2008 to 2020. The second column represents changes in the levy; changes in the levy range between 1cent to 4cent, except a 13cent increase in 2020. The fourth column represents the number of plastic bags sold nationally in South Africa in units of a billion – the number was estimated by using the plastic bag levy revenue as reflected in the tax data. The price elasticity of demand was estimated by means of the formula at the bottom of the table. The results confirmed the positive and inelastic demand from 2008 to 2010, which corroborates findings in the literature (see Dikgang et al., 2012a, 2012b).

However, factors such as the production of affordable alternatives, growth in public awareness, and continuous increase in the levy, among others, may have contributed to a consistent negative value of elasticity of demand from 2013 to 2020. The consistent negative value of the elasticity for more than a decade indicates a change in narrative that needs to be documented in the literature. This motivated the detailed investigation of the price-to-quantity relationship for plastic and reusable bags. This study moves beyond a descriptive analysis in order to explain the demand for plastic bags.

**Table 1: Sensitivity of Purchase of Plastic Carrier Bags to Changes in Plastic Bag Levy**

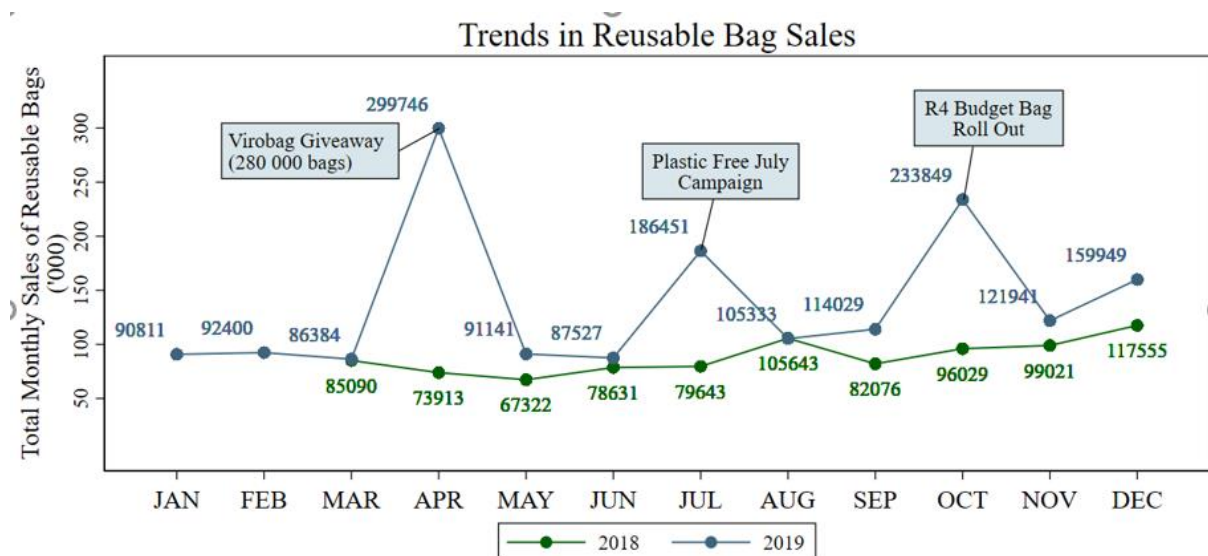
Year	Levy (Cents)	Revenue (ZAR)	Number sold (in units of a billion)	Elasticity
2008-2009	3	79000000	2633333333	
2009-2010	4	111000000	2775000000	<b>0.18335901</b>
2012-2013	4	151000000	3775000000	
2013-2014	6	169000000	2816666667	<b>-0.72692794</b>
2015-2016	6	183000000	3050000000	
2016-2017	8	232000000	2900000000	<b>-0.17647059</b>
2017-2018	8	241000000	3012500000	
2018-2019	12	300000000	2500000000	<b>-0.46485261</b>
2019-2020	12	318000000	2650000000	
2020-2021	25	581000000	2324000000	<b>-0.18653923</b>

Note: price elasticity is calculated for every year where there is a change in the levy.

Source: Author’s Computation, 2021.

$$\eta = \left( \frac{\text{New Levy} + \text{Old Levy}}{\text{New Quantity} + \text{Old Quantity}} \right) \times \left( \frac{\text{New Quantity} - \text{Old Quantity}}{\text{New Levy} - \text{Old Levy}} \right)$$

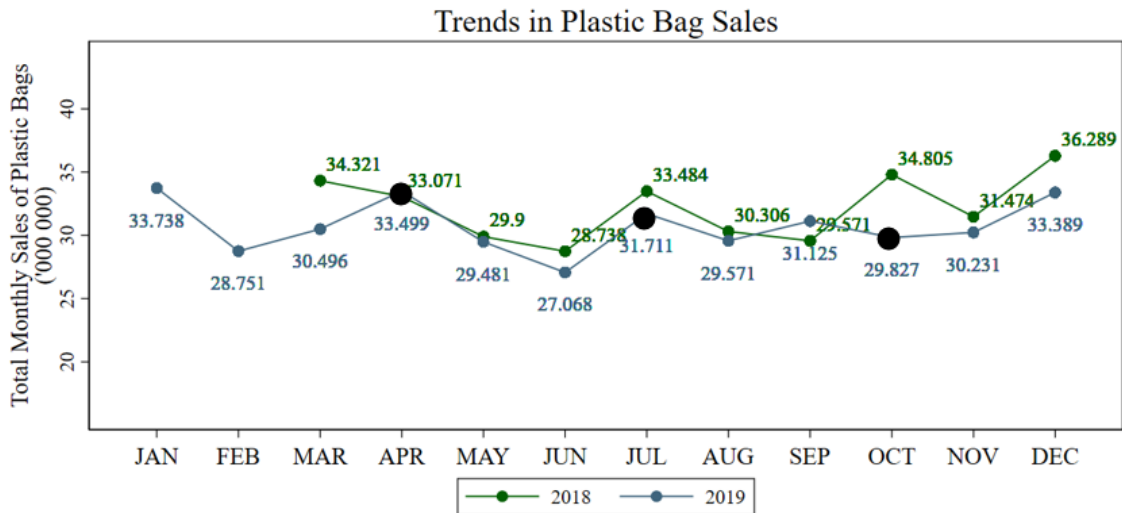
Figure 1 shows that the three interventions (T1, T2 and T3) all led to a significant increase in the uptake of reusable bags during the months of intervention. However, Figure 2 shows that on average, the sale of plastic bags did not decrease proportionately during the months of intervention, despite lower sales during 2019 compared to 2018.



**Figure 1: Trends in Reusable Bag Sales during 2018 and 2019**

The graphs in Figures 1 and 2 suggest that, although the three interventions all had a significant impact on the once-off uptake of reusable bags, there was no significant impact on

the sale of plastic bags. A comparison of the figures for the different months indicates no significant change in the average number of plastic bags sold during the months of intervention. When considering interventions that promoted reusable bags over plastic bags, it makes sense to analyse the stores that consistently sold a non-negligible number of reusable bags.



**Figure 2: Trends in Plastic Bag Sales during 2018 and 2019**

These figures do not provide a full picture, as there is no way of knowing what the plastic bags sales would have been had there been no interventions. Many other factors influenced the sale of plastic bags, and it is impossible to visualise this fact with trend analysis. It thus becomes imperative to employ a regression model to further analyse the impact of the interventions.

#### 4.0 Model Specification, Data and Methods of Estimation

This section has sub-sections. The first introduces the data sources that were used in this study, followed by a model specification in the next section. Thereafter the estimation methodology is described, concluding with a section on the appropriateness thereof.

##### 4.1 Data Presentation

The data used in this study is from a recognised nationwide retail outlet. The name will not be mentioned due to a non-disclosure agreement. The retailer accounts for more than 20% of the annual total sale of plastic bags in South Africa for the year under consideration.

The data for the weekly store sales of the plastic carrier bags and reusable bags, including store characteristics such as store size, store brand and demographics, was obtained from the retail outlet. This gives a historical dataset comprising 1039 stores over a period of 104 weeks, spanning from March 2018 to February 2020. The panel data was generated from a retailer data file, in which the cross-section and time dimensions of the data were represented by the stores and the weeks, respectively. The cleaning up of the raw data resulted in the removal of some stores where plastic bags were not compulsory when the levy was initially introduced. Also, the sale of reusable bags was not consistent across all stores, necessitating the introduction of the stock of bags available in each store as an explanatory variable. The cleaned data covered the period from March 2018 to February 2020 (104 weeks) for 800 stores where the sale of plastic bags was mandatory.

## 4.2 Model Specification

This study adapted the modelling approach by Taylor (2019). Although Taylor specifies a non-dynamic rather than dynamic model. This study also gave preference to a static specification but explore dynamic model for robustness given the need to capture the reuse of plastic bags and reusable bags. The model is specified as follows:

$$\begin{aligned}
 \ln y_{it} = & \beta_0 + \beta_1 \ln y_{it-1} + \beta_2 T1_t + \beta_3 T2_t + \beta_4 T3_t + \beta_5 \ln Price_{reusable_{i,t}} \\
 & + \beta_6 \ln Price_{plastic_{i,t}} + \beta_7 \ln Stoc_{i,t} + \beta_8 Region_i + \beta_9 Demo_i + \alpha_i \\
 & + \mu_{it} \qquad \qquad \qquad (1)
 \end{aligned}$$

where  $\ln y_{it}$  is the dependent variable which denotes either the logged sale of plastic bag or the logged sale of reusable bags, while  $\ln y_{it-1}$  is the one-period lag of dependent variables which were included to capture the reuse of previous bag sales and the sales pattern dynamic. Dummy variables were employed to capture the three treatments/interventions as follows: T1 captures the intervention based on a random “giveaway” of reusable bags in April 2019; T2 captures the non-monetary plastic-free month campaign of July 2019, while T3 represents another monetary intervention in form of a massive rollout of the subsidised R4 reusable bags in October 2019. Also included in the list of explanatory variables are the logged price of reusable bags ( $\ln Price_{reusable}$ ), the logged price of plastic bags ( $\ln Price_{plastic}$ ), and the log of stock of bags which measures the availability of plastic or reusable bags in the store. Additionally, the model includes two store-specific characteristics: “Demo” which captures

the income quantile of the store environment and customers, and “Region”, which captures the store province.

### **4.3 Method of Data Analysis**

This research adopted various panel estimation techniques, due to suspected endogeneity problems associated with price and demand relationships, in order to acquire robust findings. Firstly, there is the usual possible simultaneity bias with price being endogenous in the demand model. However, in this context, the price of plastic bags is explained mainly by the arbitrarily imposed levy by the government of South Africa, which leads to the conclusion that the price of plastic bags is exogenous. This study applies panel fixed effect regression to account for differences in time-invariant omitted variables across stores.

Given the likelihood of not capturing all time-invariant variables, such as store size, the study considered the fixed effects technique which is capable of accounting for such variables. The treatment/intervention variable (T) is represented as follows: T1 = giveaway dummy, April 2019 (monetary); T2 = plastic-free month, July 2019 (non-monetary); and T3 = R4 reusable bags roll-out dummy, October 2019 (monetary). Moreover, given the lack of certainty regarding time-invariant omitted variables, the random effect technique was also considered, following which the Hausman test was used to choose the appropriate estimation procedure, consistent with the literature (Taylor 2019; Yu & Xin, 2020; Da Silva & Hidalgo, 2020).

Finally, it was expected that the interventions would significantly and positively affect the uptake of reusable bags, followed by a negative and significant impact on the sale of plastic bags. The price of plastic bags was expected to be negative and significant, given its impact on plastic bag consumption, while that of reusable bags was expected to be positive and significant. This conclusion/expectation also applies to the price and demand relationship of the reusable bags. One of the plausible reasons for excess consumption of plastic bags is that consumers sometimes forget to bring their bags to the retail shop. Capturing the percentage of consumers that were given bags or purchased bags during period “t-1” and also remembered to bring the bag during period “t” showed a change in plastic bag sales for the period “t”. Therefore, it is important to include a lag of the dependent variable in the model in order to capture the effect of the purchase of the previous week’s reusable or plastic bags on the current week’s demand, and thus capture the impact of reuse of the bags. Furthermore, a simple estimation of one- and two-period future impact of the intervention on sales of both

plastic bags and reusable bags was done. This will measure the spill-over impact of the treatment to some weeks after the month of the intervention.

#### **4.4 Appropriateness of Fixed Effect Methodology in Estimating Price Elasticity**

The theory of demand and supply postulates that the higher the price, the lower the demand, and vice versa. However, studies provide an understanding of the problem of endogeneity inherent in the relationship between price and quantity demanded. Several studies adopted a variety of control function approaches to address the endogeneity problem. Among these were two-stage least squares estimates of water pricing (Hillenbrand et al., 2009; Musolesi & Nosvelli, 2007; Westling, Stromberg & Swain, 2020) and of electricity pricing (Bordon Lesme, Padilla & Freire-González, 2020; Burke & Abayasekara, 2018). More recently, others adopted the general method of moments for water pricing (de Bonviller, Wheeler & Zuo, 2020; Kotagama et al., 2017) and for electricity pricing (Chanthawong, Dhakal & Jongwanich, 2016; Waleed & Mirza, 2020).

However, the plastic carrier bag levy is exogenously determined by government legislation. This is an arbitrarily imposed levy in the South African context and remains the same regardless of the quantity of the plastic bags bought. Consequently, no endogeneity exists between price and quantity for retail plastic bags. Accordingly, fixed-effect regression should be appropriate to estimate the pricing effects since there is no endogeneity problem in the case of plastic bags.

Additionally, there is a concerning issue of endogeneity in the case of reusable bags price. The endogeneity issue with environmental commodities pricing usually originates from one source: reverse causality. Reverse causality exists when a dependent variable can also explain an explanatory variable in the model. Under the increasing block tariff system, the assumption that price is exogenous was violated. The increasing block tariff is a pricing system that discourages excess consumption of environmental goods such as water or electricity. The rate per unit increases as the volume of consumption increases. Such tariff increases thus create an awareness among consumers of volume consumed. However, the unit price of the reusable bag remains constant regardless of the quantity demand. This abates the suspicion of reverse causality inherent in the pricing of an environmental goods. Also, an assumption that retailers or producers may be motivated to increase the price to increase profit when demand is high, is not valid in this scenario. The uptake is low and reusable bags are still at the introduction stage in the market. Although, we cannot exclude the possibility of

some endogeneity issues with certainty. The decision to still estimate the regression is because it provides interesting results for reusable bags (something that has been understudied in Africa up to now). Therefore, the panel fixed effect estimator was used in estimating the price elasticity of demand for reusable bags (Schoengold, Sunding, and Moreno 2006; Miller and Alberini 2016; Chelwa and Walbeek).

The panel dynamic least square estimator (PLR), random effect (RANDOM) and fixed effect (FIXED) models were also explored. The Hausman test favoured the fixed effect as the most appropriate model; therefore, the fixed effect result was interpreted. The elasticity of demand for both plastic bags and the reusable bags was interpreted as log-log, since sales and prices were in natural log form. The inefficiency of the standard error was corrected with the standard robust variance estimation clustering for Store ID in Stata 15.

## **5.0 Results and Discussion**

The results presented here relate to the estimated price elasticity of demand and cross-price elasticity of demand for both plastic bags and reusable bags in South Africa using the retail outlet data. The impact of the three interventions (T1, T2 and T3) during 2019 by the retailer was also evaluated. Table 2 presents the result of the reusable bag model. Seven columns display the regression results. The first column of Table 2 lists the names of the variables starting with the natural log of bag stock, followed by the three treatments. The variables that follow are the prices of plastic bags and of reusable bags, again followed by the lag of the dependent variable to capture bag reuse. The results of the seven regressions relate to the (1) panel linear regression (PLR), (2) the random-effect (RE) regression, (3) the fixed-effect (FE) regression, (4) the reuse regression (which includes the lag value of the dependent variable to capture the reuse of reusable bags), (5) the one-period future impact regression, (5) the two-period future impact regression (to analyse the post-intervention impact on reusable bag sales), and (7) the fixed effect when the reusable bag price is dropped for comparisons of the result (FE R).

### **5.1 Price Elasticity of Demand for Reusable Bags**

Regarding the demand for reusable bags and their price, the result showed that price had a negative and statistically significant effect on the demand for reusable bags (see Table 2 column 3). The figures indicate that a one percent increase in price would lead to a 0.777 percent reduction in demand for reusable shopping bags, affirming that the demand for

reusable bags was weakly sensitive to its price changes. The implication is that an increase in price of reusable bags resulted in less than proportionate reduction in quantity demanded for reusable bag. Therefore, the coefficient of elasticity is less than one which can only be interpreted as movement along the demand curve but not enough for consumer to shift to alternatives. However, giving the initial findings in the literature where the price effect was described to be retrogressive (positive instead of negative). Therefore, there is a glimpse of hope that time theory of elasticity may eventually make consumer shift to cheaper reusable alternatives and reduces plastic carrier bag consumptions.

Similarly, the relationship between the demand for reusable bags and the price of plastic bags, as expected, showed a positive and statistically significant effect on the demand for reusable bags. This affirms that the two goods were substitutes. Moreover, the result indicates that a one percent increase in the price of plastic bags led to a 1.890 percent increase in demand for reusable bags. It implies that the demand for the reusable bag is susceptible to changes in the price of the plastic bag, since changes in the price of a plastic bag led to a more than proportionate change in demand for a reusable bag. Therefore, the demand for reusable bag was inelastic to its price, but positively elastic to the price of the plastic bag. This indicates that in future an increased demand for reusable bags could be the consequence of an increase in the price of plastic bags. Therefore, the price effect of plastic bag levy is large enough to increase the demand for reusable bags and consequently shift the consumer behaviour toward the purchase of reusable alternatives.

**Table 2: Regression Results for Reusable Bags Model**

VARIABLES	(1) PLR	(2) RE	(3) FE	(4) Reuse	(5) Future1	(6) Future2	(7) FE R
Log of bag stock	0.232*** (0.0364)	0.0683*** (0.0165)	0.0463*** (0.0169)	0.0416*** (0.0150)	0.0661*** (0.0175)	0.159*** (0.0185)	0.0898*** (0.0183)
T1	0.624*** (0.0811)	0.968*** (0.0594)	1.027*** (0.0594)	0.754*** (0.0567)	1.141*** (0.0666)	0.544*** (0.0645)	0.821*** (0.0547)
T2	0.410*** (0.0658)	0.339*** (0.0481)	0.319*** (0.0482)	0.235*** (0.0453)	0.257*** (0.0401)	0.192*** (0.0426)	0.348*** (0.0505)
T3	0.134* (0.0699)	0.241*** (0.0428)	0.244*** (0.0422)	0.108*** (0.0411)	0.412*** (0.0590)	0.321*** (0.0569)	0.469*** (0.0571)
Price of plastic bags	0.401 (0.472)	1.684*** (0.258)	1.890*** (0.261)	1.310*** (0.216)	1.862*** (0.282)	0.539** (0.250)	1.377*** (0.296)
Price of reusable bags	-0.694*** (0.0596)	-0.762*** (0.0402)	-0.777*** (0.0409)	-0.643*** (0.0374)	-0.439*** (0.0429)	-0.0707* (0.0423)	
Lag sale of reusable bags				0.299*** (0.0159)			
Constant	2.230*** (0.419)	3.679*** (0.248)	6.652*** (0.237)	4.933*** (0.223)	5.781*** (0.258)	3.627*** (0.240)	4.096*** (0.233)
Observations	7,567	7,567	7,567	7,016	7,313	7,086	7,567
R-squared	0.241		0.180	0.278	0.155	0.047	0.092
Number of Site ID		694	694	632	664	659	694

Note: The values in parenthesis are the robust standard error of the estimate, and \*\*\*, \*\*, \* represent statistical significance at 1%, 5% and 10%, respectively.

## 5.2 Price Elasticity of Demand for Plastic Bags

Regarding the relationship between the demand for plastic bag and its price, the result shown in column 3 of Table 3 is as expected. The effect of the price of a plastic bag on its demand is negative and statistically significant. However, a one per cent change in price would lead to a 0.36 per cent reduction in demand for plastic shopping bags, with all other factors remaining constant, confirming that the demand for plastic bags is weakly sensitive to its price changes, though negative. This implies that a percentage change in price leads to a less than proportional change in demand. Therefore, the demand for plastic bags is price inelastic. The price elasticity of demand for plastic bags shows an expected negative result. This is an improved result when compared to the inconsistent result from Dikgang et al. (2012b) in their investigation of first seven year of plastic levy imposition. Dikgang et al. (2012b) found poor and sometimes positive price elasticity, corroborating the result of the stylised fact (Table 1) regarding plastic bag demand.

Interestingly, there is a corroboration between the estimated price elasticity of demand for plastic bags as found in the tax data (Table 1) and the demand in retail outlet data (Table 3). Retail outlet data revealed 0.36%, while the tax data revealed 0.46%. Robustness was evaluated by reducing the time frame to only the 2018 fiscal year, for easy comparison of retail outlet data and tax data. Even though the retailer accounts for only an average of 20% to 25% of total plastic bag consumption in South Africa, the regression result for the 2018-2019 fiscal year was 0.43% which is only 3% points lower than the result based on tax data for the same time period. Meanwhile, regression accounts for other explanatory variables. This implies that the result of this model is consistent with and affirms that the retailer data is nationally representative.

The relationship between the price of reusable bags and the demand for plastic bags is both positive and statistically significant. It implies that the bags are intersubstitutable as far as price is concerned. The result indicates that a one percent increase in the average price of all reusable bags would lead to a 0.019 percent increase in demand for plastic shopping bags, with all other factors remaining constant. It implies that the demand for plastic bags is weakly sensitive to reusable bag price changes, though positive as expected. Percentage changes in price led to less than proportional changes in demand for a reusable bag. Therefore, the demand for a plastic bag demand still is inelastic, both to its own price and the price of a reusable bag.

**Table 3: Regression Results for Plastic Bags Model**

VARIABLES	(1) PLR	(2) RE	(3) FE	(4) 10_FE	(5) 20_FE	(6) REUSE FE	(7) FUTURE1	(8) FUTURE2
Bag Category	3.967*** (0.181)	0.273*** (0.021)	0.233*** (0.020)	0.250*** (0.022)	0.255*** (0.022)	0.176*** (0.017)	0.084*** (0.020)	-0.018 (0.020)
Ln Stock of Bag	0.453 (0.021)	0.030*** (0.002)	0.025*** (0.002)	0.027*** (0.002)	0.028*** (0.003)	0.019*** (0.002)	0.012*** (0.002)	-0.003 (0.002)
T1	-0.185*** (0.021)	-0.021*** (0.004)	-0.019*** (0.004)	-0.022*** (0.004)	-0.027*** (0.004)	-0.032*** (0.003)	-0.012*** (0.004)	0.008** (0.004)
T2	-0.033 (0.023)	-0.035*** (0.005)	-0.034*** (0.005)	-0.021*** (0.005)	-0.022*** (0.005)	-0.032*** (0.004)	-0.012* (0.007)	-0.008 (0.007)
T3	0.104*** (0.023)	0.012** (0.005)	0.011** (0.005)	0.020*** (0.004)	0.019*** (0.004)	0.005 (0.003)	0.017*** (0.004)	0.015** (0.006)
Price of plastic	-0.352 (0.278)	-0.356*** (0.047)	-0.358*** (0.048)	-0.484*** (0.049)	-0.518*** (0.049)	-0.339*** (0.037)	-0.548*** (0.054)	-0.467*** (0.056)
Price of reusable	0.467*** (0.022)	0.026*** (0.003)	0.019*** (0.003)	0.0293*** (0.004)	0.032*** (0.004)	0.014*** (0.002)	0.004 (0.003)	-0.004 (0.003)
Reuse (lag-plastic sales)						0.323*** (0.015)		
Constant	2.969*** (0.263)	6.686*** (0.145)	8.372*** (0.039)	8.626*** (0.039)	8.635*** (0.041)	5.590*** (0.131)	8.383*** (0.043)	8.592*** (0.045)
Observations	31,570	31,570	31,570	25,336	22,643	30,743	30,770	29,844
R-squared	0.614		0.024	0.035	0.038	0.144	0.014	0.008
Number of Site ID		777	777	628	609	774	777	777

Note: The values in parentheses are the robust standard error of the estimate, and \*\*\*, \*\*, \* represent statistical significance at 1%, 5% and 10%, respectively. Bag category is a dummy variable that is 1 for carrier bag with levy and 0 for carrier bag without levy.

### 5.3 Impact of Store Monetary and Non-monetary Interventions in South Africa

The panel least square estimator (PLR), random effect model (RANDOM) and fixed effect model (FIXED) were used to measure the impact of the three treatments (T1, T2 and T3) in order to compare monetary and non-monetary interventions. The Hausman test favoured the fixed effect model as the most appropriate one, therefore, the result of the fixed effect model was interpreted. The third column of Table 2 and 3 presents the fixed effect result, which measured the impact of interventions (T1, T2 and T3) on the sales of bags (reusable and plastic) across all the stores without restrictions. Columns 4 and 5 of Table 3 restrict the store sample to those that consistently sold more than 10 and 20 reusable bags, respectively. The interpretation follows the following outline: the first part describes the immediate impact of the three treatments on uptake/sales of reusable bags, followed by the immediate pass-through effects of the three treatments on sales of plastic bags. Finally, the estimated impact of the non-monetary intervention (T2) is compared to monetary interventions (T1 and T3).

#### 5.3.1 The Giveaway (T1 Monetary)

In this intervention, close to 300,000 core reusable bags were given away to customers in a lottery draw for every sale of more than R50 (see page 3 for details). As expected, the panel fixed effect results showed a positive and statistically significant effect on the uptake of reusable bags. The giveaway intervention (T1) resulted in a 179% increase in the uptake of reusable bags in April 2019 (see Table 1, column 8 which is correction of marginal effect for log-linear model for dummy variable using Halvorsen & Palmquist (1980) formular:  $[100 \times (e^{\beta_2} - 1)]$ ). The lag value of the dependent variable was introduced in the explanatory variable in order to capture the reuse effect on the dynamics of the sales pattern. The giveaway treatment (T1) impact on reusable bags uptakes reduces from 179% to 113% (see Table 1, column 4). Table 1, column 5 estimates the impact of the intervention on single period future sales, while Table 1, column 6 estimates the impact of the intervention on two-period future sales of reusable bags, showing 213% and 72% increase sales of reusable bags, respectively.

Regarding the impact of the giveaway intervention (Monetary-T1) on plastic bags sales. Table 2, column 3 (column 9 Halvorsen & Palmquist (1980)) reveals that the giveaway intervention (T1) had a significant and negative impact on the sale of plastic bags, as hypothesised. The intervention caused a 1.9% reduction in the sale of plastic bags. When the

dependent variable's lag value was introduced in the explanatory variable to capture the reuse effect and dynamics in the sales pattern, the impact increased to 3.15% (see Table 2, column 6). Table 2, column 7 estimates the impact of the intervention on one-period future sales, while Table 2, column 8 estimates the impact of the intervention on two-period future sales, showing a 1.2% reduction and a 0.8% increase in the sale of plastic bags, respectively. Where the estimation was restricted to only stores that consistently sold more than 10 and 20 reusable bags, it projected a consistent decrease of 2.2% and 2.7%, respectively, in the sale of plastic bags.

### **5.3.2 The Plastic-Free Month (T2 Non-Monetary)**

The plastic-free month incentives were in the form of nudges and did not involve any monetary motivation. The retailer nudged consumers to not buy plastic bags and displayed reusable bags instead (see page 3). The panel fixed effect results, as expected, showed positive and statistically significant effects on the sale of reusable bags. In addition, the plastic-free intervention (T2) led to a 38% increase in the sale of reusable bags in July 2019 (see Table 1, column 3). Also, Table 1, columns 5 and 6 reveal the impact of the intervention on one- and two-period future sales. The result shows a 29% and 21% increase in the sale of reusable bags, respectively.

Table 2, column 3 reveals that the July plastic-free month intervention (T2 non-monetary) had a significant and negative impact on the sale of plastic bags, as hypothesised. The intervention caused a 3.34% reduction in the sale of plastic bags. When the dependent variable's lag value is introduced in the explanatory variable to capture the reuse effect and dynamics in the store sales pattern, the impact reduces to 3.19% (see Table 2, column 6).

Table 2, columns 7 and 8 estimate the impact of the intervention on one- and two-period future sales, resulting in a 1.2% and 0.8% reduction respectively in the sale of plastic bags. The very slight impact of non-monetary nudges (T2) corroborates the literature on the disappearance of the effect of nudges when the motivation is withdrawn. The nudge intervention was implemented only for one month and reduced the consumption of plastic bags, but the impact faded with time. The reasons for the fading impact were clear, since the retailer did not sustain the practice, maybe for fear of losing customers. Where the model estimation was restricted to only stores that consistently sold more than 10 and 20 reusable

bags, results indicated a consistent decrease of 2.2% and 2.7%, respectively, in the sale of plastic bags.

### **5.3.3 The R4 Roll-Out (T3 Monetary)**

The rollout intervention involved the massive sale of R5 bags with a subsidy of R1 for the first 1 million pieces sold. The fixed effect result shows a positive and statistically significant effect on the uptake of reusable bags, namely a 28% increase in the uptake of reusable bags in October 2019 (see Table 1). Table 1, columns 5 and 6 reveal the impact of this intervention on one- and two-period future sales, namely a 51% and 38% increase in the sale of reusable bags, respectively.

Table 2, column 4 reveals that the rollout intervention (T3) significantly and positively impacted the sale of plastic bags, which was against expectation. This treatment had a pass-through effect of a 1.1% increase in the sale of plastic bags. Table 2, columns 7 and 8 estimated the impact of this intervention on one- and two-period future sales, showing a 1.7% increase and a 1.5% increase in the sale of plastic bags. Where the model was restricted to only stores which consistently sold more than 10 and 20 reusable bags, it estimated a consistent increase of 2% and 1.9% respectively, in the sale of plastic bags, contrary to the anticipated decrease. Thus, the result for treatment T3 is counterintuitive, but reasons for this positive effect on the sale of plastic bag are explained as follows:

Firstly, the result of the T1 monetary intervention, revealed that a 179% increase in the uptake of reusable bags could only achieve a 1.9% decrease in plastic bag consumption. Compare this to intervention T3, which achieved a 28% increase in the uptakes of reusable bags but resulted in a 1.1% increase in the sale of plastic bags. Unfortunately, there are no facts to prove that without the intervention there would have been a greater increase in the sale of plastic bags. Moreover, T3 were subsidy of R1 (From R5 to R4) per bag while T1 was a giveaway of a reusable bag worth R25 to the consumer.

The second plausible reason for the positive effect of T3 on plastic bag consumption could be that one unit of R4 could purchase 8 (at R0.50 each) plastic bags. Thus, the design of the bags to suit the middle- and lower-income groups may not have been as effective as anticipated. More importantly, the literature corroborates that subsidies to encourage pro-environmental behaviour are less effective, especially in promoting the uptake of environmental goods (Poortinga and Whitaker, 2018). Finally, remembering to reuse bags has been a significant contributing factor to habitual plastic carrier bag consumption. Therefore, consumers may

purchase reusable bags and still treat them as single-use products or forget to reuse, which would cause the subsidy treatment and massive rollout treatment (T3 monetary) to be ineffective. Furthermore, October is usually summer in South Africa. Before the Covid 19 outbreak, people went out more and spent more, thus increasing plastic consumption toward the end of the year.

Among the plausible reasons for the counterintuitive result of massive rollout and subsidy treatment (T3) is the high correlation between the price of the reusable bag and T3 since T3 represents a temporary reduction in the price of the reusable bag. A fixed-effect regression was estimated in the appendix 3, Table 3 to examine the impact of the subsidy treatment (T3) with reusable bag price and without reusable bag price. The result corroborates the ineffectiveness of subsidy treatment as the impact of T3 became very small and statistically insignificant without a reusable bag price variable in the model. This affirms the assumption that the correlation effect between reusable bag price and T3 produces counterintuitive positive results when the price of reusable bags is captured in the model.

#### **5.4 Comparative Analysis of Monetary and Non-monetary Interventions**

Treatment T1 reveals that giving away expensive reusable bags to consumers may not be a cost-effective way to reduce single-use plastic bag consumption, given the substitution ratio and immediate decrease in demand for plastic bags. The result of the giveaway treatment (T1 monetary) indicates that the supply of a single free reusable bag led to a reduction of two plastic bags. Thus, the overall substitution of 300,000 reusable bags for a reduction of 600,000 plastic bags out of an average monthly sale of 30 million for April 2019, led to only a 2% reduction in the sale of plastic bags. This reduction shows that one giveaway reusable bag (R25) substituted for two plastic bags, costing barely R1.20.

This intervention gave way to a cheaper alternative, namely a massive rollout of R4 reusable bags, subsidised with R1 (T3 monetary). Unfortunately, the intervention could not achieve its objective. It led to a 17% increase in the uptake of reusable bags and a counterintuitive 1.1% increase in the sale of plastic bags. Conversely, the plastic-free month (T2 non-monetary) intervention had a potentially active impact on the sale of plastic bags, relative to the other two interventions. Without monetary incentives, the sale of reusable bags increased by 31%, while the sale of plastic bags decreased by more than 3%, leading to an estimated reduction in sales of 900,000 units in July 2019. Results of the regression models reveal that non-

monetary nudges (T2), such as public campaigns, messages and changes in default settings, were more effective than a reusable bags giveaway (T1) and the subsidisation of reusable bags (T3). However, the retailer reported that although the plastic-free month was designed for all stores, some stores failed to comply 100% with the implementation of the treatment/intervention.

#### **5.4 Discussion of Findings**

The price elasticity of demand for plastic bags is inelastic to plastic bag levy, plastic bag price, and reusable bag price. This implies that consumers are hardly responding to the government's continuous increase of the plastic bag levy. The findings show that a price increase is insufficient to shift consumer behaviour away from plastic bag consumption. Conversely, the quantity demand for reusable bags is inelastic to its own price, but elastic to the plastic bag price. This result raises alarm on consumer rigidity with regard to single-use shopping carrier bags and the possibility of getting them to single use the purchase reusable bags. However, the results of this study must be interpreted with caution, as the demand for plastic bags is counted in tens of millions, while that of reusable bag is counted in tens of thousands. This implies that without reuse of reusable bags, it may be very difficult to how increase in reusable bags uptake will decrease plastic bag consumption. It is tantamount to a drop of water in an ocean. The price elasticity of demand result for plastic bags based on retailer's data is very consistent with that tax data.

The lag of the dependent variable (plastic bag) is statistically significant and shows a positive correlation between past and present consumption as expected. The past and present consumption relationship affirm habitual consumption among retail outlet consumers. Therefore, changing consumers behaviour require a carefully designed intervention. Similarly, the relationship between past and present reusable bag consumption indicates that habit formation is also happening for reusable bags – even though it is a relatively new alternative on the market. This provides for tentative optimism that the interventions aimed at improving uptake of reusable bags has been successful.

The impact of the giveaway intervention (T1 monetary) was statistically significant in increasing the uptake of reusable bags. This in turn led to a reduction in plastic bag consumption. This corroborates the findings of Santos and Linden (2016) in their study in which students were given reusable water bottles on their matriculation day, and which in turn led to a reduction in their consumption of single-use bottles. The findings generally

support the literature on the effectiveness of alternatives to reduce plastics consumption (Clapp & Swanston, 2009; Martinho, Balalaia & Pires, 2017; Santos & van der Linden, 2016). The rollout treatment (T3 monetary) revealed a marginal increase in the uptake of reusable bags associated with a marginal increase in plastic bag consumption. The result complements Poortinga & Whitaker's (2018) work and affirms the suggestion by Dikgang et al. (2012) for additional measures to make South African consumers aware of the plastic bag crisis, as subsidy may not be effective. The non-monetary nudge treatment (T2 non-monetary), on the other hand, which includes campaigns, messages, and changes in default settings, revealed an increase in the sale of reusable bags and a decrease in plastic bag consumption.

The findings support growing evidence of the effectiveness of non-monetary nudges to enhance pro-environmental behaviour (Egebark & Ekström, 2016; Freedman & Brochado, 2010; Goldberg & Gunasti, 2007; Lehner, Mont & Heiskanen, 2016). Several similar studies have established that campaigns may enhance the effectiveness of environmental levies (Heidbreder et al., 2019; Uehara & Ynacay-Nye, 2018), following the most popular Ireland plastic levy, recorded as one of the most successful plastic bag levies. The levied amount in Ireland was designed by a willingness to pay study that ascertain the amount that will shift consumer behaviour. This was accompanied by public campaign to raise awareness of the plastic bag pollution (Convery, McDonnell, & Ferreira, 2007). Furthermore, studies have shown that changes to default settings were a way forward to correcting habitual consumer behaviour regarding plastic bag consumption.

This study found that non-monetary intervention is more efficient in reducing plastic bag consumption (pollution) than monetary intervention. This study revealed that there is possibility of consumers single-using reusable bags, which can be more environmentally disastrous. This confirms the lack of awareness of the problem of plastic bag pollution among South African consumers (Dikgang, Johane, Leiman, Anthony & Visser, Martine, 2012a).

## **6.0 Summary, Conclusion and Policy Recommendations**

The impact of the plastic bag levy on plastic bag consumption has recently been consistently negative. Although the price remains inelastic, the price of plastic bags motivates the consumption of reusable bags. This is good news to the retailer and policymaker. The latter then provides a policy framework to increase demand for reusable bags by consistently increasing the price of plastic bags. However, among consumers the single use of reusable

bags is very likely, which may be more dangerous to the environment and resource management, according to the life cycle sustainability assessment (LCSA) report. The recent study conducted by CSIR revealed that reusable carrier bag performs best among all the carrier bags (Bisinella, Albizzati, Astrup, & Damgaard, 2018). The study affirmed that consumer reuse the reusable bag in South Africa. However, the reusable bag must be used minimum of 37 times as recommended in another study to increase its sustainability (Civancik-Uslu, Puig, Hauschild & Fullana-i-Palmer, 2019). The synergy in price elasticity of tax revenue data and of retail outlet data, affirms the claim by the retailer that its data is nationally representative. The study also investigated the impact of monetary (T1 and T3) and non-monetary (T2) interventions by stores on the uptake of reusable bags and the reduction of the consumption of plastic bags. This aspect used longitudinal retail store data, which included 800 stores for 104 weeks across South Africa.

The panel fixed effect method was considered appropriate, given the explanation favouring the exogenous claim of plastic bags and reusable bag price (see page 17 section 4.4). Three interventions were investigated, namely the giveaway (T1), the plastic-free month (T2) and lastly, the rollout and subsidies (T3). The first and last treatments were regarded as monetary interventions, while the second intervention was non-monetary, since the treatment included three nudges to discourage the consumption of plastic bags, namely campaign messages for consumers, store-level campaigns and changes to the default questions by cashiers. The monetary interventions (T1 and T3) included a random giveaway of 300,000 reusable bags to customers in April 2019 and the rollout of the cheapest R5 reusable bags subsidised with R1 during the month of October 2019.

It was found that each of the three interventions (T1, T2 and T3) had a statistically significant impact on the increase in the sale of reusable bags but only two (T1 and T2) successfully decrease the purchase of single-use plastic bags. The plastic-free month non-monetary nudge treatment had a greater impact on the reduction of plastic bag sales than the other two pecuniary treatments. The ineffectiveness of the rollout as a subsidy intervention (T3) and the giveaway treatment (T1) affirms the conclusion that consumer awareness of the environmental impact of single-use plastic bags is shallow in South Africa. In order to check for robustness, the analysis was restricted to stores that sold more than 10 and 20 reusable bags consistently. The results revealed greater reduction in plastic bags sales than the model estimate for stores without restrictions. The inclusion of an explanatory variable, bag stock, which captures the availability of any type of bags (reusable or plastic bag) at the store and

reveal possibilities of retail stores running out of bags. Whereas the availability of reusable bags will give pro-environmental consumers consistent access to an alternative to plastic carrier bags.

The plastic-free month intervention could potentially have a greater impact if more monitoring and general compliance among the cashiers and across all stores is enforced. Indeed, public campaigns, changes in the default setting, and inter-store challenges have proved to be effective nudges compared to subsidies or giveaway treatments, these nudges were the most cost-efficient way to reduce the consumption of single-use plastic bags and marine debris in South Africa. The model's dynamics suggest that consumption of plastic bags has become habitual in South Africa, and thus requires more rigorous behavioural intervention in order to nudge consumers to be more environmentally conscious.

In particular, it is recommended that the impact of constantly reminding consumers to reuse plastic bags should be investigated in an experimental study. This is necessary because this study reveals a low level of reuse of both plastic bags and giveaway (T1 and T3) reusable bags. The cultivation and sustainment of consumer consciousness regarding bag reuse is important, since remembering to bring reusable bags remains a critical problem as far as the literature is concerned. Finally, consumer behaviour and its drivers with regard to recycling should be investigated to ascertain the end-use of plastic bags and other single-use plastic materials in South Africa.

The plausible limitation of the study is possibly over-dependency on store level data. This makes it difficult to measure the impact at the aggregate level, as the demand for plastic bags is numbered in tens of millions, while that of the reusable bag is numbered in tens of thousands. This implies that capturing a pass-through impact of reusable uptake to the reduction of plastic bag consumption without the reuse of reusable bags may be very difficult. It is akin to a drop of water in an ocean. More importantly, this research was not a randomised control trial (RCT) experiment. It captured a real field experiment, in which the retail outlet and its several departments performed self-administered interventions. The effectiveness of the intervention depended solely on the organisation's internal discipline, which could be assumed to be comparable to what is expected from any well-organised company. Finally, one of the covariates in the regression model ( $\ln$  Stock of Bag) was proxy by  $\ln$  of bag supply to the stores. The supply of plastic bags and reusable bags was not frequently, which also created missing data and made the panel data unbalanced. However,

the variable is very important in the model, making its inclusion pertinent to capture a robust result. Also, the initial concern about reusable bag price endogeneity issues can be further addressed in the future research when the consumers level data is available.

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## Appendix 1 (Giveaway Promotion)

This appendix shows the reusable bags that were given away during the Giveaway month of April (T1). The table below indicates the daily number of bags that were allocated to each store/outlet category, as well as the total number of bags per store category available for the campaign.

### Virobags Daily Giveaway



FORMAT	NO. BAGS TO BE WON PER DAY	NO. BAGS TO BE WON IN EACH STORE TOTAL CAMPAIGN
Clothing	20	300
Hyper	40	600
Local	20	300
Super	30	450
Online	20	300
Express	10	150
Family	20	300
Market	10	150
Mini	20	300

## Appendix 2 (Plastic-free month)

This appendix explains the nudges that were used during the second treatment (T2), namely to promote the use of reusable bags instead of plastic bags during July 2019.

### 3 July – International Plastic Bag Free Day

#### Objectives :

- Plastic bag challenge to our Smart Shoppers: Challenge to go “plastic bag free” for July.
- Call out to customers to help us not to sell 1 plastic bag on 3 July.

#### POS :

- Stores will receive 1000 by 700 portrait posters on 1 & 2 June 2019.
- These posters must be customer facing so place them in the A Frames at the entrance of your store.
- The Re – usable bag display disciplines are attached and all stores are requested to have a huge displays of Re – usable bags with the POS in an A Frame next to the display for customers to purchase
- All Cashiers & Till Packers must be trained and aligned on this objective that we want to achieve with the support of our customers. “ So NO asking our customers do want a PLASTIC ” during the ENTIRE month of July instead lets ask our customers “ Do have a Re – usable bag “

#### Challenge :

- To have our stores to to sell MORE Re – usable bags and NO Plastic Shopping on the 3 July 2019 and during the month of July 2019.



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1

### re-usable bag display

**Traditional tills:** End of every 4<sup>th</sup> checkout stand

**Fair Queue tills:** In the last stand, wrapping round the back to face the tills

Next gen ends

Non-next gen ends



Stand-alone Magazine stand

Integrated Magazine stand



This is an option on slanted tops if no u-bars and hooks are available

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Reusable bag displays

Traditional tills: At the end of every 4<sup>th</sup> checkout

Stand-alone magazine stand

Integrated magazine stand

Fair Queue tills: The last stand wraps around the back to face the tills.

The slanted top option may be used where no u-bars and hooks are available.

### Appendix 3

Among the plausible reasons for the counterintuitive result of massive rollout and subsidy treatment (T3) is the high correlation between the price of the reusable bag and T3 since T3 represent a temporary reduction in the price of the reusable bag. A fixed-effect regression was estimated in the appendix label as table 4 to examine the price effect of subsidy treatment. The result corroborates the ineffectiveness of subsidy treatment as the impact of T3 became very small and statistically insignificant without a reusable price variable in the model. This affirms the assumption that the correlation effect between reusable bag price and T3 produces counterintuitive positive results when the price of reusable bags is captured in the model.

Table 4: Robustness for Correlation Between Subsidy Treatment (T1) and Reusable Bags Price

VARIABLES	(1) FE-With Reusable Price	(2) FE-Without Reusable Price
Bag Category	0.227*** (0.021)	0.228*** (0.021)
Ln Stock of Bag	0.025*** (0.002)	0.026*** (0.002)
T1	-0.019*** (0.004)	-0.011*** (0.003)
T2	-0.033*** (0.005)	-0.032*** (0.005)
T3	0.013** (0.005)	0.008 (0.006)
Price of plastic	-0.360*** (0.048)	-0.356*** (0.049)
Price of reusable	0.019*** (0.003)	
Constant	8.367*** (0.039)	8.413*** (0.039)
Observations	31,521	31,521
R-squared	0.024	0.020
Number of SiteID	775	775

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

### Appendix 4.

The below table reveal the summary statistics of variables used in the analysis. The dependent variable is the Bags sales which is in natural log form. Also, the explanatory variables such as price of plastic bag and reusable bag is also in natural log form.

#### Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Ln Bags Sales	78918	8.482	1.576	0	10.934
Region	78984	2.846	1.671	1	6
Demo	78984	2.762	1.44	1	7
SC dummy	76483	.017	.128	0	1
Giveaway (T1)	78984	.044	.205	0	1
Plastic-free month (T2)	78984	.044	.206	0	1
Roll out (T3)	78984	.041	.199	0	1
Price Plastic Bag	78915	-.708	.075	-1.059	.789
Price Reusable Bag	61097	2.609	.364	-4.605	3.963

Source: Retail Outlet Data, 2020

Variable	Mean	Std. Dev.	Min	Max	Observations
lnsale~3 overall	<b>8.482238</b>	<b>1.575556</b>	<b>0</b>	<b>10.93429</b>	N = 78918
between	<b>3.225085</b>		<b>0</b>	<b>10.48717</b>	n = 944
within	<b>.2757682</b>		<b>1.86883</b>	<b>11.19932</b>	T-bar = 83.5996
Region overall	<b>2.846298</b>	<b>1.671047</b>	<b>1</b>	<b>6</b>	N = 78984
between	<b>1.666696</b>		<b>1</b>	<b>6</b>	n = 947
within	<b>.0354289</b>		<b>2.117326</b>	<b>4.117326</b>	T-bar = 83.4044
Demo overall	<b>2.76161</b>	<b>1.440471</b>	<b>1</b>	<b>7</b>	N = 78984
between	<b>.9330773</b>		<b>1</b>	<b>6.626168</b>	n = 947
within	<b>1.057182</b>		<b>-2.098203</b>	<b>7.574694</b>	T-bar = 83.4044
SC_dummy overall	<b>.0167357</b>	<b>.1282805</b>	<b>0</b>	<b>1</b>	N = 76483
between	<b>.0362434</b>		<b>0</b>	<b>.2941176</b>	n = 936
within	<b>.122572</b>		<b>-.2773819</b>	<b>1.00739</b>	T-bar = 81.7126
Pric~p_n overall	<b>-.7080597</b>	<b>.0746316</b>	<b>-1.059392</b>	<b>.7888842</b>	N = 78915
between	<b>.0549825</b>		<b>-1.059392</b>	<b>-.1391656</b>	n = 944
within	<b>.0519483</b>		<b>-1.347653</b>	<b>.7666474</b>	T-bar = 83.5964
Price_r overall	<b>2.018032</b>	<b>1.137565</b>	<b>0</b>	<b>3.963286</b>	N = 78984
between	<b>.9381802</b>		<b>0</b>	<b>3.261552</b>	n = 947
within	<b>.7152493</b>		<b>-.8880395</b>	<b>5.337984</b>	T-bar = 83.4044