Predicting Petty Corruption in the Public Sector through Household Survey Non-Compliance

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Abstract

Corruption is a phenomenon in which many South Africans are well versed. While it continues to headline the news, the true extent of corruption is difficult to determine. Perception based indices have been proven to be inaccurate and experience-based data is also likely to incorrectly estimate the level of corruption. Forensic economics have come forward to fill this gap. These methods, however, are not always feasible as they rely on special datasets which are often difficult to come by. Using the National Income Dynamics Survey (NIDS) Waves 3, 4 and 5, this paper measures the difference in income underreporting between the public and private sectors. This difference is argued to represent the relative level of petty corruption in the public sector. Estimation results show an increasing trend in petty corruption over the period 2012-2017 with the public sector underreporting their income by, on average, 31.71%. Petty corruption is highest in law enforcement and the general government sectors. Evidence shows spatial variation in petty corruption with rural areas having the highest levels of underreporting. Petty corruption is also found to vary across the income distribution as levels of underreporting increase with income.

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1. Introduction

Corruption is a phenomenon that exists in societies throughout the world. Corruption's negative effect on development is well documented (Mauro, 1995; Dreher and Herzfeld, 2005) and this extends to its effects on almost all factors of a state. Corruption decreases investment and GDP growth, increases income inequality and reduces the quantity and quality of public services. In South Africa, a state with high levels of inequality and almost daily protests of poor service delivery, corruption steals much needed public resources from the people who need them most (Justesen and Bjørnskov, 2014). Minister of Economic Development, Ebrahim Patel estimates that corruption in the public sector costs the country at least R27 billion annually (Corruption Watch, 2018). The events unfolding in the Zondo Commission typify the systemic corruption that exists in South Africa. At a macro scale such activity results in the violation of human rights, prevents sustainable development and enhances inequality (Aidt, 2011). At a micro level this filters down, creating a system of petty corruption which infiltrates all aspects of public life (Transparency International, 2016). In a time where public attention is trained on corrupt activities, understanding the extent of corruption is a necessary part of addressing it through anti-corruption strategies and policies.

The dominant definition of corruption in the economic literature is "[the use of] public office … for private gain in a manner that contravenes the rules of the game" (Jain, 2001; Aidt, 2003; Svensson, 2005; Trapnell, 2008; Enste & Heldman, 2017). Based on this definition, Jain (2001) identifies three conditions which are necessary for corruption. These are the existence of discretionary power, the opportunity to extract and create economic rents through this power and the existence of institutions which create incentives to extract these rents.

South Africa is no stranger to corruption with headlines reporting almost daily of new scandals which rock the country's political landscape. In their Global Competitiveness Index of 2017-2018 (WEF, 2018), World Economic Forum (WEF) lists corruption as South Africa's top problematic factor for doing (WEF, 2018). Corruption, however, is not only a feature of the post 1994 transition and democratic rule of the African National Congress (ANC). Rather, its roots extend well into the Apartheid history of the country, where the foundations were laid for the practices we see today (Hyslop, 2005; van Vuuren, 2006). Sectors which were notorious for corruption in the Apartheid period have remained so with the police, traffic officers and Departments such as Social Development, Housing and Defence having the highest levels of perceived and reported corruption (Corruption Watch 2017, 2018; StatsSA 2017; 2018). Additionally, provinces which incorporated former Apartheid era 'Homelands' seem anecdotally to have inherited their systemic levels of corruption (Hyslop, 2005).

Corruption can be classified as either grand or petty based on its magnitude. The former involves large sums of money and significant favours, usually exchanged between high level officials. Petty corruption refers to smaller sums and commonly takes the form of bribes. Such activities are carried out by low level bureaucrats or officials. While the sums involved are small relative to grand corruption transactions, these activities have a real the impact on service provision, government income and policy development (Lambert-Mogiliansky, Majumdar & Radner, 2007). The effects of petty corruption fall disproportionately on the poor. Given the high levels of income inequality in South Africa, low income households are reliant on the public sector for the provision of basic services. These households therefore have greater exposure to petty corruption.

Due to the clandestine nature of corruption, it is a difficult phenomenon to measure. The existing measures of corruption are mostly perception- and experience-based. Indices based on perception have been proven inaccurate predictors of actual corruption levels, containing multiple measurement and definitional issues (Olken, 2009). Experience-based measures such as survey data are also unlikely to uncover the true extent of the hidden activities. Surveys suffer from similar definitional issues as perception-based studies as well as recall bias of the respondents. As many corrupt activities benefit both parties, neither have an incentive to reveal their involvement (Bruce, 2014). Similarly, reported measures of corruption do not capture these individuals, nor those who have been threatened or see bribes and such activities as 'business as usual' (Bahre, 2005).

In response to this, there has been an emergence of studies attempting to measure corruption using forensic economics (Reinikka and Svensson, 2004; Olken, 2009 and Sukhtankar, 2012 amongst others). The common feature of these approaches is the use of two data sources, one which includes the corrupt activity and one which does not. This comparison reveals the hidden activity of participants (Zitzewits, 2012). While these studies are able to uncover interesting evidence, they still require specialist data which, in developing countries with severe data shortages, is often hard to find.

The approach of this paper is one adapted from the tax evasion literature, measuring non-compliance in income tax returns. This method was developed by Pissarides and Weber (1989) and has been applied multiple times in this literature (see Apel, 1994; Schuetze, 2002; Johansson, 2005; Kim et al., 2009; Li and Pugsley, 2014). Zhong (2016) adapted this method to uncover corruption using discrepancies in expenditure data and reported income to develop a measure of

underreporting which is attributable to corruption, or at least gains from illicit economic activity of which a portion is likely corruption.

Following Zhong's (2016) approach, this paper applies an expenditure-based method to estimate the income underreporting attributed to corruption of public sector workers. The sample is split into two groups, public and private sector workers. This is based on the two assumptions that underpin this model. First it is assumed that the reporting of expenditure on some items by *all* groups is accurate and second that reporting of income by *some* groups is accurate. Public sector workers are argued to have more opportunities to engage in corrupt activities due to the higher levels of discretionary powers, inherent in the public sector (Argandona, 2003). They are also unlikely to report the corruption income in a household survey. This is due to the reluctance of people to report information that they wish to conceal which is further bolstered by the survey design which categorises income by source (Moore et al, 2000). Other issues of income reporting are argued to be randomly distributed across the two groups. Expenditure on the other hand, is likely to be similarly reported by both groups as there is no incentive to hide it. Moreover, separating the portion of expenditure attributable to corruption income requires a lot of cognitive effort and so is unlikely to occur. In order to estimate the gap between each group's income and consumption and forecast the public sector's true income, an expenditure function is estimated. This is then inverted to provide a measure of income underreporting.

The results of this paper estimate levels of petty corruption. Corrupt elites will often send income from corruption and other illicit activities overseas to avoid detection. This money will therefore not be captured in domestic expenditure (Bhorat et al., 2017). Furthermore, a problem inherent in household surveys is that they under-sample high income households. These households are also more likely to refuse to report sensitive data, such as income (Moore et al., 2017). This study therefore under-represents elites and for those that are in the sample, it is unlikely to capture their corruption income as it is not spent domestically. Low sampling of high income households, a problem inherent in household surveys, and the reluctance of households, especially high income households to report sensitive data, causes this paper to under-sample high income households. Hence, this study is more likely to capture petty corruption activities in the public sector.

The benefit of this approach is that it enables corruption to be measured across sectors within the public sector, to account for spatial variation and to measure underreporting across the expenditure distribution. Levels of petty corruption are found to increase between the period 2012-2017. This coincides with a period of decreasing economic growth, increasing unemployment rates and the rise of Zuma's state capture agenda. The results show that public sector workers are, on

average, underreporting their income by 31.71%. An important finding through quantile regressions was that this figure is not constant but rather increases along the expenditure distribution. This indicates that individuals with higher consumption in the public sector have a higher incidence of income underreporting. Across different sectors, individuals employed in Law Enforcement, which includes police, traffic officers and those who work in the Department of Correctional Services, have the highest level of underreporting income at 58.64%, suggesting a very high level of petty corruption. This is in line with various reports of corruption, most of which list the police and traffic officers as services with the highest incidences of bribery (StatsSA, 2017, 2018). The general government sector also shows a high level of estimated petty corruption at 40.67%. This is likely driven by the inclusion of the Department of Social Development and Housing which, amongst others, are well known hotspots of corruption (van Vuuren, 2006; StatsSA 2017; Corruption Watch 2018). Regarding spatial variation, rural areas show higher levels of petty corruption in comparison to urban areas. Rural areas in poor provinces appear to have the highest level of petty corruption with poorer provinces showing higher levels of corruption when accounting for the area type.

This paper is organised as follows. Section 2 presents an overview of corruption, its effects, its measurement and an analysis of corruption in the South African context. Section 3 provides a description of the data and method used in this study, as well as the econometric approach. Section 4 goes on to present and discuss the results of the estimations and Section 5 concludes.

2. Literature Review

2.1 Defining and Modelling Corruption

Corruption is a multifaceted phenomenon and a persistent feature of human societies. Corruption can refer to multiple activities including bribery, nepotism, patronage, extortion, abuse of discretion, the inappropriate use of official information and lobbying by former public officials (Langseth, 2016; Andersson, 2017). These activities can also happen on different scales, at different levels of governments and vary spatially and by sector throughout nations (Andersson, 2017). Because of this, it is difficult to give corruption a precise and comprehensive definition. While the discussion around the definition is ongoing (see Philip, 2006; Brown, 2006), the general consensus within the economic literature, and the definition used in this paper, is that the term refers to acts in which public office is used for private gain in a manner that contravenes the rules of the game (Jain, 2001; Aidt, 2003; Svensson, 2005; Trapnell, 2008; Enste & Heldman, 2017). Under this definition, two broad subcategories of corruption can be identified to exist in democratic societies. These types of corruption are distinguished based on the magnitude of the rents and favours exchanged and the source of power of the decision maker.

The first, grand corruption, is defined as "the abuse of high-level power that benefits the few at the expense of the many" (Transparency International, 2016). Grand corruption usually involves higher level bureaucrats or politicians and large sums of money or significant favours[1]. This type of corruption is the most difficult to identify as officials directly involved in the deals mostly benefit. There is therefore little incentive for an official involved in the act to report it (Bruce, 2014). Such activity has serious consequences for societies. Grand corruption undermines development attempts through the redirection and inefficient allocation of resources (Rose-Ackerman, 2006). Furthermore, elites often send their gains from illicit activities offshore to avoid detection (van Vuuren, 2006; Christensen, 2011; Bhorat et al., 2017). This prevents the reinvestment of these resources back into the domestic economy.

Petty corruption refers to acts of appointed bureaucrats or lower level officials when interacting with either their superiors or the public. Petty corruption refers to various activities but most commonly manifests as bribery, often seen as the public paying bribes to bureaucrats to obtain public services, avoid red tape or speed up procedures (Jain, 2001; Lambert-Mogiliansky, Majumdar & Radner, 2007). Petty corruption is classified as such because of the magnitude of the individual bribes which are small relative to those of grand corruption. The effects of petty corruption, however, are anything but petty. All corruption affects low-income members of society most given their vulnerability and reliance on public services (Lovei & McKechnie, 2000). While the effects of grand corruption are less direct, usually experienced through an increase in tariffs and a reduction in government resources, petty corruption activities make everyday life harder (Lovei & McKechnie, 2000). These households are those that are most reliant on the provision of public services such as housing, social grants, public education and healthcare, and therefore have more frequent interactions with public officials. These households are therefore disproportionately exposed to situations in which petty corruption can arise (Justesen and Bjørnskov, 2014).

When an individual is in a position with discretionary power, be it directly or indirectly, opportunities for corrupt activities arise (Carr, 2007). While corruption most often refers to government employees, it is also found in the private sector. Private sector involvement in corruption can extend past their dealings with the public sector to transactions with other private sector entities (Argandoña, 2003). Corruption between private sector agents, however, is less well

[1] This can include exploiting power over policy decisions, procurement practices, theft from public funds or nepotism

studied. This is because private sector firms, which operate in economies with effective competition, should be penalised by the market for inefficiencies resulting from actions such as corruption. Additionally, private sector firms are more efficient at protecting their own interests and so will weed out activity that causes such inefficiencies (Argandoña, 2003). While the above is true for petty corruption type activities, corruption at a grand level may not fall into these categories. Private sector grand corruption can take the form of a manager offering money, gifts or an advantage to secure a contact with another firm. This type of corruption is similar to grand corruption as it involves larger sums of money and, as it occurs at higher levels of management (Jain, 2001). Moreover, similarly to grand corruption it is less likely to be reported as more powerful positions are accompanied by less supervision and more discretionary power.

2.1.1 Models of corruption:

Corruption is a challenge to model in economics as it is a result of a combination of personal gain motives and a range of cultural, social, psychological and institutional factors (Fitzsimmons, 2007). Based on the above definition of corruption Jain (2001) identifies three conditions which allow for any corruption to both arise and persist. The first is that the agent must have the power to design or administer policies and regulations at their discretion. Second, economic rents must exist and the nature of the discretionary power must allow the creation and extraction thereof. Third, weak institutions need to exist such that the political, administrative and legal institutions create incentives to exploit discretionary power to pursue these rents (Jain, 2001). Within this framework, Aidt (2003) groups the existing theoretical models of corruption based on their assumptions regarding the benevolence of the government official in charge of implementing and designing policies and institutions (the principal) and the role of institutions and history in determining the level of corruption.

While the moral aspect of corruption has been widely condemned, there has been support for a theory of efficient corruption, in which corruption acts as grease money to facilitate beneficial interactions between agents (Leff, 1964; Aidt, 2003; Aidt, 2009). Corruption provides an opportunity to promote efficiency by allocating scare resources towards firms with the highest willingness to pay and who are therefore the most productive. Corruption further enhances efficiency by decreasing the queuing time associated with bureaucratic processes through paying bribes, speeding up otherwise slow processes (Huntington, 1968). These processes have been formalised through Lui's (1985) 'queue model' and Beck and Maher's (1986) 'auction model'.

The second theory is one in which a benevolent principal delegates the discretionary power to a non-benevolent agent (Aidt, 2003). The government needs to delegate specific activities, such as

tax collection and policy implementation, to a bureaucracy. Given that some bureaucrats are corruptible, the delegation of discretionary power creates the potential for corruption to occur (Asongu, 2013). The level of corruption is therefore dependent on the incentives faced by these agents, which in turn are dependent on the institutions which govern them (Aidt, 2003). Djankov et al. (2002) demonstrate this mechanism through the 'tollbooth' model of corruption. In the presence of failed market institutions, government steps in with corrective regulations. This well intentioned regulation creates 'shadow prices' for publicly provided services. Agents then realise the potential for rent-seeking that the regulations provide and create unnecessary regulations in order to increase the rents available for extraction (McChesney, 1987). In this model of rent-seeking, low regulation and high competition would reduce the gap between market values and shadow prices, reducing the potential rents to be gained from corruption.

Controlling this corruption without decreasing regulation requires government institutions to be designed in ways which reduce incentives for corrupt activities. In practice, methods such as efficiency wages and sufficient monitoring activities are costly. Acemoglu and Verdier (1998, 2000) analyse the optimal level of corruption in a bureaucracy where incentives are only provided by efficiency wages and external monitoring. Their general equilibrium framework shows the cost of paying all public servants a wage higher than the private sector as it results in a misallocation of talent. This is because a high wage will attract individuals with entrepreneurial skills to the public sector. A socially optimal efficiency wage reflects this trade-off between a high wage which reduces corruption in the bureaucracy and attracting too many individuals with the 'wrong' talent to the bureaucracy. Given this, the optimal design of institutions may leave room for some corruption (Aidt, 2003). Shleifer and Vishny (1998) refer to this as the 'helping hand' theory of corruption. Here the principal is acting benevolently in their attempt to implement socially beneficial policies and their desire to optimise institutions given the resource constraints that exist.

Third are theoretical models which view corruption occurring as a result of a non-benevolent principal. These models follow the long held Public Choice Theory view that all agents and principals are susceptible to corruption (Buchanan and Tullock, 1962). Hence, institutions and policies are intentionally designed to be inefficient and dysfunctional in order to optimise available rents (Aidt, 2003). This "grabbing hand" view of government was brought to the corruption literature by Shleifer and Vishny (1993, 1998) to describe the notion that all officials can be rent-seeking. The only restrictions on this rent-seeking activity are the existing institutions. Weak institutions can lead to endemic corruption as they allow for policies and regulations to be created based on their corruption potential rather than for public benefit. This theory is further captured

through Stigler's (1971) capture model which highlights the role of firms in influencing regulators to create legislation in their favour.

Hillman and Katz (1987) take this theory of corruptible officials and apply it to the hierarchical structure of the government and bureaucracy. Opportunities to extract bribes make the position associated with those opportunities valuable. This increases the value of the position with the power to appoint the aforementioned position as it provides an opportunity to extract rents from applicants. An internal market is therefore created for these lucrative positions (Jain, 2001). Once such mechanisms develop, all officials will have a vested interest in the persistence of corruption. Individuals at each level are therefore willing to pay bribes and invest real resources in extracting the rent created (Aidt, 2016). This internal labour market has been found to have serious consequences for department performance and constitutes a severe social cost (Wade, 1985).

The historical nature of corruption also plays an important role in understanding why organisations and societies with similar institutional characteristics experience very different levels of corruption and how corruption becomes self-reinforcing (Aidt, 2003). Three mechanisms exist in the literature which explain the existence of self-reinforcing and persistent corruption. First, it is more difficult to audit corrupt officials in societies where the level of corruption is higher (Lui, 1986). This feedback mechanism is partly described above, where non-benevolent politicians have an incentive to structure institutions in ways which decrease the likelihood of detection and persecution (Jain, 2001). Therefore, as corruption increases, detecting and prosecuting it becomes harder, further increasing corrupt activities.

Petty corruption can give rise to grand corruption in a bottom up approach to corruption. Cadot (1987) investigates how, given the existence of incentives for petty corruption, grand corruption develops upstream as a result of self-interested collusion. As lower ranked officials are caught in corruption, the opportunity to retain their position through bribing senior officials arises. This impunity creates a favourable environment in which corrupt activities can grow. Corruption therefore creates complicated relationships of protection and patronage based on bribery and blackmail (Rose- Ackerman ,1999; Kurer, 1993). Additionally, these relationships tend to expand beyond the civil service's hierarchy and distort the normal channels of information and power (Cadot, 1987).

Additionally, the collective reputation of the group is important (Tirole, 1996). The incentive for an individual to be corrupt imperfectly depends on their group's collective reputation. If their group is honest, the individual's incentive is to be honest. Similarly, if the group to which the

individual belongs has a reputation for being corrupt, it is in the interest of the individual to be corrupt. The existence of a collective reputation for corruption therefore has lasting effects. Given that a collective reputation of honesty takes a long time to build (Banjeree & Duflo, 2005), anti-corruption measures need to be substantial and long lasting to work. Small changes in institutions would not be sufficient to shift the group's collective reputation. A big push is needed to move the group away from the high corruption equilibrium (Aidt, 2003).

Finally, the reward to rent-seeking behaviour relative to entrepreneurship is higher in societies where most individuals are corrupt and rent-seeking (Murphy et al., 1993, Acemoglu, 1995). Acemoglu (1995) argues that a history of corruption results in a misallocation of talent from entrepreneurship to rent-seeking activity. If rent seekers require bribes to allow entrepreneurial activities, a cost is imposed on entrepreneurs. As the proportion of corrupt officials rises, the marginal benefits for honest officials decrease. Marginal benefits for corrupt officials follow an inverted U shape with multiple equilibria. Two stable equilibria occur when either all officials are honest or all are dishonest. Between these, an unstable equilibrium exists where the behaviour of the marginal official determines which stable equilibrium the group will move towards. The perceived level of existing corruption in a society can therefore influence the choices of talent allocation as well as the likelihood of individuals to offer, request and accept corrupt activities such as bribes (Bardhan, 1997).

2.2. Consequences of corruption

There is difficulty in discovering the causes and consequences of corruption because of the feedback loop that exists between the two. Similarly to the natural resources and governance literature, these bi-causal relationships translate into econometric issues when trying to measure them (Park & Lee, 2006). Many consequences of corruption reinforce opportunities for future corruption (Lambsdorff, 2006). An ineffective legal system, for example, would decrease the likelihood of persecution and therefore the cost of corruption. Once individuals begin to participate in corrupt activities, they are incentivised to further reduce the effect of the legal system in order to increase the effective rents to be gained. An even weaker legal system then allows for more corruption, furthering the cycle. Deciphering the causal mechanisms at work between the interconnected parts is therefore difficult (Jain, 2001). Nevertheless, many empirical studies have attempted to address these issues and draw conclusions (Lambsdorff, 2006).

In earlier research, the effects of corruption were ambivalent and arguments were made for a 'grease in the wheels' effect of corruption, as described above (see for example Huntington, 1968; Lui, 1985 and Beck & Maher, 1986). If this were true, higher levels of bribery would be associated

with higher levels of bureaucratic efficiency. This view positions corruption as a positive response to market failure but has been largely disregarded. In the presence of complex bureaucratic processes, it is unlikely that one official is able to speed up the entire process. One official can, however, slow the process down. Hence, bribes maintain what should be the usual level of efficiency. Furthermore, evidence shows that corrupt bureaucrats and officials will seek further possibilities to receive payments through the creation of unnecessary regulations (Enste & Heldman, 2017).

Moreover, the increased focus on the role of good governance in development and the measured negative effects of corruption in both developed and developing countries have provided further evidence for corruption having a 'sand in the wheels' effect (Mauro, 1995; Rose-Ackerman, 1999; Fitzsimmons, 2007; Hodge et al., 2011). Ades and Di Tella (1997) uncover no associated benefits of corruption in countries with high levels of red tape. Gupta et al. (2002) describes that once officials see the potential for increasing their income through petty corruption, they create opportunities to extract rents through regulations that require increased frequency of interactions with the public or charging a fee for what should be free public services. Therefore regardless of whether bribery speeds up individual transactions, the counterfactual is that there would be no efficiency gain or loss as a result of removing the bribe. Moreover, Porta and Vannucci (1997) show how this type of petty corruption can escalate and lead to grand corruption, demonstrated through the Italian administrative system.

Since the mid 1990's, the effects of corruption have been well documented by empirical studies. A clear negative effect has been found between corruption and total investment, FDI and capital flows. This was first identified by Mauro (1995), who proved the negative relationship between corruption and a ratio of investment to GDP. The interpretation of this relationship, however, has been debated. Campos et al. (1999) argue that it is not corruption itself but rather unpredictable corruption that lowers investment. Lambsdorff (2006) puts forward that it is the form of corruption that matters, finding a higher impact of petty corruption on investment relative to grand corruption. The author suggests that this is because grand corruption is more efficient, likely requiring an investor to deal with only one official who coordinated the activity downstream. High levels of corruption also change the form of foreign direct investment (FDI). Highly corrupt countries invite shorter term investments and more joint ventures, the latter likely because firms want to capitalise on the knowledge and networks of local firms (Uhlenbruck et al., 2006).

Although there is significant evidence that corruption has a negative effect on many aspects of a nation's development, problems of endogeneity and causality exist causing econometric challenges.

While a strong correlation has been found between GDP per capita and corruption, there is agreement that it is very difficult to derive causality from this (Enste & Heldman, 2017). Instrumental variable methods have been applied in an attempt to account for this issue but, given the interconnectedness of the two variables, a suitable instrument has proven difficult to find. Instrumental variable approaches used by Kaufmann et al. (1999) and Wyatt (2002) amongst others, investigate this relationship and find a significant negative impact of corruption on GDP per capita. However, given the burden placed on the instruments used and the endogeneity problems noted above, these results must be interpreted with caution (Lambsdorff, 2006).

Given the issues associated with GDP per capita, many studies have focused on GDP growth. Mauro (1995) conducted one of the first cross-country empirical studies using the Business International Index and found a negative relationship between corruption and GDP growth. This, as well as the negative effect of corruption on investment and fiscal and macroeconomic stability is supported by numerous other studies (see Tanzi, 1998; Svensson, 2005; Dreher and Herzfeld, 2005 and Hodge et al, 2011). Aidt (2011) argues that GDP is not an accurate indicator of development and prefers sustainable development, measured by genuine growth of wealth per capita. He analyses a sample of 110 countries and finds evidence for a significant negative effect of corruption on sustainable development.

A body of literature has investigated the effect of corruption on income inequality. Gupta et al. (2002) find a significant correlation between corruption and income inequality across 37 countries. They argue that the true effect of corruption on income inequality is likely larger as they find evidence for corruption increasing inequality in education and land distribution, both of which contribute to income inequality. This relationship is also found by Gymiah-Brempong (2002) for a sample of African countries and at a global level by Li et al. (2000) who find an even stronger effect. The direction of causality between corruption and income inequality has been discussed theoretically by Husted (1999) and Swamy et al. (2001). You and Khagram (2005) provide empirical evidence for reverse causality, arguing that low income individuals are less able to monitor officials and hold them accountable. Using an instrumental variable approach, the authors show that inequality increases corruption. Considering the literature evidencing causality in the opposite direction, the authors conclude that there exists a bi-causal relationship between corruption and inequality which creates a vicious cycle of inequality and corruption. This is partly influenced by the social norms surrounding corruption. A higher level of inequality appears to increase people's acceptance of corrupt activities such as bribing (Lambsdorff, 2006).

Corruption also leads to the misallocation of resources. Due to the clandestine nature of corruption, certain goods present better opportunities for hidden payments. This includes military spending and arms procurement (Gupta et al. 2001) as well as large infrastructure projects. Tanzi and Davoodi (1997) and Esty and Porter (2002) find significant evidence for corruption causing an overinvestment in public infrastructure, however the empirical link is weak which they suggest is due to the limitations of corruption data. This over-investment does not result in an proportional increase in public infrastructure (Golden and Picci, 2005) and corruption in procurement practices also results in infrastructure being of lower quality (Isham and Kaufmann, 1999). Furthermore, high levels of corruption also decrease spending on infrastructure maintenance (Tanzi and Davoodi, 1997).

Countries with high levels of corruption also have less efficient government services, resulting in a lower quality and quantity of health and education services (Mauro, 1998; Gupta et al., 2001; Esty & Porter, 2002; Gupta et al., 2002). Corruption also imposes a cost on the environment. High levels of corruption are associated with poor environmental regulation and enforcement (Pellegrini & Vujic, 2003; Welsch, 2004) and have a negative impact on biodiversity and the overall quality of the environment (Esty & Porter, 2002). Citizens in corrupt countries also bear a cost beyond the purely economic. Corruption has been found to decrease trust in the state and the public sector agents (Anderson & Tverdova, 2003; Blanco, 2013) as well as inter-personal trust (Banerjee, 2015). As trust is important for good governance, infrastructure, investment and the effectiveness of redistributive policies (La Porta et al., 1997; Bergh & Bjørnskov, 2014; Gillanders & Neselevska, 2017), this has negative consequences for the society. Welsch (2008) finds further that corruption has a negative impact on welfare due to factors such as the effort and time required to deal with corruption and psychological costs associated with the general culture of unlawfulness.

2.3. The South African Context

To many people, corruption seems endemic in South Africa. The legacy of corruption in South Africa extends far back and is not, as ignorant opinion suggests, a feature unique to the post 1994 democracy (Lodge, 2002). In order to begin to effectively try to combat corruption it is important to understand the current extent of corruption as well as the context that enables it to exist and persist.

2.3.1 Apartheid and its legacy of corruption

Corruption in the Transvaal has many parallels with the corruption that exists in modern day South Africa. During 1870-1910, imperial propaganda had administrative corruption as its main theme (Hyslop, 2005). After the Second Boer War, Sir Alfred Milner presided over the re-

organisation of the administration system of the Transvaal. During this period corruption remained low but the elaboration of the pass law system began to create opportunities for low level bureaucrats and police officers to extort bribes from the victims of the system (Marks & Trapido, 1981). In rural areas, the indirect rule of the government vested some discretionary power in traditional leaders and chiefs. This created opportunities for corruption but, given the high levels of poverty in these areas, however, the available rents were minimal and so levels of corruption were low (Hyslop, 2005).

The victory of the National Party (NP) in 1948 signified an administrative revolution. Malan and his successors blatantly pursued practices of patronage and favouritism in order to achieve their strategic goals (Posel, 1997). The Broederbond, which played a key role in the rise of the Afrikaner nationalist movement, oversaw the co-ordination of patronage activities and resource allocation. This was conducted through policies providing preferential funding to Afrikaner education and cultural establishments and the favouring of Afrikaners in the awarding of contracts, subsidies and other benefits.

A key action of the NP was to drive non-Afrikaners out of the civil service. The civil service, particularly the junior level positions, provided a strategic rent-seeking vessel for the NP, facilitating the upwards mobility of low income Afrikaners through the provision of stable employment. Overall the number of individuals directly employed by the civil service quadrupled between 1939 and 1967 (Posel, 2000). Unskilled and under qualified clerical level entrants in to civil service increased, as did the exodus of competent Anglophone managers. This occurred at the same time as public administration tasks were becoming increasingly complex (Lodge, 2002). The inflation of the bureaucracy and decreasing level of competence resulted in a decline in the professionalism of the civil service. Additionally, the expansion of racial laws intensified instances of petty corruption, providing minor officials with opportunities to extort bribes from vulnerable members of society (Hyslop, 2005).

While in the early decades of NP rule, stringent constraints on the public sector meant that senior bureaucrats had little opportunity to engage in "patronage and conferment of financial benefits for the achievement of improper objectives" (Cloete, 1978 from Lodge, 2002), the early 1970's saw a rise in the extent of political corruption in South Africa. The increasing secrecy of government undertakings from the 1960's enhanced the arbitrary discretion enjoyed by bureaucrats (Lodge, 2002). This was coupled with a capacity shortage in the Auditor General's office which limited oversight functions of the government, a key facilitator in lowering the cost of rent seeking. In addition to this, in the early 1970's the public service pay scale declined and by 1973 civil service

demoralisation had reached a point of state rebellion which characterised labour relations in several government departments (Lodge, 2002).

Corrupt activities were particularly common in departments which were connected to the strategic goals of the government, including Departments of Information, Defence, and Homeland Development (formerly Native Affairs) (Lodge, 2002). Indicative of this corruption is the 1978 Information Department scandal. Senior officials in the department were discovered to be using public money to purchase properties registered in their own names, provide tax-free supplementary allowances and fund their family holidays, as well loan R13 million to Louis Luyt to start a newspaper, most of which was found to have been invested in one of Luyt's companies (Lodge, 2002). This scandal resulted in the closure of the department but not the end of such corruption activities.

Extortion was especially prominent in areas where people were particularly disenfranchised and defenceless. Apartheid era legislation created many opportunities for civil servants to extract rents. Petty corruption was most common in the police who enforced many of these laws outside of government buildings and therefore had little oversight. The pass laws and racially restrictive liquor licenses provided the two most common opportunities for police bribery and extortion (Lodge, 2002). There is also evidence of the Bantu Administration boards selling residence permits to the inhabitants of Crossroads in Cape Town in the late 1980's (Lodge, 2002).

As the political ideology of apartheid was weakening, the organisation of the administration along racial lines peaked with the formation of homeland states (Hyslop, 2005). Homelands became a hotbed of corruption with a lack of resources and skills resulting in ineffectual governance and an abundance of rent seeking. In the Transkei in 1975, civil servants stole more than R600 000 from pensioners and shortages of funds were frequently found where money passed from officials to the public. In Kwazulu, legislative assembly debates in 1978 evidence the high incidence of petty corruption within the civil service (Lodge, 2002). Leaders of 'homelands' presided over large patronage networks and the legal fiction of independence also provided opportunities to extract rents from the private sector through opportunities to allow activities such as casino gambling, which were illegal in South Africa at the time (Hyslop, 2005).

The nature of the Apartheid state also created stringent and secretive conditions under which the African National Congress (ANC) had to operate. During the struggle, the ANC received international funding to support the resistance movement. Due to the security difficulties, this money was transferred to prominent leaders in the movement. Hyslop (2005) argues that this

created a precedent for how the organisation viewed handling money with senior individuals developing a cavalier ethos to handling large sums. Additionally, the necessity for secrecy and underground operation developed a cardinal ethos of organisational loyalty. This sense of loyalty was carried over to the post-apartheid period. These loyalties were very susceptible to developing into patronage networks and made it difficult for the ANC to denounce acts of corruption that were performed by old comrades (Hyslop, 2005).

Towards the end of the apartheid regime, corruption spread and became systemic, operating at every level of the public sector. As it became clear that the end was approaching, officials rushed to grab as much as they could. Scandals in the Department of Development Affairs (DDA) in 1991 caused it to be shut down with Judge Pickard writing that "public officials felt they were missing out if they were not helping themselves" (RSA, 1991). He also noted that "many of these officials had become disillusioned by their futile efforts to serve apartheid ideology" (RSA, 1991). Similar activities were found to exist in the Department of Education and Training. Accounts of corruption from homeland governments also spiked towards the end of the Apartheid regime, indicating that individuals were motivated by the looming end to their power and privileges (Lodge, 2002).

Apartheid was inherently a corrupt system as it excluded the majority of the citizens, attempting to only serve one subset of the population. The denial of democratic rights to citizens of colour substantially reduced the state's accountability while the exclusion and vulnerability of the majority of the population created opportunities for positions of power to be abused and for corruption to take place (Habtemichael & Cloete, 2010). Apartheid era legislation and practices played an important role in shaping South Africa's present day institutions. The creation of a parallel set of procedures for the disenfranchised population that required bribes or nepotism to access services laid the foundation for much of the petty corruption that we see today (Lodge, 2002).

2.3.2 The Transition

It was against this backdrop that South Africa became a democratic society. The advent of the new democracy brought with it a new hope for tackling the seemingly endemic problem of corruption through an open commitment to ethics and transparency, most notably through the Constitution (Constitution of the Republic of South Africa, 1996). This framework, consisting of state mandated and civil society bodies such as the public protector, and appointment of multiple official inquiries into corruption, was a positive sign. These measures were accompanied by an

increased freedom of press which helped to stimulate journalistic interests and willingness to report and publish corruption stories (Van Vuuren, 2006).

During the transition process, the nine provincial administrations were formed and homelands were incorporated into the mainstream system. These new provincial governments were critically afflicted by corruption. Senior officials in departments and regional governments were replaced with less bureaucratically-experienced personnel. In order to facilitate a smooth transition, many pre-1994 civil servants retained their positions and the size of the civil service remained stable (Hyslop, 2005). The inexperience of the new senior officials coupled with the existing civil service resulted in low levels of internal monitoring. There was a strong correlation between the level of corruption in a provincial government and the administrative continuity with the homeland administrations. The corruption and practices of the pre-1994 era were carried over, with the difference that civil servants were now able to enjoy the support, protection and patronage of ANC leaders (Hyslop, 2005). The most extreme corruption has appeared in the three provinces where the provincial civil service was largely carried over from the old Homeland structures; Limpopo, Mpumalanga and the Eastern Cape (Lodge, 2002).

Further evidencing the self-reinforcing nature of the corruption culture in South African government, the departments in which corruption activities were concentrated post-1994 were the Departments of Safety and Security, Defence and Social Welfare (van Vuuren, 2006). The police too remained a notoriously corrupt body. In 1996 in Johannesburg, four police a week were being suspended for corruption and, following an increasing annual trend, 1076 police nationally were under investigation for corruption related charges (Lodge, 2002). In Gauteng and the Eastern Cape, there are reports of police accepting bribes to destroy evidence and dockets as well as colluding with criminals and officials within the Department of Justice.

In order to redress the exclusive policies and service delivery of the Apartheid regime, the government expanded its activities to extend public services and welfare programmes. This increase in the breadth and complexity of public service provision increased opportunities for corruption. Most of these activities were directed by the Department of Social Welfare which inherited 14 separate bureaucracies, many of which were incompetent and corrupt (Lodge, 2002). The department's 1996 white paper stated that "the fragmentation of government has led to gross inefficiencies… any loopholes were created which could be exploited by officials and the public". In 1997, clean up attempts revealed 94 000 illegal recipients of the pension grant as well as a scheme where, for a fee of R400, you could receive a disability grant. The low fee, with the grant

paying R750 per month in 2005, is also indicative of how widespread this type of corrupt transaction was (Lodge, 2002).

The democratic state inherited old systems of corruption but new policies also created new opportunities. The introduction of affirmative action policies was intended to promote equitable economic engagement. A further consequence of these new processes of bureaucratic recruitment, promotion and tendering principles was the creation of opportunities for corruption (Hyslop, 2005). Such policies also require a more efficient administration to handle them which, given the increasing shortage of skills, the civil service did not have sufficient capability to do (Lodge, 2002).

In line with Shleifer and Vishny's (1998) helping hand theory, there was also likely a level of corruption that was accepted during the transition. At Pickard Commission in 1991, few officials from the Apartheid regime were genuinely committed to the regime goals but rather valued self-preservation and self-protection (RSA, 1991). Therefore, for a time Mandela's government must have tolerated a certain level of corruption rather than inciting their hostility. During the transition from the Apartheid system to the new, free and democratic society, South Africa in many ways was drastically changed but this did not extend to the corrupt practices of the powerful elite. Many of the economic crimes of Apartheid were left un-prosecuted in an effort of the new government to conserve peace and stability during the transition (van Vuuren, 2006). Those entering into powerful positions post 1994, who were motivated by greed to participate in corrupt activities, took this opportunity, networking and forming relationships with those who had escaped persecution. In this way, the system of corruption in South Africa was carried forward to the new democracy (van Vuuren, 2006).

2.3.3 Recent years

Despite the efforts made to curb the expansive corruption it has remained, culminating recently with the exposure of state capture, the Zuma-centred elite and the relationship that they have created between our constitutional state and the shadow state, a saga which continues to unravel daily (Bhorat et al, 2017). State capture, as present in South Africa, occurs when an economy becomes trapped in a cycle in which the institutional and policy reforms necessary to improve and enable governance are systematically undermined by collusion between firms and state officials who extract substantial private gains (Myburgh, 2017). State capture has undermined the efficiency of the state through the redirection of fiscal resources away from public goods and value-adding economic endowments and towards servicing patronage networks, who provide sub-standard output if any, and by weakening state capacity through appointing compliant but incapable people to key positions (Martin & Solomon, 2016).

In South Africa, state capture also represents a political conviction that the formal rules of the game are unfair and biased towards specific groups and as such, it is legitimate to ignore them. This view has normalised institutional corruption and it is no longer seen as inherently negative or detrimental to the proper functioning of the state. Corruption has therefore been able to thrive at all levels of government and function with impunity alongside established bureaucratic processes (Myburgh, 2017).

Along with this shift in the norms surrounding corruption, key changes at a national level, which were used to facilitate the consolidation of power, have resulted in an increase in corruption at all levels of government. In 2009, the year Zuma become president, the size of the cabinet increased. This was facilitated by the creation of new departments, the splitting up of existing departments, a similar increase in ministers, deputy ministers, director generals and the rise of inter-ministerial committees (IMCs) (Bhorat et al., 2017). The official reasons given for this were based on a strategic assessment of policy and functional demands. It is, however, more likely due to the increased pressure of patronage that was exerted on Zuma following his appointment as president as well as the need to secure loyalty of key institutions including intelligence and prosecuting bodies (Naidoo, 2017).

The increase in strategic political appointments also demonstrates the movement of the organisation of the state from being functional to being derived from political motives. The increase in under-qualified individuals being appointed to political and bureaucratic positions resulted in a decreased capacity of departments to fulfil their functions (Naidoo, 2017). Additionally, their political connections shield them from accountability. Illicit political appointments such as these ensure the sustainability of corruption as once these mechanisms are developed, officials at all levels have a vested interest in the persistence of corruption (Aidt, 2003).

2.3.3.1. What is the current status of corruption in SA

The effects of these factors can clearly be seen in the existing measures of corruption. South Africa is currently ranked 71 out of 180 countries with a corruption perception score of 43/100 by Transparency International (2018). This places South Africa in the critical category of corruption pervasiveness. This is supported by the increasing trend in complaints of corruption made to Corruption Watch from 2013-2017, seen in Table 1, which show that reports of corruption have increased by 58% over the period. Public perception of those participating in corruption also appears not to be favourable, with the most common reasons for participating in corrupt activities being thought to be greed and trying to get rich quickly (StatsSA, 2017).

Corruption Watch (2017,2018) also provides insight into the institutional location of reported corruption. Table 1 shows the number of reported corruption cases and the share of those in the national, provincial and local government as well as private sector. While corruption in the private sector was minimal at 1% during 2013 and 2014, it increased by 8% in 2017. This could be an indication of an increase in private sector corruption or an increase in the reporting of it. The provincial level of government is associated with the highest number of corruption reports (30%) and has seen the largest increase (14%). While still the recipient of the second highest number of reports, the percentage share of reports in national government has decreased by 19% since 2013. The frequency of reports at the national and provincial level are unsurprising as the police are a competency of the former and schools and housing of the latter (Constitution of South Africa, 1996). The increase in the share of reports in the provincial government also corresponds with Zuma's increasing dependence on provincial party machines, represented by the 'Premier League'[2], since the 2014 elections (Bhorat et al., 2017).

Table 1: Reports of corruption and their institutional location between 2013-2017

Year	2013	2014	2015	2016	2017	% Change 2013-2017
Reported cases of corruption	2262	2714	2382	4391	5334	58
Institutional location of reported cases (% share)						Change in % share
Local Government	18	19	16	22	22	4
Provincial Government	16	21	26	26	30	14
National Government	48	42	24	28	29	-19
Private Sector	1	1	6	12	9	8
Other	17	17	28	12	10	-7

Source: (Corruption Watch, 2017, 2018)

The incidence of corruption also appears to vary spatially in South Africa. While the historical nature of provincial governments suggest that the more rural provinces should have higher corruption, Corruption Watch (2017, 2018) has consistently reported Gauteng as having the highest incidence of corruption reports. Additionally, VOCS 2018 reports metros as having the

[2] The 'Premier League' is a lobby group led by the premiers of Mpumalanga, North West and the Free State who participated in former president Jacob Zuma's campaign of state capture (Munusamy, 2015)

highest incidences of corruption in comparison to urban and rural areas (StatsSA, 2018).The perceived prevalence of corruption in metro areas may be due to two factors. First, Gauteng is the most populace province in South Africa and so will likely have the higher number of absolute reports (StatsSA, 2017). Similarly, metro areas are more densely populated than rural or urban areas (StatsSA, 2017). They likely also have better access to justice due to the concentration of courts and services that exist in these areas (Mcquoid-Mason, 1999, 2013). Secondly, Gauteng and metro areas in general have a higher level of education and income per capita. Citizens are therefore more likely to be informed of their legal rights and the channels through which corruption can be reported. Furthermore, while these areas appear to have a higher incidence of corruption, it is unknown whether this translates into a similar relationship for the value of corruption.

During the period 2013 – 2016, Corruption Watch (2017) has consistently reported the "abuse of power" to be the largest category of confirmed corruption incidents (Corruption Watch, 2017). This includes the abuse of public funds or resources, abuse of assets or abuse of a position. A well-known example of this is the creation of ghost social grant beneficiaries by officials who pocketed the money themselves (Bruce, 2014). In South Africa procurement is a large source of corruption. Lowe (2013) estimates that 20% of South Africa's total 2011 procurement budget was lost to corruption. This loss was spread mainly amongst sectors with the highest procurement budgets including the Departments of Public Work, Health, parts of the Department of Education and municipalities (Bruce, 2014). The negative effects of procurement corruption are twofold. First, firms that are awarded contracts through corruption are often unsuitable choices and produce inferior results (Isham and Kaufmann, 1999). Secondly, firms that pay bribes will attempt to recoup the loss of the bribe money through their contracted work (Bruce, 2014).

Bribery and extortion are commonly reported examples of corruption. Transparency International (2015) reported that 7% of people surveyed in their Global Barometer Survey who used one of six services having been asked to pay a bribe in the last year. In the 2017/18 Victims of Crime Survey (VOCS), respondents were most commonly asked for bribes to avoid traffic fines and from the police. In the 2015/16 VOCS a more detailed breakdown of bribery was given with bribes most commonly being asked for employment purposes (16.4%), from the police (14.4%) and to avoid traffic fines (13.8%) as seen in Table 2. Respondents in the VOCS felt that the most common reasons for paying bribes were, in order, to speed up procedures, to receive better treatment and to finalise procedures (StatsSA, 2017).

Table 2: Bribes per service activity over the last year

Activity	Number of Bribes	Percentage share of total bribes (%)
Employment	2568	16.4
Policing	2259	14.4
Traffic Fines	2165	13.8
Social welfare grant	1920	12,2
Housing	1793	11.5
Drivers licenses	1325	8.5
ID documents/ passports	1061	6.8
Other	1019	6.5
Court-related services	587	3.8
Water or electricity	452	2,9
Education/schooling	162	1.1
Medical Care	158	1
Revenue service/customs	106	0.7
When visiting a prison	56	0.4
Total	15631	100

Note: Employment refers to bribes paid to secure employment or to speed up employment processes. Housing category refers to bribes to speed up the allocation process and the unauthorised allocation of houses i.e. selling houses. Water and electricity refers to bribes related to meter readings and payment of accounts.
Source: (StatsSA, 2017)

2.4 Measuring corruption

In order to develop effective anti-corruption strategies and policies, reliable indicators of the extent and locations of corruption are needed. Unfortunately, the difficulties that pertain to defining and modelling corruption carry through to its measurement. Corruption, a clandestine activity by nature, is deliberately kept out of the public eye and records. Developing quantitative measures of corruption is therefore a difficult task. In spite of these difficulties there have been several attempts to do so.

2.4.1 Perception-based measures

The dominant mode of corruption measurement in the literature since the mid 1990's has been perception based indices. These measures have raised awareness of corruption and enabled cross country comparisons (Mauro, 1995). These indices are mostly composed at a national level and are drawn from expert assessments and surveys (Heywood and Rose, 2014). Indices such as

Corruption Perception Index (CPI), the Global Corruption Barometer, the Bribe Payers Index, the Business Environment and Enterprise Performance Surveys and aggregate indicators including the World Bank Group's Worldwide Governance Indicators (WGI) have therefore been an important source of data which has advanced our understanding of corruption.

While perception-based indices have played an important role in the study of corruption, they are now widely thought to be imperfect proxies for actual levels of corruption as they are inherently prone to bias (Heywood and Rose, 2014). A central challenge of perception-based measures is their interpretation. These indices are often interpreted as representing the level of corruption in a society but more recent research has found this to be a flawed conflation. Triesman (2007) has found that many factors that predict perceived corruption; such as freedom of press, level of economic development and democracy; are uncorrelated with measures of actual corruption experience. This was supported by Donchev and Ujhelyi (2014) who found that, when controlling for such factors, perceptions of corruption are an insignificant determinant of corruption experience. Through constructing an objective measure of corruption on road construction projects in Indonesia, Olken (2009) finds that perceptions of corruption do not accurately adjust to changes in real levels of corruption. He finds only a marginal increase in perceptions of corruption in response to a significantly higher corruption experience. Donchev and Ujhelyi (2014) review the accuracy of corruption indices used in cross-country analysis. They find that perception indices are more strongly influenced by absolute, rather than relative, levels of corruption which results in larger countries having higher perceptions of corruption. Additionally, they find that perception-based indices show a diminishing sensitivity to corruption experience. This implies that perception-based measures are a better measure of actual corruption in countries with low levels of corruption.

A further criticism of indices such as the CPI or WGI is based on their measurement methods. The surveys incorporated into these indices suffer from definitional issues. As each survey has its own understanding of corruption, aggregating the responses into a single index may be unhelpful (Saisana & Saltelli, 2012). Additionally, the emphasis placed on different understandings of corruption in the final index is proportional to the number of surveys included that use that conceptualisation. Indices may therefore over represent a type of corruption because it was over-sampled though the choice of surveys included (Heywood and Rose, 2014). The surveys that the CPI draws upon, for example, focus on the perceptions of country experts and business leaders (Andersson and Heywood, 2009). The measure of corruption therefore more accurately represents corruption experienced by business. This may obscure the distinction between different types of corruption and hide the true effects of corruption as a whole.

Langbein and Knack (2010) argue further that by amalgamating all the sources into one, the conceptual clarity of the aggregate index may be lost. This is important as the ability to draw informed inferences is dependent on an understanding of the concept being measured (Trapnell, 2008). This is a particular issue for indices such as the WGI which is composed of 6 sub-indices; control of corruption, rule of law, voice and accountability, political stability, government effectiveness and regulatory quality. The validity of this index is dependent on the ability of the individual sub-indices to effectively distinguish between the six concepts. Langbein and Knack (2010) find no empirical difference between the six indicators. Therefore, as these indicators are assumed to be empirically distinct, results obtained using this index may be misleading.

The choice of data sources included in these indices is often based on convenience rather than theoretical justification (Apaza, 2009). Additionally, the data sources themselves may be subject to bias. Hawken and Munck (2009) demonstrate that country evaluators vary in their strictness of evaluation criteria. This generates a systemic margin of error within and across countries and regions. Triesman (2007) also warns that "it could be that the widely used subjective indexes are capturing not observations of the frequency of corruption, but inferences made by experts and survey respondents on the basis of conventional understandings of corruption's causes". This notion is supported by Razafindrakoto and Roubaud (2010) look at eight African countries and find a number of biases in the perceptions of country experts relative to the experiences of ordinary citizens.

Additionally, Heywood and Rose (2014) find that indices such as the CPI are inappropriate to use for comparisons across time. While Transparency International has been clear that the CPI is not designed to allow comparisons over time, that annual publication of the scores invites such comparisons to be made. First, there is a consistent lag in the CPI as the score for any given year is generated using data from up to two years previously (Transparency International, 2011). Second, Heywood and Rose (2014) find that the scores from CPI and WGI are remarkably consistent over time, especially given the inherent measurement error associated with perception-based measures. The findings of their analysis suggest that these measures show no substantive change between 2001 and 2011. The authors therefore argue that the fluctuations observed in these indices on a year-to-year basis are likely to be misleading when informing policy discussions or as an academic resource. They suggest that changes in the indices over the eleven-year period they analysed could be attributed to random fluctuations and demonstrate that yearly publication is unnecessary. Rather they argue that an analysis once every 10 years would be sufficient.

The above discussion demonstrates a gap between the concept of corruption and its measurement (Heywood and Rose, 2014). Indicators of corruption do not always relate systematically and reliably to how they have been defined conceptually (Langbein & Knack, 2010). Additionally, the use of data from different and potentially incompatible sources, the lack of transparency and the potential for a tautological relationship between dependent and independent variables all pose serious methodological problems. These problems could potentially have a significant effect on both research findings and the way that they inform policy.

2.4.2 Experience-based measures

Given the difficulties associated with perception-based measures, other measures of corruption have also been developed. Bruce (2014) identifies two main channels through which corruption becomes visible. The first is through surveys. Surveys such as the EBRD-World Bank Business Environment and Enterprise Performance Survey provide useful data and are likely closer to the first-hand accounts of corruption. Survey data, however, is still subject to perception based limitations. Questions in surveys such as these ask for perception-based responses, albeit that these are perceptions based on experience. The International Crime Victim Survey (ICVS) and the Victims of Crime Survey (VOCS) attempt to gain a more direct measure of the experience of corruption by asking respondents if they have been asked for a bribe in the preceding year (Heywood and Rose, 2014). This data, though influenced by a respondent's ability to remember corrupt encounters, reflects a more objective rate of corruption.

Survey data, however, is subject to various biases. First, surveys may result in an underestimation of the level of corruption as questions on corruption seldom capture repeat offences experienced by one person (Bruce, 2014). In addition, surveys are more likely to capture corruption in which one party involved in the transaction is adversely affected, as the wronged party has a stronger incentive to report it (Bruce, 2014). This means that surveys are more likely to capture petty corruption than grand corruption as the latter is often carried out by co-perpetrators rather than a perpetrator and a victim. A victim may also not report experiences of corruption to the survey as they may feel complicit in the activity (Heywood, 2015).

The second channel through which corruption becomes visible is through the process of reporting (Bruce, 2014). Reported corruption measures are useful in so far as they are not subject to perception or recall bias. While it is likely that not all corruption will be reported, measures based on reported corruption can be seen as a lower-bound estimate of corruption in a society. An example of such a measure is the approach used by the United States of America, measuring corruption through the rate of criminal convictions of public officials for corruption related crimes

(Goel and Rich, 1989; Glaeser and Saks, 2006). While this method may provide a more objective count of corruption, it does suffer from other limitations which result in its infrequent use. First, it is dependent on the list of crimes that are included in the judiciary's (or organisation's in another context) definition of corruption. To fully capture corruption, the list needs to include various forms of corruption so as not to depend on one specific conceptualisation i.e. not just bribery, as Goel and Rich (1989) used. Second, these measures do not capture the full magnitude of corrupt activities. Officials convicted of taking bribes of $5 000 and $5 million would be treated the same way. Finally, these measures may result in perverse incentives for tackling corruption. Increased effort in anti-corruption measures will result in more convictions, implying a higher level of corruption. Moreover, a characteristic of many corrupt regimes is an influence over the judicial system which would influence the number of prosecutions (Heywood and Rose, 2014).

In South Africa the levels of reporting corruption, especially petty corruption, are low. The literature describes three dominant reasons for this. The first, similarly to survey responses, is that people fear that by reporting an exchange in which they were involved, they will incriminate themselves (Bruce, 2014). Secondly, there exists a norm of dismissing instances of corruption, seeing it as 'business as usual' or something that everyone has to put up with (Bahre, 2005). Thirdly, acts of corruption may be accompanied by threats of violence to dissuade reporting. Bahre (2005) describes a situation at a Cape Town school where parents attempting to report the principal for corrupt activities were threatened with violence should they take action. A further indication of the extent of violence in such circumstances are the 14 politically motivated ward councillor assassinations during the 2016 local elections which analysts concur were conducted in order to secure control of resources such as municipal vacancies and tenders (Martin and Solomon, 2016).

While experience-based measures account for some of the biases inherent in perception-based measures, they still have weak points. Many face similar problems to perception-based measures including how to define corruption, define the severity of particular instances of corruption and distinguish between different types (Andersson, 2017). Additionally, they fail to capture instances of corruption which individuals have an incentive to hide.

2.4.3 Objective measures

The emerging consensus in the field of corruption measurement is that qualitative, disaggregated and local or internal assessments are more likely to result in actionable insights (Andersson, 2017). A new body of work has therefore emerged, aiming to uncover evidence of the hidden activity using forensic economic methods. This type of analysis is necessary for clandestine activities such

as corruption, as it is often the only way to produce objective results. Forensic economic studies identify hidden behaviours through testing data against a null hypothesis which is commonly derived from economic theory (Zitzewits, 2012). A number of studies have been conducted under this umbrella, each using different methods and a variety of data sources but all with a common aim of uncovering corruption.

The most common approach in this literature when measuring corruption, is to compare two sources of data measuring the same outcome, one with and one without corruption, referred to as measure comparison (Zhong, 2016). Common types of data sets used are administrative records and special purpose surveys as well as data sets from experimental studies or internal firm records (Zhong, 2016). The null hypothesis for measuring corruption is simply that two measures of the same activity should yield similar results. If the hidden activity is present, one rejects the null hypothesis. There are four main approaches when comparing two measures and which one is used depends mainly on the available data. This includes the use of two official data sets, a researcher-created measure, a measure of inputs and outputs and a discontinuity approach (Zitzewits, 2012). Fisman and Wei (2004) and Mishra et al. (2008) compare two official sources of data which measure the same activity, using import/export data to look for evidence of tariff evasion in India and China. Both find that for products with higher tariffs, the gap between the sending country and China/India's reported amount received is highest or is recorded as having more 'missing imports'.

When a second measure is not available, researchers may create them. Olken (2006) constructs a counterfactual from a measure of rice received from a government programme in Indonesia using a survey of recipients. He then compares this with administrative data on the rice distributed. Olken finds that 18% of rice was misappropriated and that the level of misappropriation was higher in more ethnically heterogeneous and sparsely populated areas. A similar approach was taken in Uganda to measure corruption in schools (Reinikka and Svensson, 2004). This study compared administrative data on central government grants given to schools with data from a unique survey based on school's recorded data. They find that on average only 13% of the funds allocated reaches the schools.

A study of Indian sugar mills by Sukhtankar (2012) uses a measure of inputs and outputs to find evidence of corruption during election years in India. Using the fact that sugar production is close to being a fixed proportions technology, the author measures the inputs and outputs and finds that sugar mills have smaller input-output ratios in election years, with a greater effect found in mills controlled by politicians who are contesting the election. Sukthankar (2012) hypothesised

that this is because politicians divert resources away from the mills to finance campaigns. The author also finds evidence of mill members being compensated with higher prices the following year, contingent on the politician winning.

A regression discontinuity approach is used when incentives for hidden activities vary discontinuously but other factors vary continuously. This is caused by sudden policy changes or the release of new information. Olken (2007) employs a method used in tax auditing experiments to detect skimming in Indonesian road building projects. Government audits of road projects were announced in advance for randomly selected of projects. Skimming on the pre-announced audits and the control group audits was then measured. Pre-announcing the audit was found to reduce skimming in the treatment group by 8% in comparison to the control group.

Where such data exists, the approaches described above can be informative. Unfortunately, in many developing countries where corruption levels are high, this type of data is difficult to come by. In response to this, two studies have attempted to use household survey data to measure the degree of corruption. Gorodnichenko and Peter (2007) proposed a method of estimating the aggregate level of bribery in the Ukraine using the conditions of labour market equilibrium. They develop an aggregate measure of bribery and find the lower bound estimate of bribery in Ukraine to be between 460 and 580 million U.S. dollars. Their method however, relies on the condition that public sector employees are paid less than private sector employees. In South Africa this is not the case, with the public sector wage premium being well documented (Kerr & Wittenberg, 2017; Kwenda & Ntuli; 2018).

The second method using household survey data to measure corruption was developed by Zhong (2016). The author estimates the discrepancies between consumption expenditure on specific products and reported income between the public and private sectors to measure the level of income underreporting attributed to corruption that exists in China. This identification method was adapted from the public finance literature on tax evasion.

2.4.4 Tax evasion and corruption

Self-employed individuals are well known to have a larger incentive to under-report their taxable income than their wage earning counterparts (Slemrod, Blumenthal & Christian, 2001; Slemrod, 2007; Kleven et al., 2011; Kogler Muehlbacher & Kirchler, 2013; Korndörfer, Krumpal & Schmukle, 2014). Based on this, multiple studies have attempted to estimate the level of underreporting that occurs. A dominant approach has been to estimate the extent of underreporting using information on food or other consumption expenditure and reported income.

Samples are split into two groups; those compliant with tax legislation, defined as wage and salary owners, and those who are non-compliant, the self-employed. The compliant group is then used as a benchmark in order to assess the true income of the group of non-compliers. Within this body of work, there are two key studies which address tax evasion through micro-economic methods, Lyssiotou et al. (2004) and Pissarides and Weber (1989).

Lyssiotou et al. (2004) use a consumer demand system approach to estimate the extent of tax evasion in the United Kingdom. Their approach enables the estimation of underreporting from various sources of household income. While this avoids the potential bias from mistaking preference heterogeneity for underreporting, it requires all items of consumer expenditure to be accurately reported. In an environment of wide-spread corruption this condition is not met as consumption of various goods may be subject to measurement error due to bribes in kind or other forms of corrupt behaviour.

Pissarides and Weber (1989) apply a product expenditure-based method in order to estimate the size of the black economy in Britain, defined as activities which should normally be reported and taxed but are not. Their analysis is based on two assumptions; first that the reporting of expenditure on some items by all groups is accurate and second that reporting of income by some groups is accurate. They separate their sample into two groups, the self-employed and the wage and salary earners, arguing that self-employed individuals are more likely to underreport their income for tax evasion purposes. They use an Engel curve, based on the demand for food, estimated from individual household data in order to calculate the underreporting of income by households which have a self-employed head. In order to forecast income for the self-employed group from its reported expenditure, a linear -log expenditure function is estimated using a log of income and a vector of household characteristics. This function is then inverted to provide a measure of income underreporting.

This type of expenditure-based estimation of tax evasion has been used in several studies since Pissarides and Weber (1989). Using household survey data from 1988, Apel (1994) measures income underreporting in Sweden. Schuetze (2002) uses Canadian survey data from 1969 – 1992 to examine tax evasion amongst the self-employed, disaggregated over years and demographic characteristics. Johansson (2005) estimates income underreporting in Finland using survey data from the mid 1990's. Kim et al. (2009) apply this method to the self-employed in Russia and Korea and Hurst, Li and Pugsley use two data sets to measure income underreporting in the United States.

3. Approach, Data and Method

Zhong (2016) developed Pissarides and Weber's (1989) public finance model and applied it to the challenge of corruption measurement. Using a quadratic clothing expenditure function, Zhong estimates the extent of income underreporting, attributed to corruption, in the Chinese public sector in 2002. He finds that public sector employees in China top up their income by an average of 20% through corrupt activities. The method applied in this paper is based on Zhong's model, extending it to address the possibility of changes in the level of corruption across the distribution.

Zhong (2016) argues that, similarly to the self-employed and wage earners described in Section 2.4.4, the propensity to engage in corrupt activities can be approximated by whether an individual works in the public or private sector. This follows the logic that public sector employees have more opportunities to engage in corrupt activities relative to those in the private sector. Zhong (2016) acknowledges that some private sector corruption exists but reasons that it is minimal. The monopolistic nature of the public service industry provides employees with, on average, more discretionary power (Argandoña, 2003). Furthermore, public sector work involves the frequent handling of funds and face to face transactions with the public. This, coupled with inefficient systems of monitoring, creates an opportunity for economic rents to be extracted with little chance of being caught. Zhong (2016) therefore uses private sector workers as the reference group assuming that they report their true income while public sector employees, in an attempt to conceal their illicit activity, do not. Reported expenditure is assumed to be true for both groups as no reason can be found for a difference based on the sector in which an individual is employed. The income-consumption discrepancy between these two groups is then estimated and the difference attributed to corruption.

As described in Section 2.3 above, there exists a systemic culture of corruption in South Africa. Amidst such a culture, corrupt behaviour is unlikely to be confined to the public sector and there exist numerous reports supporting this, most notably surrounding the Gupta family and their illicit dealings with government (Bhorat et al., 2017). As described in Section 2.1.1, for corruption to occur agents need (1) discretionary power which will allow them to extract (2) economic rents in the presence of (3) weak institutions which create the incentives to exploit their discretionary power (Aidt, 2003). The extent to which these conditions exist in the private sector influences the level of corruption. Private organisations are likely to have better internal monitoring systems as profit motives, a competitive market and reputational concerns provide strong incentives to weed out inefficiencies such as corruption (van Vuuren, 2004; Lambert-Mogiliansky, Majumdar & Radner, 2007). This decreases the discretionary power of employees and increases the cost of engaging in corrupt activities. These conditions seldom apply to the private sector elites. Senior

company officials have significant decision making power and many opportunities to extract rents from both the organisation itself and through business transactions. These elites are therefore more likely to engage in corruption as they have opportunities to do so (Corruption Watch, 2017).

In comparison, other employees in the private sector have fewer opportunities for corrupt rent-seeking. Less powerful positions have less discretionary power. What discretionary power does exist is limited by strict monitoring processes of the private sector (Argandoña, 2003). There are also fewer rents available to be extracted at these levels. The public are unlikely to pay bribes for goods that can be bought elsewhere (van Vuuren, 2004). Less senior employees also seldom have access to resources that can be appropriated[3]. A form of corruption that may exist throughout the private sector is employment corruption. A high demand for employment can create a 'shadow price' for the position. This creates opportunities for bribery. In the 2003 Victims of Crime Survey (VOCS), 4.3% of respondents said that either they, or a family member, had been asked for a bribe in return for speeding up a job application in the private sector and 5% reported that they, or a family member, had been requested to pay a bribe in return for employment in a private company (Victims of Crime Survey, 2003). While these figures may seem high, they must be viewed in context. First, 18% of respondents reported requests for bribes relating to employment in the public sector (Victims of Crime Survey, 2003). Second, both of these figures are likely a reflection of the high demand for employment in South Africa. Therefore, while corruption at lower levels of the private sector is much less likely to occur in comparison to senior levels, the existence of some petty corruption-type activities in the private sector cannot be ruled out.

This study does not capture the high-earning elites, who constitute the majority of private sector corruption, due to the nature of household survey design and the offshore movement of illicit funds, both elaborated on below in Section 3.1.1. While some corruption exists at lower levels, the nature of institutions in the private sector prevent such activities from becoming widespread. Therefore the amount of petty corruption that occurs in the private sector is likely to be small relative to the public sector. Additionally, there is both theoretical and survey evidence showing a much higher incidence of petty-corruption in the public sector (Victims of Crime Survey, 2003; Corruption Watch 2017, 2018). While it is unlikely that the sample of the private sector in this

[3] This statement applies to the average private sector worker. There are non-elite positions which have access to organisational funds and resources, such as a firm's internal accountant and these individuals are well placed to steal resources. They constitute a small portion of the total pool and so are the exception rather than the rule (Argandoña, 2003).

study is devoid of all corruption, the level in the public sector is expected to be higher. The estimation of this paper therefore provides a measure of the level of corruption in the public sector relative to the private sector rather than a measure of total corruption.

3.1 Data and descriptive statistics

The data used in this paper is taken from the National Income Data Survey (NIDS) Secure Data, Waves 3 (2012), 4 (2014-2015) and 5 (2017) (SALDRU, 2012, 2015, 2017). This data set contains the necessary disaggregation of expenditure at the product level, income variables and labour market information for the analysis. From this, four samples are formed, a panel of the three waves and each wave as an individual cross section. The sample selection criteria used in the paper were people of working age, defined as between 15-64 years of age, and employed in full-time work, excluding the self-employed in order to prevent tax evasion incentives from contaminating the results. This left 7578 households in the panel sample.

3.1.1 Public/private sector

Following Zhong (2016), the sample populations are split into two groups, those who have more opportunities to engage in corrupt activities- public sector workers- and those that have fewer opportunities to do so - private sector workers. The NIDS data set does not include an explicit public/private sector variable. In order to separate the observations into public and private sector workers it was therefore necessary to manually code a categorical variable. This was based on the responses to the survey question Eb7 "*What is the name of your place of work?*". Answers to this question could be considered sensitive or private information, a factor which reduced the number of responses. This decreased the number of households to 5840. Additionally, although the phrasing on the survey specified that it should be the name of the respondent's employer and provided examples, the qualitative nature of the question invited a very broad range of responses, from the city in which a respondent works to the name of the specific police station.

The public/private sector variable (henceforth referred to as the sector variable) was coded into 8 categories: (0) private sector, (1) general government, (2) education, (3) health, (4) state owned enterprises (SOE), (5) public/community works programmes (P/CWP), (6) defence and (7) law enforcement. Respondents who listed a private organisation or household as their place of work were coded as (0). If respondents listed a government department, at a local, provincial or national level, as their workplace they were coded as (1), unless they listed the Department of Defence or Department of Correctional Services. In this case they were coded as (6) or (7) respectively. Individuals who responded with a school or hospital as their place of work were coded as (2) and (3) respectively. These categories were coded separately as employees of institutions, could work

for either the public or private sector. Individuals who listed an SOE as their place of work were coded as (4). Respondents who listed P/CWP as their workplace were coded separately. Workers engaged in P/CWP activities, which include cleaning of public spaces, maintenance of community gardens and parks, fencing and road maintenance projects, have less discretionary power then other public sector employees as they do not provide services directly to the public. Additionally there is less economic rent to be extracted as the work does not involve handling money or valuable resources that are easily stolen (Department of Cooperative Governance and Traditional Affairs, n.d.). Individuals who reported working in the defence force, department of defence, army, navy or air force were coded as (6). Respondents who reported working as a policeman, in a police station, traffic control, in a prison or for the Department of Correctional Services were coded as (7). Ambiguous cases, such as those where just the name of a city was reported, were coded as missing in order to achieve a cleaner sample. Categories (4), (6) and (7) were coded separately based on the findings from the literature which suggests high levels of corruption in each of these sectors (Hyslop, 2005; van Vuuren, 2006; StatsSA, 2017). While other departments, such as housing and social development, were also flagged as high corruption sectors, their numbers in the sample were too low to be included as individual categories.

The breakdown of the sector variable is shown in Table 3. In the sample, the private sector is much a larger than the public sector which is an appropriate reflection of reality. Kerr and Wittenberg (2017) note the ratio of public to private sector employment to be 20% in 2015 and at an average of 17.5% for the period between mid-1990's to 2015. Given that the sample used in this paper excludes self-employed and part time workers, it is expected that public sector workers will constitute a larger proportion of this sample. The panel data set has 72.65% of the population employed in the private sector. The largest components of the public sector are education and general government, which contribute 28,76% and 24,83% respectively. This is followed by the health sector and law enforcement. The defence sector is the smallest contributor to the public sector, making up 2.37% of the public sector.

3.1.2 Income

A key assumption of this paper is that income from corruption will not be reported. Pérez-Duarte et al. (2010) show that sensitive questions such as those regarding income are inaccurately answered or refused as the respondents feel that they infringe on their privacy (Pérez-Duarte et al., 2010). This is because, while the cost of accurately reporting income is small, there is an even lower cost, if any, to inaccurately reporting it (Pérez-Duarte et al., 2010). Corruption income is

Table 3: Description of Sector Variable

Category	Average % of Total Employment	Average % of Total Public Sector Employment
Private Sector	72,62	
General Government	6,80	24,83
Education	7,87	28,76
Health	4,37	15,98
SOE	1,93	7,04
Public Works	0,97	3,53
Defence	0,65	2,37
Law Enforcement	4,79	17,50
Total Public Sector	27,38	100
Total	100	

Source: NIDS Waves 3-5, 2013-2017.

therefore very unlikely to be reported as the illicit source of the money provides an additional incentive to refrain from reporting it. The structure of the NIDS survey also primes respondents to exclude their corruption income. The NIDS survey obtains income data through questions that specify the source of the income, for example employment, grants, private pensions, dividends or interest on investment, inheritance and lobola. These categorised questions are asked before requesting a figure of total household income from the respondent. In this way, the respondent is primed to avoid reporting their corruption income in the total figure as it would not have been included in any of the aforementioned categories.

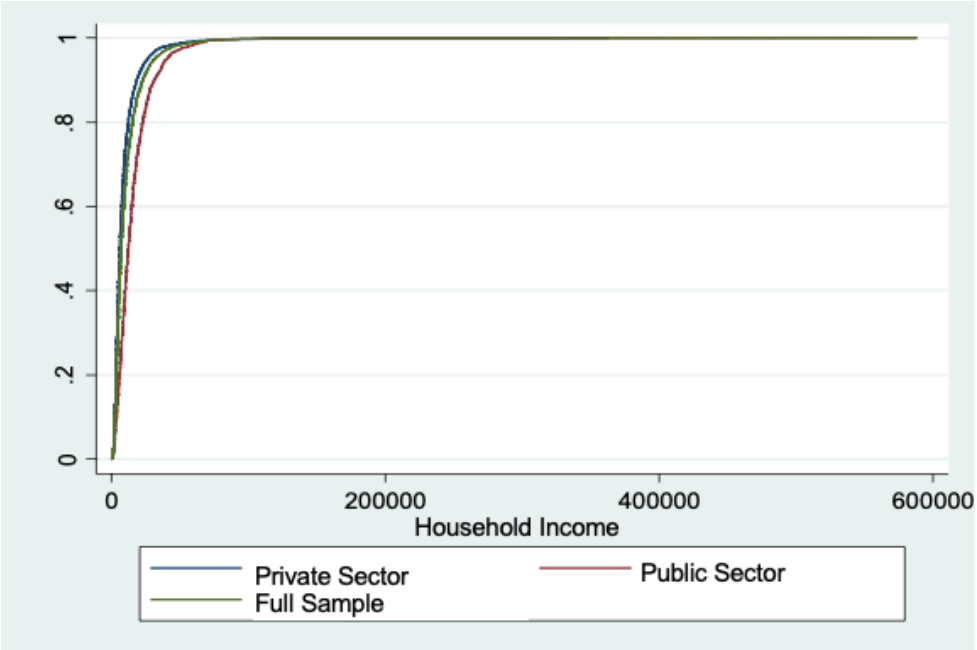
When measuring welfare, many studies in developing countries avoid using income, opting for expenditure instead (Meyer and Sullivan, 2003). This is because income is vulnerable to measurement error and underreporting bias whereas consumption is less so. As this study uses a model based on the relationship between income and expenditure, such concerns are important. For the purposes of this study the amount of measurement error does not matter as long as it is randomly distributed between the public and private sector. If a bias exists in the underreporting between the two groups from a source other than corruption, the interpretation of the underreporting becomes unclear. there is no difference in underreporting between the two groups, except for that resulting from corruption. Bound, Brown and Mathiowetz (2001) find consistent evidence that errors in reported earnings are mean-reverting, and only weak evidence that errors are correlated with standard human capital and demographic variables. Similarly, Marquis et al. (1981), who review a body of literature on response error in reports of wage and salary and total income, find that there is very little bias in survey reports of wage and salary income.

Moore et al. (2000) find that income is consistently underreported, but that the extent of underreporting varies between income types. Wage income for example is only slightly under reported by 5-8% whereas interest and dividend income is found to be under-reported by 50% or more. This is due to factors such as definitional issues, recall and salience problems as well as issues of data sensitivity (Moore et al., 2000). Neri and Zizza (2010) support this, finding that misreporting is particularly severe for income from self-employment, financial assets and secondary employment. While this sample excludes the self-employed, a difference in the incidence of receipt of dividend and interest income between the public and private sector groups may bias the results. This issue is nullified as the data shows no statistical difference between the proportion of each sector that receives dividend income nor a statistical difference in the existence of secondary employment.

A feature of this study is that it is unlikely to capture the activities of the elite or high-income respondents. NIDS follows a similar pattern to many other household income surveys and has low response rates from levels of high-income individuals. This is because high earners are more difficult to contact, less likely to respond to the survey and, if they do respond, are less likely to reveal their earnings (Moore et al., 2000). Figure 1 below demonstrates this. The cumulative distribution function (CDF) of household income shows a steep increase at the beginning of the distribution and then plateaus. This indicates that the majority of the sample lies in the lower end of the income distribution. The plateau illustrates that there are some high-income earners but these are few in number as the gradient of this section appears almost flat. The curves for public and private sector follow a similar pattern, but the public sector curve has a slightly lower gradient, indicating a higher average income for the sector. Moreover, this method is unlikely to capture the corruption income of the few elites that are in the sample. High-income elites commonly take their illicit income offshore to avoid detection (Christensen, 2011; Bhorat et al., 2017). The method employed in this study estimates corruption through domestic expenditure. It will therefore only capture this corruption in so far as the presence of the offshore income influences current consumption decisions through its effect on permanent income. The estimation in this paper, therefore, predominantly captures petty corruption activities.

The income variables used in this study include the log of net reported household income, following Pissarides and Weber (1989), Hurst et al. (2014) and Zhong (2016).

Figure 1: Cumulative Distribution Function (CDF) of Household Income



Source: NIDS Waves 3-5

3.1.3 Expenditure variables

In order to accurately estimate the level of corruption, the product chosen as the expenditure item has to be linearly related to *true* income and not influenced by corruption activities such as bribes in-kind which could decrease expenditure. Pissarides and Weber (1989) used food expenditure as, unlike other forms of expenditure, it is difficult to claim food as a business expense when investigating tax evasion. In relation to corruption, however, Zhong (2016) argues that food, meals, alcohol and cigarettes are often used as bribes in China and would be unsuitable expenditure categories. The author therefore uses clothing and household equipment and services as the dependent variables in the estimations. In South Africa items such as food, alcohol, clothing and jewellery are reported as being asked for as favours or gifts during petty corruption activities (van Vuuren, 2006; Selebi v State, 2011; Bezuidenhout, 2019). Similarly, there are also instances of food being used as payment in kind in all three waves of NIDS with 105 in Wave 5, 40 in Wave 4 and 240 in Wave 3. Items such as health care and education are government subsidised or related to employment through medical aid schemes and so are not always linearly related to income (Government of South Africa, 2018).

The NIDS survey classifies expenditure into 9 broad categories, all of which are made up of related subcategories. These are personal items, transport costs, energy, water and municipal rates, insurance, household items, cars, clothing and shoes, health care, education and

miscellaneous. This study uses the logarithm of two composite expenditure variables in order to estimate the relative level of corruption in the public sector. The first is clothing which includes money spent on clothes and shoes, account payments for clothes and shoes and fabric for clothes. Although evidence shows that clothing expenditure is affected by corrupt activities, it will provide a useful comparison. The second expenditure item is expenditure on household items and services (henceforth referred to as household items) which includes kitchen equipment, home maintenance, linen, fabric, furniture and money spent on hire purchase items. It is unlikely that bribe payers will use household items as bribes because accurate information about an individual's taste, needs and other household specific characteristics may be difficult to get. This is especially true for petty corruption where most transactions are once off interactions. Expenditure on household items and services is also unlikely to be claimed as a tax-deductible expense nor is it likely to be subsidised by an employer. It is also important to note that nominal reports of these expenditure items had very low response rates. The overlap between the sector variable and the expenditure responses resulted in a sample size of 1486 for clothing and 981 for household items.

Behavioural economics recognizes that unusual or infrequent income is viewed and spent differently to expected or frequent income. Mental accounting is defined as "the set of cognitive operations used by individuals and households to organise, evaluate, and keep track of financial activities" (Thaler, 1999). This describes the use of virtual accounts, such as rent or food, or real accounts, such as checking or investment, to guide consumption and savings choices, preventing the need to re-evaluate after every change in circumstances (Koszegi & Matejka, 2018). As corruption income is an unstable source of income, it is unlikely to be factored into an household's everyday budget. It will therefore, except in instances of extreme need, most likely be spent on non-necessities such as clothing and household items.

3.1.4 Descriptive statistics and control variables

When comparing the incomes of the two groups in Table 4, the public sector has a significantly higher mean income. Looking at the kernel density plot in Figure 2a, we can see that the public sector income distribution dominates the private sector's. This is further confirmed through a Kolmogorov-Smirnov test which rejects the null at the one percent level. This higher income is reflected in the summary statistics in Appendix 1, which show that public sector households are better off in terms of household assets. This extends to household expenditure for clothing and household items, both of which show significantly higher consumption by the public sector. Looking at Figure 2b, we can see that again the public sector distribution rumps the private sector, but it is not as obvious. The Kolmogorov-Smirnov test, however, shows that they are significantly different at the five percent level.

This paper aims to estimate the difference in income underreporting which is attributed to corruption through the estimating the difference in expenditure at a product level and income between the public and private sector. The unconditional raw difference is therefore interesting to investigate. Given that the public sector has on average significantly higher income, the absolute difference between household items expenditure and income would not be useful. The far right column in Table 4 presents the gap between the ratio of household items expenditure to household income (budget share) for public and private sectors, broken down by various characteristics. If the public sector does not receive more unreported income than the private sector, the share of budget used by each on household items should be similar and the raw gaps insignificant. It is important to note that, while these raw gaps provide an indication of the level of underreporting, they do not control for other differences in the sample. As Table 4 above shows, the public and private sector do differ on characteristics, such as education and gender, which may affect the preferences of the household and therefore the budget share of household items expenditure.

Table 4 reports the results of the unconditional raw gap analysis in the far right column. For the full sample, we can see a negative difference, meaning that the public sector spends a larger share of their income on household items. This is a statistically significant difference of 3.2%. A Kolmogorov-Smirnov test was also performed and finds the distributions of the two sectors to be statistically different from each other. Looking at the gap by gender, there is no statistical difference between underreporting in the private and public sectors. Coloured and African race categories have the highest c/y gap by race, but this may be because these groups make up more than 90% of the public sector. Rural households appear to have high instances of underreporting with a significant gap of 2.1&. Of the provinces, the Eastern Cape specifically displays an indication of high levels of underreporting with a difference in budget shares of household items of 8.62%. Differences for four provinces appear positive which may indicate low or no levels of underreporting in these areas.

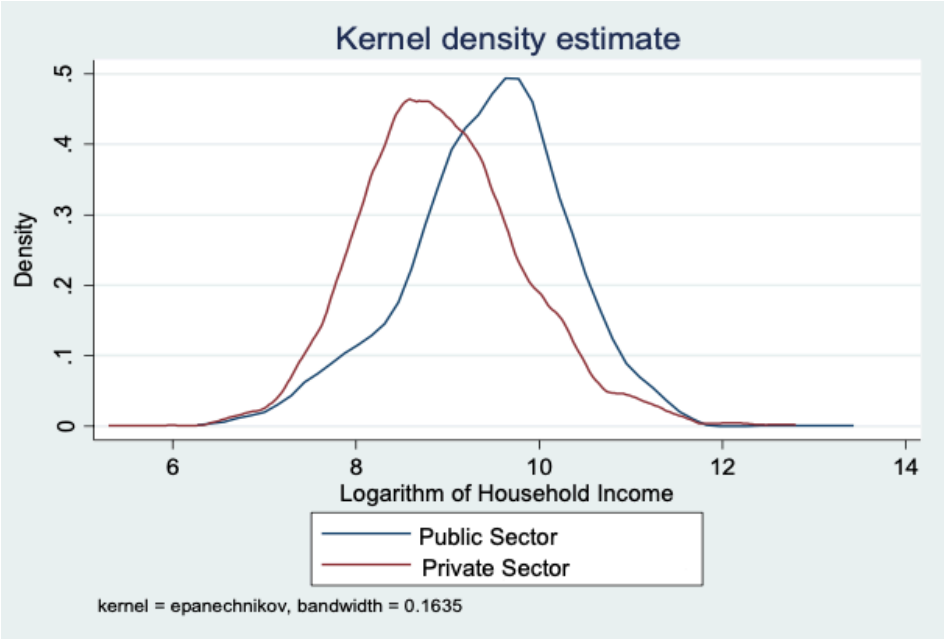
Table 4: Descriptive statistics

		Full Sample	Private Sector	Public Sector	Difference (%) $Mean_{priv}$-$Mean_{pub}$	Gap (%) C/Y_{priv}-C/Y_{pub}
Household Income		12754.99 (18593.59)	11511.19 (18708,34)	16114.5 (17927.75)	-39.82***	
Clothing Expenditure		337.29 (773.67)	317.09 (761.13)	464.86 (897.02)	-40.34***	
Household Equipment Expenditure		305.45 (3332.94)	223.01 (1411.18)	544.63 (6110.59)	-47.07***	-3.23***
Demographic controls (%) (Selected)						
Race	African	79.51	78	83.44	-2.46**	-1.34***
	Coloured	10.68	11.14	9.45	2.53**	-1.46*
	Asian/Indian	2.33	2.64	1.53	0.05	-1.33
	White	7.48	8.22	5.58	-0.05	0.69
Secondary Occupation		0.62	0.62	0	-0.02	
Male		41.28	36.92	51	0.14***	-0.58
Trust		92.17	90.88	96	-4.50***	
Household Characteristics (%) (Selected)						
Rural Area		24.12	24.14	23.84	-3.38**	-2.1***
Province	Western Cape	12.56	13.38	10.45	7.70***	0.84*
	Eastern Cape	7.36	5.48	12.39	-5.52***	-8.62*
	Northern Cape	2.41	2.07	3.27	-4.83***	-3.11*
	Free State	7.00	5.66	10.45	-3.34***	0.74
	KZN	13.56	14.54	10.95	0.50	-1.48**
	North West	7.04	7.69	5.36	1.00*	-1.20
	Gauteng	34.58	35.18	33.12	5.3***	2.80
	Mpumalanga	8.32	9.07	6.21	0.96	1.34
	Limpopo	7.17	6.91	7.80	-9.17***	-3.60*
Household Size		3.72 (2.63)	3.76 (2.73)	3.61 (2.35)	-1.49	
Additional adult employed in the public sector		1.97	1.97	0	-7.72***	

Note: This table includes only variables of econometric and descriptive relevance. A table of descriptive statistics for all variables used in this analysis can be found in Appendix 1. Percentage share of sample is reported for categorical or indicator variables, mean of sample otherwise. Standard deviations in parenthesis.

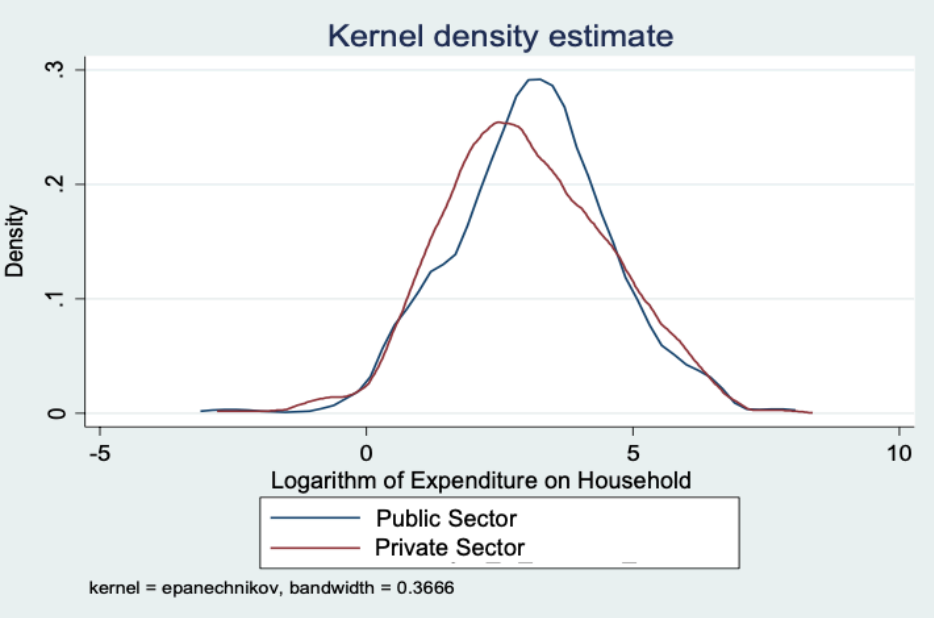
Source: NIDS Waves 3-5.

Figure 2a: Kernel Density Plot of Household Income



Source: NIDS Waves 3-5

Figure 2b: Kernel Density Plot of Household Items Expenditure



Source: NIDS Waves 3-5

3.2 Theoretical Model

An expenditure function is used to estimate the public and private sector's demand for each expenditure function based on individual household data. Following Zhong (2016) and Pissarides and Weber (1989), a linear log expenditure equation, based on product level expenditure, using log of income and a vector of household characteristics, is estimated. This function is then inverted to provide a measure of income underreporting. In order to accurately estimate the level of corruption, the expenditure item used must be for a product that is linearly related to and therefore determined by true income and not influenced by corruption activities. The reported expenditure item j of household i is denoted as $E_{ij}$and the after-tax income as Y_i. We assume that E_{ij} is the true expenditure of all households but that Y_i is only the true income of some of the households. Therefore, for the private households, Y_i=Y_i^* where Y_i^* is true income. Public sector employees are those assumed to be more likely to engage in corrupt activities which would provide a higher level of additional, assumedly unreported, income through the receipt of monetary bribes as well as in-kind gifts and favours. This, therefore either directly increases the household's disposable income or increases it indirectly through decreasing expenditure on certain goods. Public sector households are therefore represented by

$$Y_i^* = \theta_i Y_i, \qquad \theta_i \geq 1 \tag{1}$$

Where θ_i is a random variable which shows the extent of corruption, with a higher θ_i indicating a higher degree of corruption. We assume that θ_i is log-normally distributed. This intuitively makes sense as the distribution of θ_i is likely skewed to the right, with many people increasing their incomes a small amount through corrupt activities and fewer gaining large amounts of money from these activities. A logarithm function also compresses larger values and stretches out smaller ones. Writing θ as a deviation from its mean we get

$$ln\theta_i = \bar{\mu} + \eta_i \tag{2}$$

where $\bar{\mu}$ is the mean of $ln\theta_i$ and η_i is a random variable with a mean of 0 and a constant variance of σ_η^2. When estimating the expenditure function, a Working-Leser linear expenditure equation is used, following Zhong (2016) and Pissarides and Weber (1989):

$$lnE_{ij} = X_i\beta + \gamma_1 lnY_i^* + \varepsilon_i \tag{3}$$

where X_i is a vector of household characteristics, β is a vector of parameters, $\gamma_1$is a scalar and ε_i is the error term. Pissarides and Weber (1989) use permanent income in order to address income

uncertainty. Zhong (2016) however, records the lack of consensus on the permanent income hypothesis and argues further that household non-durable consumption is sensitive to changes in income when credit market imperfections exist. In South Africa, credit market imperfections are well documented with a large percentage of the population having imperfect access to credit institutions (Ardington et al., 2009; Lam et al., 2013). This paper therefore follows Zhong (2016) and uses current income as the income measure.

Substituting (1) and (2) into (3) we can express the expenditure equation in terms of reported income Y_i:

$$lnE_{ij} = X_i\beta + \gamma_1 lnY_i + \gamma_1\bar{\mu} + (\gamma_1\eta_i + \varepsilon_i) \tag{4}$$

Equation (4) is then estimated as

$$lnE_{ij} = X_i\beta + \gamma_1 lnY_i + \delta'_1 D_i + \Psi_i \tag{5}$$

where D_i is a dummy variable taking on a value of 1 if household i is in the public sector and 0 otherwise, with $\beta + \gamma_1$ being the same for all households. Based on (3) the following can be formed:

$$\delta'_1 = \gamma_1\bar{\mu} \tag{6}$$

Using (5) we are therefore able to calculate $\bar{\mu}$.

The error term Ψ_i in equation (5) is heteroskedastic, as indicated by equation (4). This is corrected for by estimating robust standard errors. Here we also have to make a relatively strong assumption that η_i is statistically independent of $\ln Y_i$. In order to estimate σ_η^2 we again follow Zhong (2016) and first estimate the reduced form regression for income

$$lnY_i = X_i\zeta_1 + \zeta_2 D_i + \kappa_i \tag{7}$$

If we denote the predicted value of log income as $ln\widehat{Y}_i$, then $var(\kappa_i) = var[ln\widehat{Y}_i - ln\widehat{Y}_i]$ where Y_i is interpreted as explained actual income. $var(\kappa_i)$ is the sum of the variance of the unexplained part of observed income and the variance of the deviation of observed income from true income. We estimated equation (4) under the assumption that its variance takes only two values: one for public sector households and one for private sector households. The observed income of private sector households is taken as the baseline and so the residual term κ_i for these households is assumed to be only unexplained variation in observed income. It is then assumed that the variance

in the unexplained part of the observed household income can be approximated by the variance in observed household income for the two groups of households

$$var(\kappa_i)_{public} - var(\kappa_i)_{private} = \sigma_\eta^2 + [var(lnY)_{public} - var(lnY)_{private}] \quad (8)$$

where the subscripts *public* and *private* represent public households and private households, respectively. σ_η^2 is an estimate of the variance associated with deviations in observed and actual incomes for public sector households.

Using this we solve for $\bar{\theta}$, calculating the mean based on the property of log normal distribution, which provides an estimate of the degree of corruption.

$$\bar{\theta} = exp(\bar{\mu} + \frac{1}{2}\widehat{\sigma_\eta^2}) \quad (9)$$

On average, therefore, the income of public sector households is $(\bar{\theta} - 1)$ higher than their reported income, assuming that the difference in variance holds.

A key assumption of this approach is that $\bar{\theta}$ captures only the effect of corruption. In reality however, it may capture a range of other factors. First, $\bar{\theta}$ may be influenced by the existence of secondary employment. If this employment is not accounted for, the model would report the increased expenditure as corruption income. In South Africa, there is evidence of some secondary employment, most notably by nurses in the health sector (Rispel & Blaauw, 2015; Rispel et al. 2014; Erasmus, 2012; Rothman et al., 2006). Older household surveys did not allow for the reporting of more than one occupation. More recent surveys such as NIDS, however, have included the option of reporting secondary employment (Muller and Posel, 2004). A variable was therefore added to the regression to control for the this. While there may still be a level of secondary employment in the sample that is unreported, it may be assumed that unreported secondary employment occurs equally across the public and private sectors.

$\bar{\theta}$ may also capture income from illegal activities beyond corruption. The effects of such activity is unable to be differentiated from the effects of corruption. The existence of these illegal activities, however, is likely related to corruption. As discussed above in Section 2.3, a culture of corruption can lead to a culture of lawlessness (Dobie, 2017). The ability to bribe one's way out of the justice system enables the existence of corruption and other criminal activity. There is therefore a strong link between corruption and other forms of illegal activities and capturing the effect of all such activities can be argued to represent the culture of corruption. The measure of corruption may

also include income hidden for tax evasion purposes. Most South Africans pay only income tax. As income tax is deducted by the employer, wage and salary earners have little opportunity to evade it. Self-employed individuals do have an opportunity in this regard. In order to account for this, the sample excludes self-employed workers.

A central concern of this approach is that it may not take into account preference heterogeneity. If private sector households have different preferences regarding the consumption of the expenditure items used, then the estimates of corruption will capture both the corruption and the preference heterogeneity. Lyssiotou et al. (2004) show that self-employed households have different preferences for necessities such as food and fuel in comparison to employed households. Banerjee et al. (2015) argue that the public sector, especially those with known opportunities for corruption, attract dishonest employees. An individual's level of honesty, however, is unlikely to influence their preferences. Regardless, a variable controlling for honesty has been included. Costa-Gomes et al. (2014) find a causal link causal link between first-order beliefs about trustworthiness and actions and therefore individuals who believe others to be more trustworthy are more likely to be trustworthy themselves. The trust variable captures a respondent's belief that their wallet with money in it will be returned to them by either a stranger or a friend.

This study assumes that public and private sector households have similar preferences for the product expenditure items used in the analysis. In South Africa, there are few fringe benefits associated with a government job in comparison to the private sector, except for higher pay. There is no empirical evidence of better job security (Yousef, 2017; Schneider et al., 2015). If these conditions do exist, however, they may lead to increased expenditure on non-necessities such as luxury clothing or jewellery. In order to test this hypothesis, a dummy variable was added for households where another member of the household who was not the household head's was employed in the public sector. The coefficient on this variable was small and not statistically significant.

A further concern may be that higher-ranking employees have different preferences for consumption of clothing and household items than others. In order to address this, a variable was included representing the nature of the positions, including managers, armed forces, professionals, technicians and associate professions, service and sales workers, skilled agricultural, forestry and farming, craft and related trades workers, plant and machine operators, and assistants and elementary occupations. There may, however, still be other reasons for heterogenous preferences. Differences in household and individual characteristics may influence consumption preferences. From the table in Appendix 1 we can see that characteristics of households in the public and

private sector do differ. Some of these differences, such as differences in household assets, are likely to be a function of the difference in income. All of the variables in this table, however, are included as controls.

3.3 Econometric Approach

The existing literature on corruption lacks a more detailed investigation of the phenomenon (Andersson, 2017). The benefits of the approach used in this study are that it enables an objective measure of petty corruption and provides an estimation of its magnitude. Additionally, it allows an analysis of the spatial variation of the petty corruption and of the variation of petty corruption across sectors, through adjustments to the sample groups, and across the income distribution, using quantile regressions, providing unique insight into the nature of petty corruption in South Africa. This is crucial in exploring the causes and consequences of petty corruption as well as strategies to combat it (Morris, 2011).

The dependent variables used in the analysis were the logarithm of expenditure on clothing and expenditure on household items. The independent variables used are the log of household income and the sector dummy. In addition to these, a vector of control variables was added, including household head's race, age, age squared, years of education, marital status, occupation, existence of secondary occupation, trust, language and health, the province and area type of the household, household size, whether the household pays rent, a bond and owns it's dwelling, controls for household assets including car, landline, cell phone, washing machine, tv, fridge/freezer and a computer and a control for the season in which the interview was conducted as this may influence spending patterns. Appendix 1 reports summary statistics of all variables in the regression analysis. Specifically, the estimated equation takes the form:

$$lnE_{ij} = X_i\beta + \gamma_1 lnY_i + \delta'_1 D_i + \Psi_i \quad (5)$$

where lnE_{ij} refers to the log of the expenditure of product j with i being a function of the $k \times 1$ vector, X of household characteristics. β is the $1 \times k$ vector of parameters. lnY_i is the logarithm of household income and D_i is a dummy variable taking on a value of 1 if household i is in the public sector and 0 otherwise. γ_1 and δ'_1 are scalars and Ψ_i is the error term.

4 Results and Discussion

The parameters of interest from the fixed effects regression are reported in Table 5, with the full results for all regressions reported in Appendix 2. Specification (1) estimates the expenditure equation with clothing expenditure as the dependent variable and Specification (2) estimates the

equation for household items expenditure. From these results we can obtain the estimation of $\bar{\mu}$ using equation (6), with parameters γ_1 and δ'_1 in Table 5. In order to calculate $\bar{\mu}$, the mean of $ln\theta_i$, we follow equation (5). Next, the variance (σ_η^2) is calculated using the method described in Section 3.2 and is estimated to be 0.06. Based on the property of log-normal distribution, $\bar{\theta}$ is calculated using equation (9). The same procedure is followed for both expenditure items.

The estimation shows that the public sector is underreporting their income on average by 5.58% and 31.71% for clothing expenditure (1) and household item expenditure (2) respectively. This is an average nominal increase of R899.19 and R5109.91. These results demonstrate that, in-line with the literature, there is a higher level of petty corruption in the public sector in relative to the private sector (Corruption Watch 2016, 2017; Victims of Crime Survey, 2003; Argandoña, 2003; Jain, 2001). The estimation of underreporting using clothing is much lower than the level found when using household items as the dependent variable. Zhong (2016) uses the same two expenditure categories and finds that clothing has a higher level of associated income underreporting in comparison to household items, at 21.3% and 14.6% respectively. The difference between the South African and Chinese results indicate that petty corruption is context specific. In China there appears to be no practice of using clothing as a bribe in kind. In South Africa, the low estimate of underreporting using clothing as the dependent variable provides evidence for the practice of clothing items being used as bribes in kind.

Only for household items expenditure are both, γ_1 and δ'_1 significant. This holds true for various specifications of the sector variable. Household items expenditure is therefore used as the dependent variable.

4.1 Estimations with different reference groups

In South Africa, though corruption is acknowledged as a widespread issue, much of the survey and anecdotal evidence suggests that activity is more highly concentrated in certain departments such as the police and education (Corruption Watch, 2016, 2017; Victims of Crime Survey, 2018). In order to examine the relative extent of corruption within different parts of the public sector, the sector indicator variable was recoded to provide further detail to the analysis.

Table 5: Estimation of income underreporting for clothing and household items expenditure

	Clothing Expenditure	Household Items Expenditure	
	General Sector Indicator	General Sector Indicator	Clean Sector Indicator
	(1)	(2)	(3)
$\boldsymbol{\gamma_1}$ *Coefficient on log of income*	0.97	1.21	1.25
	[0.06]***	[0.07]***	[0.1]***
$\boldsymbol{\delta'_1}$ *Coefficient on sector dummy*	0.02	0.30	0.56
	[0.17]	[0.17]**	[0.25]
$\bar{\boldsymbol{\mu}}$ *Mean of* $ln\theta_i$	0.02	0.25	0.45
$\widehat{\boldsymbol{\sigma_\eta^2}}$ *Variance of* η_i	0.06	0.06	0.02
$\bar{\boldsymbol{\theta}}$ *Extent of corruption*	1.06	1.32	1.58
Level of income underreporting (Conditional Mean)	5.58%	31.71%	57.67%

Note: Coefficients and standard errors [in parenthesis] from fixed effects estimation of the expenditure function are reported. Full regression table can be found in Appendix 2. Dependent variables are the logarithm of clothing and household items described in Section 3.1.2.. Explanatory variables included in this table are the logarithm of household income and the sector indicator variable, in in different formulations explained in Section 4.1. All demographic and household characteristics can be found in Appendix 1 and are controlled for.
$\bar{\mu}$ is calculated through formula (6): $\delta'_1 = \gamma_1\bar{\mu}$. The level of underreporting can be calculated based on formula (9): $\bar{\theta} = exp(\bar{\mu} + \frac{1}{2}\widehat{\sigma_\eta^2})$ where $\widehat{\sigma_\eta^2}$ is estimated using equation (8): $var(\kappa_i)_{public} - var(\kappa_i)_{private} = \sigma_\eta^2 + [var(lnY)_{public} - var(lnY)_{private}]$
P<0.10*, p<0.05**, p<0.01***

First, the public sector category was recoded to represent the cleanest form of the public sector. This excluded those in education, health and SOEs. The clean sector variable therefore includes only those who are unambiguously employed in the public sector, all government departments and the defence force. The results from this estimation, specification (3), can be found in Table 5. This shows a substantial increase in the underreporting of income with an estimation of 57.67%. The magnitude of underreporting in this estimation indicates that the inclusion of education, health and SOEs was bringing down the average level of corruption. The increase of 26% from

the general sector variable to the clean version likely indicates a lower than expected level of petty corruption in education as education is the largest component of the public sector. This is contrary to anecdotal evidence. Reports of corruption in schools were the most frequent of all corruption reports to Corruption Watch in 2016 and 2017. More than half of these reports were carried out by individuals employed by the school, rather than those who work in the Department of Education, implying a high level of corruption exists in schools (Corruption Watch, 2017,2018). It is important to note, however, that the sector dummy was not significant and, given that the increase in the level of underreporting is mainly a result of the increase in the sector variable coefficient, this is only weak evidence for this magnitude of petty corruption.

It is also of interest to determine the relative level of corruption in specific departments in the public sector. As discussed in Section 2.3., specific departments and sectors of the public sector seem to have entrenched practices of petty corruption. Instances of corruption in the Departments of Social Development and Housing are well documented by the media (Bruce, 2014). These departments are included in the 'general government sector' category of the sector variable. In order to better understand the influence of these departments on the level of underreporting, the general government alone was used as the public sector reference group. The results of this estimation can be seen in Table 6. Relative to the more broadly defined sector indicator, the indicator variable containing only the general government sector reports an 8.98% higher level of income underreporting, at 40.67%. This provides further evidence for the variation of petty corruption across sectors. The higher level of underreporting also indicates that government departments experience high levels of petty corruption. Based on the evidence from Lodge (2002) and Hyslop (2005), it is likely that this activity is concentrated in departments which have historically be known for their high levels of petty corruption such as the Department of Social Development.

Law enforcement, defined here as the police, traffic officers and correctional service workers, are notorious for their high incidence of petty corruption. Throughout Apartheid and into the present day the police, and more recently traffic officers, are consistently reported as having one of the highest incidences of corruption (see StatsSA, 2017, 2018; Lodge, 2002). It would therefore be interesting to estimate whether this translates into a higher magnitude of income underreporting. The sector variable was recoded to represent only those individuals who work in law enforcement. This category had too few observations to act as a reference group alone and so it was combined with the general government category. The results from this estimation are reported in Table 6. Restricting the public sector to the police, traffic officers and correctional services and general public sector increases the level of corruption by 26.9% relative to the general sector variable and

17.94% relative to the general government sector to 58.61%. This is a nominal increase of R7 475,70. This result corroborates the numerous reports, including all Corruption Watch reports (2013 - 2017), the Victims of Crime Survey (2012-2018) and the Bribery Survey (Dobie, 2017), which describe high levels of petty corruption in these professions.

The high level of corruption in law enforcement, specifically the police and traffic officers is likely due to their high levels of discretionary power and minimal monitoring. These sectors operate as 'field workers' and are seldom under direct supervision of a superior. There is therefore little preventing them from engaging in petty corruption activities. This result is particularly troublesome given the nature of their work which has a direct impact of public safety. If people know that they can avoid punishment for disobeying the rules of the road or other crimes, there is little incentive to abide by them. This results in more dangerous and risky activity and an increase in the level of lawlessness in a society (Dobie, 2017).

Similarly to law enforcement, an indicator variable was created for assessing corruption in the health sector by combining general government and health sector categories. The resulting level of income-underreporting attributed to petty corruption in the health sector is found to be 42.46%. Given that this was combined with the straight public sector estimate, this is also likely a lower bound estimate of underreporting. While reports of bribery in the health sector constitute only 1% of VOCS 2015/16 total bribery reports (StatsSA, 2017), there is little other evidence for the magnitude of corruption found in this study. There is, however, a body of evidence explaining the propensity of individuals in the health sector, nurses specifically, to 'moonlight' (Rispel et al. 2014; Rispel & Blaauw, 2015). Many nurses have second jobs in the sector which they work during their time off from their primary occupation. There were very few reports of such activity in the sample as seen in Table 4 with few in this sample reporting as such. This is a stark comparison to the 70% of nurses in the private and public sectors who were found by Rispel et al. (2014) to be moonlighting. A part of the high corruption figure may therefore be due to the existence of this unreported secondary employment in this field.

As the level of underreporting in the health sector is similar to the general government sector, this does not explain the increase seen in the public sector underreporting for the 'clean' public sector. This therefore warrants an investigation into education, another sector that is documented as a hotbed of corruption in reported corruption measures (Corruption Watch, 2017, 2018). The sector variable was therefore recoded to include only individuals in the education category. The resulting figure is lower than the average result from the sector indicator variable at 19.32%. This may be interpreted as a low figure, both relative to the other sectors estimated above and given

the numerous reports of corruption in the education sector. Given that the education sector is the largest component of the public sector (28.76%), this difference explains the lower figure for the full public sector.

Table 6: Estimation of income underreporting for different public sector groups

	General Government	Law Enforcement and General Government	Health	Education
$\boldsymbol{\gamma_1}$ *Coefficient on log of income*	1.23 [0.1]***	1.27 [0.12]***	1.23 [0.09]***	1.23 [0.09]***
$\boldsymbol{\delta'_1}$ *Coefficient on sector dummy*	0.41 [0.19]*	0.54 [0.26]**	0.41 [0.19]**	0.20 [0.14]*
$\bar{\boldsymbol{\mu}}$ *Mean of* $ln\theta_i$	0.32	0.43	0.43	0.16
$\widehat{\boldsymbol{\sigma_\eta^2}}$ *Variance of* η_i	0.03	0.05	0.05	0.03
$\bar{\boldsymbol{\theta}}$ *Extent of corruption*	1.41	1.58	1.42	1.19
Level of income underreporting **(Conditional Mean)**	40.67%	58.61%	42.46%	19.32%

Note: Parameters of interest and standard errors (in parenthesis) from fixed effects estimation of household expenditure function are reported. Full regression table can be found in Appendix 2. The dependent variable is the logarithm of household items, equipment and services described in Section 3.1.2.. Explanatory variables included in this table are the logarithm of household income and the sector indicator variable, in in different formulations representing different public sectors, explained in Section 4.1. All demographic and household characteristics can be found in Appendix 1 and are controlled for but are not presented.
$\bar{\mu}$ is calculated through formula (6): $\delta'_1 = \gamma_1\bar{\mu}$. The level of underreporting can be calculated based on formula (9): $\bar{\theta} = exp(\bar{\mu} + \frac{1}{2}\widehat{\sigma_\eta^2})$ where $\widehat{\sigma_\eta^2}$ is estimated using equation (8): $var(\kappa_i)_{public} - var(\kappa_i)_{private} = \sigma_\eta^2 + [var(lnY)_{public} - var(lnY)_{private}]$
p<0.10*, p<0.05**, p<0.01***

The discrepancy between this figure and the various anecdotal and survey evidence may be due to the nature of the service of education as well as the institutional nature of schools. Parents have a vested interest in ensuring that their children receive the resources intended for them.

Corruption in schools is therefore more likely to be reported (Reinikka & Svensson, 2004). Schools also present fewer opportunities for bribes. Staff have limited interaction with parents in a one-on-one fashion and it is not a particularly lucrative venture to bribe students. Corruption Watch (2018) finds that most reported incidences of corruption in schools involve the theft of school funds, followed by corruption from employment, often taking the form of nepotism or the appointment of ghost teachers. These types of activities cannot be too widespread as they are limited to principals and more senior levels of staff. Additionally, school staff are under supervision of the principal and their colleagues, in addition to the parents. This combination of higher levels of reporting and high levels of action in addressing corruption creates a strong monitoring system. This, coupled with low levels of discretionary power may account for the lower than expected levels of corruption found in this sector.

4.2 Cross-Regional Corruption

An advantage of this method is that it also enables us to get a view of cross-country or cross-regional variation in the level of corruption. This provides further insight into the economic effects of corruption. Historical evidence suggests that more rural areas will experience higher levels of corruption because of their former homeland status. In South Africa, this also translates into poorer provinces likely experiencing more corruption. Whether this is in magnitude or incidence however, one is unable to say. Reports of corruption and survey data (Corruption Watch 2018; StatsSA 2017) show the incidence of corruption to be higher in urban areas, most notably in Gauteng, the richest province in South Africa. As discussed in Section 2.3.3.1, these results may not reflect reality when looking at absolute as opposed to per capita numbers. Additionally, there may be less reporting in rural areas as access to institutions of justice not as high as in urban areas (Mcquoid-Mason, 1999, 2013). Again, data limitations have placed necessary restrictions on the analysis and so the inter-provincial level of corruption could not be estimated. Provinces were therefore grouped into 'rich' and 'poor' based on their level of income per capita. 'Rich' provinces include Gauteng, Western Cape and Kwa-Zulu Natal. 'Poor' provinces include the Northern Cape, North West Province, Mpumalanga, Eastern Cape, Limpopo and the Free State (Stats SA, 2017). Expenditure equations were estimated separately for each group.

This dichotomy of rich and poor provinces provides insight into the relationship between economic development and corruption. The literature notes a bi-directional relationship between the two (Zhong, 2016). On the one hand, high levels of corruption can harm development while, on the other, high levels of economic development may also increase the opportunities for corruption (Zhong, 2016). In South Africa, the former appears to be true. Poorer provinces have higher levels

of underreporting at 32.63% in comparison to the 20.96% of underreporting in richer provinces as seen in Table 7.

Table 7: Estimation of income underreporting for different regions and area types

	Poor Provinces	Rich Provinces	Rural Areas	Urban Areas
$\boldsymbol{\gamma_1}$ *Coefficient on log of income*	1.22 [0.1]***	1.05 [0.09]***	1.12 [0.10]***	1.21 [0.10]***
$\boldsymbol{\delta'_1}$ *Coefficient on sector dummy*	0.30 [0.13]*	0.19 [0.47]**	0.36 [0.28]**	0.25 [0.21]*
$\boldsymbol{\bar{\mu}}$ *Mean of* $ln\theta_i$	0.24	0.18	0.33	0.20
$\boldsymbol{\widehat{\sigma_\eta^2}}$ *Variance of* η_i	0.08	0.02	0.05	0.01
$\boldsymbol{\bar{\theta}}$ *Extent of corruption*	1.33	1.20	1.42	1.27
Level of income underreporting (Conditional Mean)	**32.63%**	**20.96%**	**42.02%**	**26.85%**

Note: Parameters of interest and standard errors (in parenthesis) from fixed effects estimation of household expenditure function are reported. Full regression table can be found in Appendix 2. The dependent variable is the logarithm of household items, equipment and services described in Section 3.1.2.. Explanatory variables included in this table are the logarithm of household income and the sector indicator variable, in in different formulations representing different provincial groups and area types, explained in Section 4.2. All demographic and household characteristics can be found in Appendix 1 and are controlled for but are not presented.
$\bar{\mu}$ is calculated through formula (6): $\delta'_1 = \gamma_1\bar{\mu}$. The level of underreporting can be calculated based on formula (9): $\bar{\theta} = exp(\bar{\mu} + \frac{1}{2}\widehat{\sigma_\eta^2})$ where $\widehat{\sigma_\eta^2}$ is estimated using equation (8): $var(\kappa_i)_{public} - var(\kappa_i)_{private} = \sigma_\eta^2 + [var(lnY)_{public} - var(lnY)_{private}]$
p<0.10*, p<0.05**, p<0.01***

A second dichotomy of interest to economic development is that which exists between rural and urban areas. Public sector workers in rural areas often have less oversight and therefore more discretionary power, potentially increasing the level of corruption. Alternatively, the higher concentration of people in urban areas provides more opportunities for corruption though an increased frequency of interactions and transactions (Zhong, 2016). The results from this study

support the case of the former with rural and urban areas having estimated petty corruption levels of 42.02% and 26.85% respectively, as seen in Table 7.

Table 8: Estimation of income underreporting for interacting regions and area types

	Rich Provinces, Urban Area	Rich Provinces, Rural Area	Poor Provinces, Urban Area	Poor Provinces, Rural Area
$\boldsymbol{\gamma_1}$ *Coefficient on log of income*	1.14 [0.13]***	1.065 [0.125]***	1.095 [0.121]***	0.933 [0.615]
$\boldsymbol{\delta'_1}$ *Coefficient on sector dummy*	0.02 [0.332]*	0.134 [0.460]	0.319 [0.280]*	0.381 [0.260]
$\boldsymbol{\bar{\mu}}$ *Mean of* $ln\theta_i$	0.01	0.13	0.29	0.41
$\boldsymbol{\widehat{\sigma_\eta^2}}$ *Variance of* η_i	0.09	0.08	0.08	0.06
$\boldsymbol{\bar{\theta}}$ *Extent of corruption*	1.06	1.18	1.39	1.55
Level of income underreporting (Conditional Mean)	**6.85%**	**18.04%**	**39.28%**	**55.02%**

Note: Parameters of interest and standard errors (in parenthesis) from fixed effects estimation of household expenditure function are reported. Full regression table can be found in Appendix 2. The dependent variable is the logarithm of household items, equipment and services described in Section 3.1.2.. Explanatory variables included in this table are the logarithm of household income and the sector indicator variable, in in different formulations representing different provincial groups and area types, explained in Section 4.2. All demographic and household characteristics can be found in Appendix 1 and are controlled for but are not presented. p<0.10*, p<0.05**, p<0.01***
$\bar{\mu}$ is calculated through formula (6): $\delta'_1 = \gamma_1 \bar{\mu}$. The level of underreporting can be calculated based on formula (9): $\bar{\theta} = exp(\bar{\mu} + \frac{1}{2}\widehat{\sigma_\eta^2})$ where $\widehat{\sigma_\eta^2}$ is estimated using equation (8): $var(\kappa_i)_{public} - var(\kappa_i)_{private}\sigma_\eta^2 + [var(lnY)_{public} - var(lnY)_{private}]$

In South Africa richer provinces contain a higher percentage of urban population and poorer provinces are more rural and estimating them independently ignores the potential interaction effect. Therefore another estimation was done in which the sample was grouped into rich province-urban, rich province-rural, poor province-urban and poor province-rural. This will aid the disentanglement of the above effects. The overall results, presented in Table 8, show an interesting

trend. Underreporting appears to be highest in rural areas, regardless of whether the household is in a rich or poor province. The rich provinces have lower levels of underreporting. This is in line with the results in Table 7 which reported rich provinces as having lower levels of petty corruption. Urban areas in rich provinces specifically have the lowest levels of petty corruption. This suggests that using the incidence of corruption as a measure of the extent of corruption may produce misleading results. It is, however, important to note that by splitting up the already small sample further, the sample size for the estimations drops. Additionally, the significance of the coefficients for income and the sector dummy decrease with rich provinces and rural areas showing an insignificant coefficient for the sector dummy and poor and rural provinces, with the smallest number of observations (135), show a less significant effect for income and insignificant effect for the sector variable.

4.3 Cross Sectional Analysis

While a panel analysis is able to control for time invariant effects, it does not allow us to evaluate potential trends over time. In this section, waves 3, 4 and 5 of the NIDS data set was used as a cross-section. Following Zhong (2016) and others from the tax evasion literature (Pissarides and Weber, 1969; Hurst et al., 2014), a Working–Leser model was used to estimate the expenditure function for each wave. The results of these estimations can be seen in Table 9.

Corruption across the waves suggests an increasing trend. In Wave 3 the level of income underreporting is estimated to be 35.72%. In Wave 4, the estimated levels of corruption is 40.34%. The estimate for Wave 5, however, was significantly greater than both other waves, at 50.38%. These values corroborate the trends shown by other measures of corruption. When mapped against other measures of corruption such as reported cases of corruption from Corruption Watch (Corruption Watch, 2018) or the National Victims of Crime Survey data, a similar trend emerges. Corruption Watch reports 3223 cases in 2012, the same year as NIDS Wave 3. In 2014 and 2015 they report 2262 and 2714 cases respectively. In 2017 the number of reported cases more than double to 5334 (Corruption Watch, 2018). This spike in reporting in 2017 was previously argued to be inflated due to increases in awareness of corruption and reporting procedures but evidence from this study suggests that it may also be attributable to a real increase in the extent of corruption.

The spike in the Wave 5 estimate mirrors a similar trend reflected in the Victims of Crime Survey (VOCS). In 2014/15 the VOCS reported 63,437 individual incidents of corruption being experienced by 53,458 people. This meant that 15% of individuals in the sample had experienced corruption. By 2017, these figures had doubled. The number of corruption incidents rose to

134 442, the number of people affected increased to 116014 and the proportion of people in the sample affected doubled to 30% (Victims of Crime Survey, 2018).

Table 9: Estimation of income underreporting for over time

	2012 (Wave 3)	2014/15 (Wave 4)	2017 (Wave 5)
$\boldsymbol{\gamma_1}$	0.51	0.56	0.50
Coefficient on log of income	[0.18]	[0.23]**	[0.25]*
$\boldsymbol{\delta'_1}$	0.15	0.19	0.20
Coefficient on sector dummy	[0.24]***	[0.19]**	[0.41]**
$\bar{\boldsymbol{\mu}}$	0.29	0.34	0.40
Mean of $ln\theta_i$			
$\widehat{\boldsymbol{\sigma_\eta^2}}$	0.02	0.003	0.016
Variance of η_i			
$\bar{\boldsymbol{\theta}}$	1.35	1.40	1.50
Extent of corruption			
Level of income underreporting **(Conditional Mean)**	35.72%	40.34%	50.38%

Note: Parameters of interest and standard errors (in parenthesis) from OLS estimation of household expenditure function are reported. Full regression table can be found in Appendix 2. The dependent variable is the logarithm of household items, equipment and services described in Section 3.1.2.. Explanatory variables included in this table are the logarithm of household income and the sector indicator variable. Estimations are performed on Waves 3, 4 and 5 of NIDS. All demographic and household characteristics can be found in Appendix 1 and are controlled for but are not presented.
$\bar{\mu}$ is calculated through formula (6): $\delta'_1 = \gamma_1\bar{\mu}$. The level of underreporting can be calculated based on formula (9): $\bar{\theta} = exp(\bar{\mu} + \frac{1}{2}\widehat{\sigma_\eta^2})$ where $\widehat{\sigma_\eta^2}$ is estimated using equation (8): $var(\kappa_i)_{public} - var(\kappa_i)_{private} = \sigma_\eta^2 + [var(lnY)_{public} - var(lnY)_{private}]$
p<0.10*, p<0.05**, p<0.01***

The results shown in Table 10 show a percentage point increase in corruption between 2012 and 2014/15 of 4.62%. Between 2014/15 and 2017 the growth is twice as big: 10.04%. These figures can be explained by looking at South Africa's macro-economic context over this period. Between 2012 and 2015, unemployment rose by 0.93% and between 2015 and 2017 it rose by 2.56%. The direction of this causality, however, is unclear. The literature finds that unemployment has a bi-causal relationship with corruption. Kayode, Arome & Anyio (2014) find that higher levels of corruption increase unemployment while Mocan, (2008) finds that unemployment leads to a higher

incidence of bribery in a country, with a one percent increase in male unemployment increasing a country's risk of bribery by 0.06 %. This reflects the findings of Samadi and Farahmandpour (2013) and Saha et al. (2009) who provide further evidence for the negative relationship between unemployment and corruption. Additionally, South Africa also experienced a period of decreased economic growth. During this time, between 2012 and 2017 GDP growth decreased by 0.85%, from 2.21% to 1.32%. As reported in the literature above GDP growth also exhibits a bi-causal negative relationship with corruption (Mauro, 1995).

The political situation and extent of the state capture agenda in South Africa is also reflected in these trends. Since 2012, the Zuma- centred elite have been seeking control of the State's resources. As time went on the stronghold of this group increased with more resources being stolen and more institutions captured, culminating in the capture of the National Treasury, made possible by the cabinet reshuffle which occurred in in March 2017 (See Bhorat et al., 2017 for an analysis of the state capture process). As this culture of lawlessness spread, evidenced by the increasing level of state capture (Bhorat et al., 2017), these results show that it has filtered down and infiltrated all aspects of government. This is both due to the culture which seeped through as well as the need for lower level officials and bureaucrats to coordinate and facilitate illicit activities. As the spread of state capture increased, so did the number of officials and bureaucrats exposed to and involved in this kleptocratic culture.

4.4 Quantile Regressions

While we have an estimate of the average level of income underreporting attributed to petty corruption that exists for the sample, there may be differences within the expenditure distribution which could enhance the understanding of the petty corruption. The analysis in the sections above is based on the estimation of conditional mean functions. This provides the average response of the sample's expenditure to the changes in the explanatory variables. However, when there is heterogeneity in the effects of variables, quantile regressions provide a more comprehensive picture of behaviour as the effect of determinants is allowed to vary over the distribution.

Previous versions of this method in both the tax evasion literature and in its application to corruption have been based on ordinary least squares (OLS) and instrumental variable (IV) estimations which provides an estimate of the conditional mean of the level of income underreporting attributed to corruption. While these findings are important, this study expands upon them through quantile regressions. Additionally, an assumption of OLS is that the error term and the dependent variable are normally distributed. Quantile regressions do not require a

normally distributed error term. Based on this technique we can therefore assess the level of underreporting attributable to petty corruption throughout the conditional distribution.

Quantile regressions were first proposed by Koenker and Bassett (1978) and since then have been applied throughout the economic literature. Quantile regressions have also been used in the context of corruption. Multiple studies have utilised this method to investigate the determinants of corruption over the conditional distribution of corruption across countries and anti-corruption activities (Billger and Goel, 2009; Okada and Samreth, 2012; Asongu, 2013). The literature on corruption has a gap in terms of looking at how corruption changes across the income distribution. The use of quantile regressions with this approach to measuring corruption can therefore fill this gap and provide insight into the nature of petty corruption.

A general statement of the quantile regression models can be taken across all quantiles. The estimation for the regression quantile is achieved through minimizing Equation (10):

$$\min_{\beta \in R^k} \left[\sum_{i \in \{i: y_i \geq X'_i \beta\}}^{N} q \left| y_i - X'_i \beta_q \right| + \sum_{i \in \{i: y_i \geq X'_i \beta\}}^{N} q \left| y_i - X'_i \beta_q \right| \right] \tag{10}$$

where q is a specific quantile, with $0<q<1$, y_i is the dependent variable X is a $(k \times 1)$ matrix of independent variables and β is the coefficient vector. The coefficients $\hat{\beta}_q$ are achieved through minimizing the above function (Koenker and Bassett, 1978; Bhorat and Oosthuizen, 2008). The conditional quantile of y_i given X'_i is:

$$Q_y \left(\frac{q}{X_i} \right) = X'_i \beta q \tag{11}$$

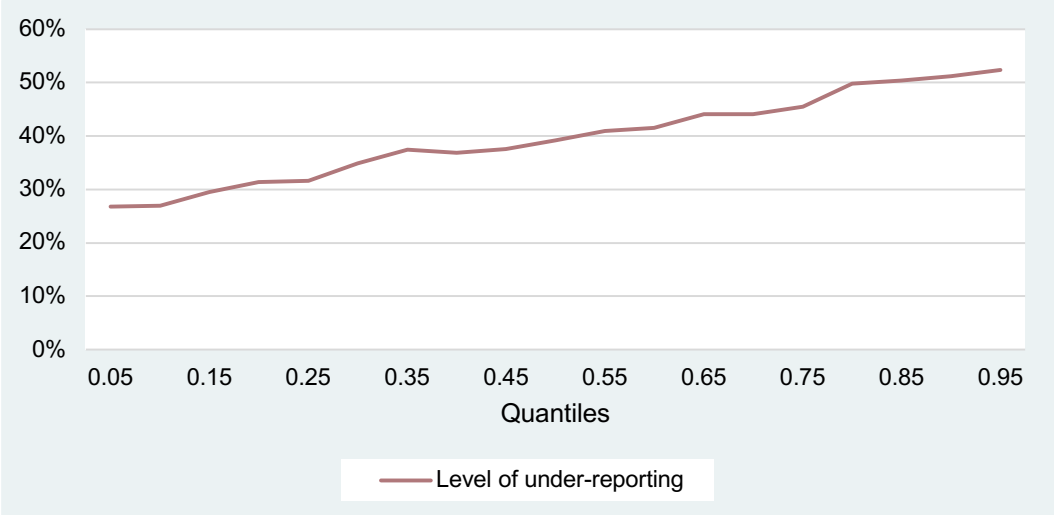
where unique slope parameters are estimated for each qth quantile of interest. This formulation is analogous to $E\left(\frac{y}{x}\right) = x'_i \beta$ in the OLS slope though parameters are estimated only at the mean of the conditional distribution of the dependent variable. Regarding the model in equation (11) the dependent variable y_i is the logarithm of household expenditure on household items and X_i contains a the log of household income, the sector indicator variable and the vector of household characteristics as described above in Section 3.1.3. Estimations using quantile regressions are more robust than an OLS approach when there are outliers in the sample, as the high income households are here (Okada and Samreth, 2012).

The results from the fixed effect quantile estimations are given below in Table 10. The model used is the same as that described in Section 3.3 above. The dependent variable used in the analysis was the logarithm of expenditure on household items, equipment and services. The independent variables used are the log of household income and the sector dummy. In addition to these, a vector of control variables was added.

In the first column, the original fixed effects regression results are reported, and provide a baseline of mean effects against which the quantile estimations can be compared. The additional five columns show the estimation of corruption level for five key quantiles to give an overview of parameters across the distribution. Figure 3 graphs the results of income underreporting over 20 quantile regressions in order to provide a clearer view of the pattern of underreporting across the distribution.

The quantile regressions show a different picture to that expressed by the fixed effect regression. While the fixed effect estimate shows an average estimate of 31.71% for the sample, the quantile estimates show that the level of petty corruption is not constant throughout the distribution of expenditure. Levels of underreporting show an increasing trend over the distribution, from 26.97% at the quantile 0.1 to 51.17% at quantile 0.9. This is an increase of 24.2%. Therefore, while there is high levels of petty corruption at all levels of income, there is evidence for higher petty corruption activity at the upper end of the distribution. As Figure 3 shows, this trend is close to linear. A possible explanation for this can be found through Aidt's (2003) description of the conditions necessary for corruption. As the income rises, it is assumed that the power of the associated position also increases. Higher positions are likely to provide the holder with a higher level of discretionary power. Additionally, higher positions may put the holder in a position to extract larger rents from more sources. These individuals could have the opportunity to extract rents from activities of their subordinates, as well as from their work with the public.

Figure 3: Level of underreporting across 20 quantiles at 0.05 intervals



Source: NIDS Waves 3-5

Table 10: Estimation of income underreporting across the distribution

	Fixed Effects	Quantile 0.1	Quantile 0.25	Quantile 0.5	Quantile 0.75	Quantile 0.9
$\boldsymbol{\gamma_1}$	1.21	0.67	0.73	0,83	0,97	1,03
Coefficient on log of income	[0.07]***	[0.16]***	[0.10]***	[0.08]***	[0.10]***	[0.15]***
$\boldsymbol{\delta'_1}$	0.30	0,14	0,20	0,27	0,33	0,42
Coefficient on sector dummy	[0.17]*	[0.22]	[0.14]*	[0.11]***	[0.14]**	[0.22]*
$\boldsymbol{\bar{\mu}}$	0.25	0.21	0,27	0,33	0,34	0,41
Mean of $ln\theta_i$						
$\boldsymbol{\widehat{\sigma_\eta^2}}$	0.06	0,05	0,00	0,01	0,07	0,02
Variance of η_i						
$\boldsymbol{\bar{\theta}}$	1.32	1.27	1.32	1.39	1.46	1.51
Extent of corruption						
Level of income underreporting	31.71%	26.97%	31.60%	39.14%	45.53	51.17%

Note: Parameters of interest and standard errors (in parenthesis) from fixed effects quantile regression estimation of household expenditure function are reported. The dependent variable is the logarithm of household items, equipment and services described in Section 3.1.2.. Explanatory variables included in this table are the logarithm of household income and the sector indicator variable. Estimations are done for 20 quantiles but only five are presented here. The full table can be found in Appendix 3 and regressions for the estimations in this table can be found in Appendix 2. All demographic and household characteristics can be found in Appendix 1 and are controlled for but are not presented. $\bar{\mu}$ is calculated through formula (6): $\delta'_1 = \gamma_1\bar{\mu}$. The level of underreporting can be calculated based on formula (9): $\bar{\theta} = exp(\bar{\mu} + \frac{1}{2}\widehat{\sigma_\eta^2})$ where $\widehat{\sigma_\eta^2}$ is estimated using equation (8): $var(\kappa_i)_{public} - var(\kappa_i)_{private} = \sigma_\eta^2 + [var(lnY)_{public} - var(lnY)_{private}]$
p<0.10*, p<0.05**, p<0.01***

5. Conclusion

Corruption is a persistent phenomenon in human societies and the negative consequences of it on growth, inequality, investment, welfare and numerous other aspects of society are well documented in a large empirical literature (Mauro, 1995; Lambsdorff, 2006; Hodge et al., 2011). Much of this research uses perception-based indices, such as the Corruption Perception Index (CPI), as a measure of corruption. These indices have recently come under scrutiny as they have been found to be inherently prone to bias and inaccurate proxies for actual levels of corruption in a society (Heywood & Rose, 2014). Measures of corruption based on experience such as reports and survey data do come closer to providing a more accurate and objective measure but a low level of reporting creates bias these estimates. In South Africa specifically, corruption is not well reported

as fear of prosecution, apathy and threats of violence prevent individuals from reporting corruption (Bahre, 2005; Carr, 2007).

Based on this, there has been a move to move towards more disaggregated measures of corruption using local or internal assessments. In this literature, forensic economic methods are often employed (Olken, 2006, Mishra et al., 2008). These methods provide objective measures of clandestine activities such as corruption. They compare two sources of data which measure the same activity, one which includes corruption and one which does not. These methods however, rely on specialist data sets which are difficult to come by, especially in developing countries with high levels of corruption (Zhong, 2016). Methods of measuring corruption have therefore been developed which use household survey data.

This study is based on the approach used by Zhong (2016) who adapts Pissarides and Weber's (1989) method of detecting tax evasion to detect corruption. The sample is split into two groups based on their likelihood of engaging in corrupt activities, one group being the measure which includes corruption and the other being the 'clean' measure which does not. The discrepancy between income and consumption between these two groups is then estimated and the difference attributed to corruption. Following Zhong (2016) this paper splits the sample into public and private sector workers. This is based on the argument that public sector workers are more likely to be involved in corrupt activities because the nature of the public sector industry provides the necessary (1) discretionary power to extract the (2) existing rents and (3) weak institutions and low levels of monitoring create incentives to do this (Aidt, 2003). The private sector, however, is not a clean reference group. Reports of private sector corruption exist and although evidence of corruption, especially petty corruption, in the private sector is minimal, it cannot be ruled out. This paper therefore provides a measure of public sector corruption relative to the private sector.

This study uses NIDS Waves 3, 4 and 5 to estimate the relative level of corruption. It does not, however, capture all corruption. Corruption can be classified as either petty or grand, based on the magnitude of the money or favours exchanged. Petty corruption occurs at lower levels of power, often at the interface of government officials with the public and most commonly takes the form of a bribe. Grand corruption occurs amongst elites who have the extent of discretionary power necessary to participate in such a transaction. These are high-income individuals. High-income elites, however, are under-sampled in household surveys as they are difficult to contact and have low response rates. Additionally, in the context of corruption, elites will move their corruption income offshore to avoid detection (Christensen, 2011). The corruption of the few elites in the sample will therefore not be captured as it is not reflected in their domestic expenditure.

The estimates in this study therefore provide a measure of petty corruption, rather than grand corruption.

This method is based on two assumptions. First it is assumed that the reporting of expenditure on some items by *all* groups is accurate and second that reporting of income by *some* groups is accurate. Public sector workers are more likely to receive income from corruption and are unlikely to report this income in a household survey. This is due to the reluctance of people to report information that they wish to conceal which is further bolstered by the survey design which categorises income by source (Moore et al, 2000). Other issues of income reporting are argued to be randomly distributed across the two groups. Expenditure on the other hand, is likely to be similarly reported by both groups as there is no incentive to hide it and separating the portion of expenditure attributable to corruption income requires a lot of cognitive effort, a key cause for the mis-reporting of income (Moore et al., 2000), and so is unlikely to occur.

In order to forecast income for the public sector group from its reported expenditure, an expenditure function is estimated using a log of expenditure on household items and services, a log of income and a vector of household characteristics. This function is then inverted to provide a measure of income underreporting. This figure of underreporting is attributed to corruption. Using the full panel, the public sector are estimated to underreport their income by 31.71%. This is a R5109.91 increase in nominal terms. This is also higher than the 20% level of underreporting that Zhong (2016) found in China. The level of underreporting across the distribution is also estimated using fixed effects quantile regressions and the results show that the level of underreporting increases across the expenditure distribution. This indicates that individuals with higher incomes in the public sector likely have a disproportionally higher income from petty corruption.

South Africa has a complex legacy of corruption. Its Apartheid past created conditions in which certain types of corruption could flourish and many of these practices were carried over to the new democratic nation. Additionally, new regulations and policies intended to redress previous exclusion, such as affirmative action employment processes, enabled new forms of corruption to develop. Departments with high reports of corruption therefore often have a history of high corruption. This has resulted in significant sectoral variation in the existence of petty corruption. In order to investigate the extent of these effects, petty corruption is estimated at a sectoral level. Across sectors within the public sector, individuals employed in Law Enforcement, have the highest incidence of underreporting income at 58.64%, suggesting that this sector has a very high level of petty corruption. This is in line with reports of corruption with this category being at the

top of numerous surveys and reports regarding bribe paying and corruption reports. In contrast, while education was expected to produce high levels of underreporting, it returned relatively low results. As expected, corruption in the general government sector was high at 40.67%. Health was hypothesised to have a lower level of petty corruption but the resulting figure was 42.46%. There is, however, a large body of literature which documents the existence of unreported secondary employment amongst and estimated 70% of nurses (Rispel et al., 2014).

The homeland states have also left a legacy which impacts present day corruption. Homeland governments were notorious for corruption (Hyslop, 2005). They were predominantly rural areas and were incorporated into the new provincial system after 1994. Estimations of the level of petty corruption by area therefore provide an interesting picture of the spatial variation in present day petty corruption. Rural areas are consistently found to have higher levels of petty corruption. Poor provinces appear to have higher petty corruption than richer ones and this effect is maintained when combined with the geographic area type. Rural and urban areas in poorer provinces are found to have higher levels of petty corruption than in richer provinces.

When estimates of petty corruption are disaggregated over time, a clear trend emerges which is consistent with reported and survey evidence of corruption (Corruption Watch, 2018; VOCS, 2018). Corruption increases over the period considered (2012-2017) but the change in the level of underreporting doubles between 2014/15 and 2017. These trends also coincide with a period of declining economic growth and rising unemployment, both of which are negatively related to corruption. Additionally, the large jump in the increase in corruption between 2014/15 and 2017 coincides with the increasing activities of the Zuma-centred elite's state capture agenda, culminating in the capture of the National Treasury in 2017. The impact of these grand corruption events on petty corruption levels evidences the effect that a culture of corruption can have on all levels of government.

While the estimations of this study provide an interesting and unique description of the nature and extent of petty corruption in South Africa, it does have limitations. First, the low response levels of both the source of the sector variable and the expenditure items used resulted in a small sample. A larger sample would enable more robust results to be estimated as well as a more in-depth look at corruption by allowing a lower level of disaggregation. Second, as explained by Zhong (2016), significance tests are unable to be performed on the key parameters as the available standard errors for terms which include $\bar{\mu}$ and σ_η^2 also include the variation of all parameters as well as the covariance between them. In so far as testing for significance is important, this limits the robustness of the reported results.

A further concern of this approach is that the level of income underreporting is not solely a result of petty corruption. While this estimation attempted to control for factors that could influence underreporting such as the existence of secondary employment, self-employment and preference heterogeneity, unforeseen biases in income or expenditure reporting between the public and private sector could still exist. The only foreseen contaminator that was not controlled for was that the level of underreporting could be influenced by other illicit activities.

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Appendix 1

Table 11

Mean by sector for all variables used in the estimation

		Full Sample	Private Sector	Public Sector	Difference
Household Income		12754.99 (18593.59)	11511.19 (18708,34)	16114.5 (17927.75)	-6416,35***
Clothing Expenditure		337.29 (773.67)	317.09 (761.13)	464.86 (897.02)	-187.54***
Household Equipment Expenditure		305.45 (3332.94)	223.01 (1411.18)	544.63 (6110.59)	-426.34***
Household Head Characteristics					
Race	African	79.51	78	83.44	-0.025**
	Coloured	10.68	11.14	9.45	0.025**
	Asian/Indian	2.33	2.64	1.53	0.001
	White	7.48	8.22	5.58	-0.001
Age		38.89 (9.57)	37.90 (9.62)	41.58 (8.89)	-4.26***
Education		10.89 (3.23)	10.31 (3.22)	12.44 (2.70)	-2.48***
Marital Status	Married	40.05	35.57	52.19	-0.14***
	Living with partner	9.68	11.56	4.71	0.07***
	Widow/widower	3.70	3.59	4.01	-0.02***
	Divorced/ separated	4.91	4.50	6.06	-0.02***
	Never married	41.66	44.79	33.02	0.11***
Occupation	Private households	0.33	0.06	1.05	-0.01***
	Agriculture, hunting, forestry and fish	5.46	5.33	5.85	-0.003
	Mining and Quarrying	13.37	5.39	34.80	-0.34***
	Manufacturing	6.91	6.78	7.21	-0.23***
	Electricity, gas and water supply	0.65	5.59	9.51	-0.04***
	Construction	16.19	17.71	20.17	-0.01
	Wholesale and Retail trade; repair etc;	0.46	0.63	0.02	0.01
	Transport, storage and communication	11.62	13.94	5.34	0.08***
	Financial intermediation, insurance, re	13.76	17.94	2.54	0.12***
	Community, social and personal services	25.25	29.62	13.50	0.216***
Secondary Occupation		0.62%	0.62%	0	-0.0002
Male		41.28%	36.92%	51%	0.14***
H	Excellent	36.80	37.04	35.92	0.007

	Very good	31.55	32.51	29.17	0.045***
	Good	25.04	24.30	27.04	-0.039***
	Fair	5.58	5.26	6.46	-0.02***
	Poor	1.04	0.89	1.14	0.004
Honest		92.17	90.88	96	-0.05***
Language	IsiNdebele	1.32	1.68	0.36	0.01***
	IsiXhosa	12.94	11.76	16.11	-0.03***
	IsiZulu	23.50	23.71	2.3	0.02*
	Sepedi	10.69	10.36	11.5	-0.01
	Sesotho	11.15	10.57	12.68	-0.002
	Setswana	12.39	12.88	11.1	0
	SiSwati	1.52	1.67	1	0.01*
	Tshivenda	1.64	1.12	2.95	-0.01***
	IsiTsonga	3.19	2.98	3.77	-0.01*
	Afrikaans	14.94	15.74	12.85	0.02*
	English	6.61	7.36	4.68	0.003
	Othe	0.11	0.15	0	0
Household Characteristics					
Car		29.52%	24%	41.49%	-0.19***
Motorbike		2.52	2.55	2.47	-0.002
Landline		9.10	8.63	10.45	-0.03***
Cellphone		93.31	92.66	95.02	-0.05***
Washing Machine		45.89	41.52	57.85	-0.19***
TV		86.68	84.65	92.27	-0.09***
Fridge/freezer		85.24	83.87	89.14	-0.11***
Computer		28.37	25.11	37.07	-0.12***
Rural		24.12%	24.14%	23.84%	-0.03**
Province	Western Cape	12.56%	13.38%	10.45%	0.077***
	Eastern Cape	7.36%	5.48%	12.39%	-0.06***
	Northern Cape	2.41%	2.07%	3.27%	-0.048***
	Free State	7.00%	5.66%	10.45%	-0.03***
	KZN	13.56%	14.54%	10.95%	0.01
	North West	7.04%	7.69%	5.36%	0.01*
	Gauteng	34.58%	35.18%	33.12%	0.053***
	Mpumalanga	8.32%	9.07%	6.21%	0.01
	Limpopo	7.17%	6.91%	7.80%	-0.09***
Household Size		3.72 (2.63)	3.76 (2.73)	3.61 (2.35)	-0.05
Rent		32.67	34.06	29.13	0.40
Bond		8.47	5.31	16.83	-0.09***
Seas	Summer/Autumn	20.45	19.07	24.28	-0.03***
	Autumn/Winter	32.40	31.22	35.51	-0.03**

Winter/Spring	21.49	23.24	16.59	0.03***
Spring/summer	25.66	26.46	23.62	0.03***
Own dwelling	60.42	57.26	68.73	-0.16***
Additional adult employed in the public sector	1.97%	1.97%	0	-0.08***

Note: Percentage share of sample is reported for categorical or indicator variables, mean of sample otherwise. Standard deviations in parenthesis.
Source: NIDS Waves 3-5.

Appendix 2

Table 12: Fixed effects regressions results for expenditure equations in Table 5

Dependent Variable	Clothing	Household Items and Expenditure	Household Items and Expenditure
Sector Variable	0.023	0.296	
	[0.161]	[0.172]**	
Pure Sector Variable			0.558
			[0.257]
Log of Income	0.967	1.207	1.253
	[0.060]***	[0.069]***	[0.093]***
Western Cape	-0.385	0.026	-0.016
	[0.255]	[0.234]	[0.201]
Eastern Cape	-3.856	-0.215	-1.913
	[1.801]**	[1.469]	[0.469]***
Northern Cape	-3.738	-0.068	0.290
	[1.592]**	[1.143]	[1.122]
Free State	-1.240	1.441	
	[1.279]	[1.123]	
KZN	-2.390	1.366	1.324
	[1.202]**	[0.837]	[0.721]*
North West	-0.565	0.848	1.047
	[0.921]	[0.549]	[0.652]
Gauteng	-2.139	-0.813	-0.755
	[0.706]***	[0.348]**	[0.390]*
Mpumalanga	-1.477		
	[0.376]***		
Age	-0.131	0.091	0.065
	[0.082]	[0.095]	[0.103]
Age^2	0.001	-0.001	-0.001
	[0.001]	[0.001]	[0.001]
Years of education	0.013	0.057	-0.013
	[0.024]	[0.056]	[0.058]
Private households	0.162	-0.150	-0.304
	[0.157]	[0.202]	[0.213]
Agriculture, hunting, forestry and fish	2.135	-1.093	-2.292
	[1.348]	[1.732]	[1.812]
Mining and Quarrying	1.144	-0.865	-1.887
	[1.237]	[1.602]	[1.647]
Manufacturing	0.982	-0.783	-1.616
	[0.972]	[1.305]	[1.347]
Electricity, gas and water supply	0.996	-0.513	-1.045
	[0.876]	[1.123]	[1.156]
Construction	0.768	-0.527	-1.188
	[0.704]	[0.934]	[0.983]
Wholesale and Retail	1.201	-0.334	-0.678

trade; repair etc;			
	[0.639]*	[0.689]	[0.696]
Transport, storage and communication	0.198	-0.793	-1.283
	[0.443]	[0.706]	[0.711]*
Financial intermediation, insurance, re	0.071	-0.083	-0.210
	[0.261]	[0.318]	[0.323]
Married	-0.146	-0.065	0.159
	[0.223]	[0.326]	[0.320]
Living with partner	-0.375	-0.299	0.553
	[0.681]	[1.203]	[1.154]
Widow/widower	-0.673	0.229	1.032
	[0.606]	[0.970]	[0.926]
Divorced/ separated	-0.090	0.220	0.750
	[0.326]	[0.575]	[0.659]
Health: Excellent	0.246	-0.048	0.136
	[0.308]	[0.265]	[0.334]
Health: Very good	0.937	-0.193	0.427
	[0.989]	[0.851]	[1.045]
Health: Good	0.755	-0.326	0.124
	[0.689]	[0.581]	[0.701]
Health: Fair	0.440	0.068	0.337
	[0.401]	[0.335]	[0.389]
IsiNdebele	0.436	-0.883	-2.006
	[0.313]	[0.691]	[0.385]***
IsiXhosa	3.093		
	[2.923]		
IsiZulu	3.464	-6.988	
	[2.515]	[5.542]	
Sepedi	1.452		
	[2.310]		
Sesotho	0.886		
	[1.988]		
Setswana	1.429		
	[1.699]		
SiSwati	0.006	-3.833	-8.316
	[1.393]	[2.793]	[1.608]***
Afrikaans	-1.257	-0.983	-1.755
	[0.713]*	[0.874]	[0.683]**
Trust	-0.109	-0.100	-0.055
	[0.097]	[0.192]	[0.204]
Secondary Occupation	-0.251	-0.675	-0.643
	[0.262]	[0.399]*	[0.371]*
Urban	0.029	0.213	0.436
	[0.175]	[0.228]	[0.307]
Household Size	0.006	-0.078	-0.070
	[0.040]	[0.031]**	[0.033]**
Vehicle	-0.021	-0.039	-0.088

	[0.141]	[0.141]	[0.135]
Landline	0.128	0.208	0.199
	[0.189]	[0.210]	[0.261]
Cellphone	0.167	-0.032	-0.054
	[0.103]	[0.093]	[0.124]
Washing Machine	-0.040	0.119	0.093
	[0.081]	[0.093]	[0.099]
TV	-0.061	-0.257	-0.118
	[0.107]	[0.123]**	[0.126]
Fridge	-0.025	-0.280	-0.198
	[0.140]	[0.126]**	[0.143]
Computer	0.029	0.035	0.085
	[0.072]	[0.091]	[0.086]
Own dwelling	-0.043	0.504	0.582
	[0.116]	[0.150]***	[0.202]***
Rent	0.173	0.100	0.170
	[0.120]	[0.133]	[0.161]
Bond	0.403	0.054	-0.424
	[0.284]	[0.195]	[0.341]
Summer/Autumn	-0.086	0.128	0.109
	[0.101]	[0.186]	[0.211]
Autumn/Winter	-0.192	0.274	0.230
	[0.286]	[0.513]	[0.585]
Winter/Spring	-0.155	0.160	0.141
	[0.171]	[0.328]	[0.368]
Constant	-4.883	-3.200	3.966
	[4.937]	[6.570]	[5.022]
R^2	0.50	0.73	0.76
N	1,486	981	806

Note: Coefficients and standard errors [in parenthesis] from fixed effects estimation of the expenditure function are reported. Dependent variables are the logarithm of clothing and household items described in Section 3.1.2.. Explanatory variables included in this table are the logarithm of household income and the sector indicator variable, in in different formulations explained in Section 4.1. All demographic and household characteristics can be found in Appendix 1 and are controlled for.
P<0.10*, p<0.05**, p<0.01***

Table 13: Fixed effects regressions results for expenditure equations in Table 6

	General Government (GG)	Law Enforcement and General Government (LEGG)	Health	Education
GG Sector Variable	0.413			
	[0.200]**			
LEGG Sector Variable		0.544		
		[0.266]**		
Health Sector Variable			0.406	
			[0.197]**	
Education Sector Variable				0.198
				[0.179]*
Log Household Income	1.234	1.267	1.225	1.228
	[0.093]***	[0.106]***	[0.086]***	[0.087]***
Western Cape	0.063	-0.009	0.016	-0.119
	[0.223]	[0.204]	[0.212]	[0.248]
Eastern Cape				-0.280
				[1.663]
Northern Cape	0.316	0.331	0.003	-0.683
	[1.187]	[1.188]	[1.127]	[1.189]
KZN	1.655	1.339	1.540	1.050
	[0.804]**	[0.741]*	[0.797]*	[0.878]
North West	1.001	1.055	0.935	0.645
	[0.596]*	[0.671]	[0.581]	[0.534]
Gauteng	-0.637	-0.733	-0.691	-0.816
	[0.383]*	[0.407]*	[0.345]**	[0.411]**
Age	0.141	0.063	0.104	0.108
	[0.107]	[0.106]	[0.103]	[0.108]
Age^2	-0.002	-0.001	-0.001	-0.001
	[0.001]	[0.001]	[0.001]	[0.001]
Years of education	-0.018	-0.015	-0.036	0.005
	[0.061]	[0.058]	[0.050]	[0.049]
Private households	-0.284	-0.301	-0.272	-0.094
	[0.224]	[0.222]	[0.227]	[0.219]
Mining and Quarrying	-1.724	-1.857	-1.619	-0.351
	[1.749]	[1.740]	[1.775]	[1.707]
Manufacturing	-1.552	-1.580	-1.516	-0.366
	[1.457]	[1.430]	[1.465]	[1.418]
Electricity, gas and water supply	-0.983	-1.017	-1.000	-0.113
	[1.237]	[1.218]	[1.243]	[1.219]
Construction	-1.094	-1.175	-0.965	-0.288

	[1.034]	[1.020]	[1.039]	[1.022]
Wholesale and Retail trade; repair etc;	-0.538	-0.648	-0.567	-0.015
	[0.749]	[0.746]	[0.748]	[0.753]
Transport, storage and communication	-1.171	-1.274	-1.157	-0.715
	[0.746]	[0.738]*	[0.769]	[0.718]
Community, social and personal services	-0.213	-0.190	-0.166	-0.044
	[0.349]	[0.351]	[0.353]	[0.360]
Married	0.255	0.169	0.237	-0.508
	[0.512]	[0.327]	[0.403]	[0.462]
Living with partner	0.990	0.588	0.829	-1.753
	[1.845]	[1.173]	[1.483]	[1.681]
Widow/widower	1.295	1.063	1.198	-1.092
	[1.483]	[0.947]	[1.158]	[1.341]
Divorced/ separated	0.921	0.740	0.737	-0.301
	[0.972]	[0.664]	[0.792]	[0.757]
Health: Excellent	0.088	0.130	0.120	0.032
	[0.331]	[0.332]	[0.331]	[0.312]
Health: Very good	0.290	0.399	0.346	0.090
	[1.046]	[1.039]	[1.054]	[1.009]
Health: Good	0.085	0.104	0.112	-0.260
	[0.716]	[0.699]	[0.720]	[0.686]
Health: Fair	0.299	0.327	0.337	0.143
	[0.397]	[0.389]	[0.396]	[0.374]
IsiNdebele	-2.029	-2.011	-2.116	-0.694
	[0.391]***	[0.404]***	[0.392]***	[0.731]
IsiZulu				-5.656
				[5.861]
SiSwati	-8.461	-8.340	-8.844	-2.989
	[1.644]***	[1.697]***	[1.648]***	[2.955]
Afrikaans	-1.860	-1.738	-2.003	
	[0.689]***	[0.757]**	[0.656]***	
Trust	-0.093	-0.045	-0.117	-0.215
	[0.216]	[0.217]	[0.217]	[0.201]
Secondary Occupation	-0.784	-0.644	-0.780	-0.121
	[0.342]**	[0.371]*	[0.334]**	[0.214]
Urban	0.495	0.450	0.407	0.008
	[0.290]*	[0.321]	[0.253]	[0.262]

Household Size	-0.102	-0.072	-0.095	-0.073
	[0.032]***	[0.033]**	[0.031]***	[0.033]**
Vehicle	-0.053	-0.091	-0.063	0.003
	[0.144]	[0.136]	[0.155]	[0.146]
Landline	0.174	0.192	0.183	0.209
	[0.283]	[0.272]	[0.265]	[0.234]
Cellphone	-0.054	-0.066	-0.069	-0.133
	[0.133]	[0.132]	[0.133]	[0.134]
Washing Machine	0.164	0.103	0.174	0.154
	[0.096]*	[0.105]	[0.090]*	[0.106]
TV	-0.125	-0.120	-0.190	-0.028
	[0.132]	[0.132]	[0.144]	[0.131]
Fridge	-0.313	-0.195	-0.282	-0.130
	[0.144]**	[0.152]	[0.135]**	[0.119]
Computer	0.066	0.078	0.031	0.120
	[0.093]	[0.090]	[0.100]	[0.103]
Own dwelling	0.693	0.578	0.592	0.494
	[0.201]***	[0.223]***	[0.185]***	[0.182]***
Rent	0.115	0.169	0.142	0.149
	[0.189]	[0.166]	[0.166]	[0.193]
Bond	-0.154	-0.402	-0.081	0.237
	[0.276]	[0.341]	[0.247]	[0.216]
Summer/Autumn	0.096	0.106	0.116	0.091
	[0.198]	[0.215]	[0.204]	[0.240]
Autumn/Winter	0.236	0.227	0.266	0.132
	[0.549]	[0.600]	[0.561]	[0.683]
Winter/Spring	0.111	0.131	0.038	0.016
	[0.343]	[0.381]	[0.358]	[0.432]
Constant	1.564	3.591	3.200	-2.201
	[5.748]	[5.511]	[5.460]	[7.197]
R^2	0.77	0.76	0.76	0.78
N	771	763	799	783

Note: Coefficients and standard errors (in parenthesis) from fixed effects estimation of household expenditure function are reported. The dependent variable is the logarithm of household items, equipment and services described in Section 3.1.2.. Explanatory variables included in this table are the logarithm of household income and the sector indicator variable, in in different formulations representing different public sectors, explained in Section 4.1. All demographic and household characteristics can be found in Appendix 1 and are controlled for.

P<0.10*, p<0.05**, p<0.01***

Table 14: Fixed effects regressions results for expenditure equations in Table 7

	Poor Provinces	Rich Provinces	Rural Areas	Urban Areas
Sector Variable	0.295	0.190	0.363	0.247
	[0.211]*	[0.495]*	[0.277]	[0.211]*
Log of Household Income	1.218	1.053	1.116	1.213
	[0.112]***	[0.086]***	[0.095]***	[0.095]***
Age	0.037	0.087	0.359	0.129
	[0.114]	[0.143]	[0.201]*	[0.110]
Age^2	0.000	-0.002	-0.005	-0.001
	[0.001]	[0.002]	[0.003]*	[0.001]
Years of Education	0.085	-0.089	-0.159	0.088
	[0.120]	[0.074]	[0.107]	[0.070]
Private households	-0.637	-0.083	-0.082	-0.374
	[0.293]**	[0.312]	[0.327]	[0.283]
Agriculture, hunting, forestry and fish	-5.112	-1.084		-2.831
	[2.497]**	[2.891]		[2.415]
Mining and Quarrying	-4.921	0.576	-1.633	-2.270
	[2.233]**	[2.396]	[2.632]	[2.127]
Manufacturing	-4.082	-0.316	-1.010	-1.987
	[1.887]**	[2.115]	[2.096]	[1.837]
Electricity, gas and water supply	-3.630	-0.167	-0.720	-1.533
	[1.668]**	[1.851]	[1.849]	[1.567]
Construction	-2.742	-0.491	-0.578	-1.444
	[1.362]**	[1.616]	[1.537]	[1.309]
Wholesale and Retail trade; repair etc;	-2.005	-0.192	-0.461	-0.957
	[1.017]**	[1.240]	[1.151]	[0.994]
Transport, storage and communication	-1.790	-0.520	-0.184	-1.707
	[0.844]**	[0.925]	[0.875]	[0.890]*
Community, social and personal services	-0.933	0.016	-0.478	-0.416
	[0.518]*	[0.530]	[0.600]	[0.474]
Married	0.071	-0.223	-0.684	-0.009
	[0.376]	[0.576]	[0.225]***	[0.375]
Living with partner	0.051	-0.746	-1.942	-0.120
	[1.376]	[2.014]	[0.618]***	[1.327]
Widow/widower	0.861	-0.662	-1.843	0.316
	[1.165]	[1.650]	[0.614]***	[1.076]
Divorced/ separated	0.133	0.468		0.429
	[0.771]	[0.933]		[0.645]
Health: Excellent	-0.283	-0.420	0.265	-0.089
	[0.506]	[0.275]	[0.175]	[0.297]
Health: Very good	-1.133	-1.221	0.416	-0.342
	[1.662]	[0.876]	[0.424]	[0.971]
Health: Good	-0.993	-1.053	0.299	-0.532
	[1.158]	[0.618]*	[0.257]	[0.669]
Health: Fair	-0.288	-0.297		-0.047

	[0.670]	[0.307]		[0.395]
Trust	-0.011	0.012	-0.057	-0.091
	[0.217]	[0.291]	[0.323]	[0.284]
Secondary Occupation	-0.241	-2.255	0.494	-0.804
	[0.444]	[0.687]***	[0.606]	[0.443]*
Household Size	-0.094	-0.075	-0.049	-0.063
	[0.052]*	[0.051]	[0.096]	[0.038]*
Vehicle	-0.147	-0.023	-0.143	-0.090
	[0.229]	[0.096]	[0.162]	[0.165]
Landline	0.552	-0.208	-0.631	0.218
	[0.317]*	[0.189]	[0.493]	[0.238]
Cellphone	0.002	-0.396	0.135	-0.071
	[0.203]	[0.169]**	[0.203]	[0.126]
Washing Machine	0.178	0.115	-0.296	0.123
	[0.169]	[0.205]	[0.241]	[0.121]
TV	-0.451	0.075	-0.043	-0.299
	[0.204]**	[0.166]	[0.108]	[0.179]*
Fridge	-0.324	-0.007	0.072	-0.493
	[0.217]	[0.190]	[0.096]	[0.177]***
Computer	0.004	0.309	-0.521	0.033
	[0.131]	[0.167]*	[0.287]*	[0.105]
Own dwelling	0.585	0.388	0.003	0.576
	[0.197]***	[0.205]*	[0.167]	[0.173]***
Rent	0.162	-0.048	0.142	0.097
	[0.182]	[0.150]	[0.098]	[0.176]
Bond	0.128	-0.174	-0.729	0.001
	[0.212]	[0.299]	[0.355]**	[0.246]
Summer/Autumn	0.390	-0.196	0.018	0.127
	[0.140]***	[0.327]	[0.201]	[0.207]
Autumn/Winter	0.925	-0.614	-0.053	0.193
	[0.374]**	[0.895]	[0.526]	[0.582]
Summer/Autumn	0.473	-0.294	0.059	0.110
	[0.242]*	[0.584]	[0.290]	[0.390]
Western Cape	0.016			1.046
	[0.213]			[0.306]***
Eastern Cape				6.379
				[1.871]***
Northern Cape				5.423
				[1.590]***
Free State				5.911
				[1.325]***
KZN				4.906
				[1.156]***
Gauteng				2.291
				[0.688]***
IsiNdebele		-0.959		-1.024
		[0.315]***		[0.830]
IsiZulu		-7.620		-8.224
		[2.524]***		[6.661]
SiSwati		-3.960		-4.546

		[1.388]***		[3.371]
Afrikaans		-1.180		-1.264
		[0.680]*		[1.099]
Urban	0.487	0.354		
	[0.468]	[0.239]		
Constant	-6.046	4.927	-7.739	-8.682
	[4.977]	[6.769]	[4.435]*	[7.620]
R^2	0.83	0.65	0.83	0.75
N	497	484	257	724

Note: Coefficients and standard errors (in parenthesis) from fixed effects estimation of household expenditure function are reported. The dependent variable is the logarithm of household items, equipment and services described in Section 3.1.2.. Explanatory variables included in this table are the logarithm of household income and the sector indicator variable, in in different formulations representing different provincial groups and area types, explained in Section 4.2. All demographic and household characteristics can be found in Appendix 1 and are controlled for but are not presented.
p<0.10*, p<0.05**, p<0.01***

Table 15: Fixed effects regressions results for expenditure equations in Table 8

	Rich Provinces, Urban Area	Rich Provinces, Rural Area	Poor Provinces, Urban Area	Poor Provinces, Rural Area
Sector Variable	0.02	0.134	0.319	0.381
	[0.332]*	[0.460]	[0.280]*	[0.260]
Log of Household Income	1.14	1.065	1.095	0.933
	[0.13]***	[0.125]***	[0.121]***	[0.615]
Age	0.680	0.083	0.006	0.033
	[0.294]**	[0.158]	[0.196]	[0.131]
Age^2	-0.009	-0.002	0.000	0.001
	[0.004]**	[0.002]	[0.002]	[0.002]
Years of Education	-0.003	0.053	-0.203	0.117
	[0.040]	[0.082]	[0.128]	[0.117]
Private households	0.367	-0.044	0.086	-0.822
	[0.249]	[0.436]	[0.278]	[0.450]*
Agriculture, hunting, forestry and fish	3.136	1.214	0.181	-6.342
	[1.782]*	[3.373]	[1.959]	[3.362]*
Mining and Quarrying	2.003	0.031	0.540	-5.391
	[1.424]	[3.044]	[1.811]	[2.896]*
Manufacturing	1.562	0.641	-0.684	-4.595
	[1.196]	[2.619]	[1.448]	[2.462]*
Electricity, gas and water supply	2.086	-0.177	2.053	-3.603
	[1.540]	[2.283]	[1.599]	[2.009]*
Construction	-0.202	0.171	0.634	-2.582
	[1.382]	[1.772]	[1.054]	[1.475]*
Wholesale and Retail trade; repair etc;	1.144	-0.480		-2.459
	[0.720]	[1.284]		[1.312]*
Transport, storage and communication	0.254	-0.361	0.290	-0.991
	[1.049]	[0.627]	[0.509]	[0.695]
Community, social and personal	-0.095	0.147	-0.083	-0.041

services				
	[0.216]	[0.908]	[0.146]	[0.422]
Married	-0.049	0.658	-0.223	-0.338
	[0.812]	[3.046]	[0.825]	[1.490]
Living with partner	-0.476	0.468	-0.345	0.544
	[0.541]	[2.437]	[0.502]	[1.289]
Health: Excellent	-0.099	-0.512	0.465	-0.737
	[0.351]	[0.273]*	[0.177]***	[0.728]
Health: Very good	0.052	-1.439	0.839	-2.823
	[1.166]	[0.869]*	[0.401]**	[2.441]
Health: Good	-0.097	-1.281	0.712	-2.293
	[0.615]	[0.616]**	[0.283]**	[1.726]
Trust	0.417	-0.213	-0.061	-0.003
	[0.403]	[0.397]	[0.220]	[0.294]
Secondary Occupation	-0.047	-2.563		-0.308
	[0.809]	[0.828]***		[0.483]
Household Size	0.029	-0.072	0.031	-0.071
	[0.068]	[0.056]	[0.077]	[0.064]
Vehicle	-0.180	-0.008	0.501	-0.137
	[0.245]	[0.116]	[0.216]**	[0.278]
Landline	0.185	-0.453	0.055	-0.287
	[0.322]	[0.193]**	[0.150]	[0.291]
Cellphone	-0.260	0.312	-0.050	0.150
	[0.240]	[0.239]	[0.257]	[0.231]
Washing Machine	0.213	0.348	0.417	-0.242
	[0.365]	[0.276]	[0.230]*	[0.337]
TV	-0.242	0.036	0.313	-0.698
	[0.167]	[0.256]	[0.228]	[0.335]**
Fridge	-0.209	0.409	-0.613	0.003
	[0.205]	[0.183]**	[0.279]**	[0.152]
Computer	-0.067	0.409	0.060	0.733
	[0.172]	[0.235]*	[0.211]	[0.201]***
Own dwelling	-0.560	-0.033	0.131	0.229
	[0.418]	[0.169]	[0.164]	[0.235]
Rent	-0.380	-0.211	-0.797	0.142
	[0.314]	[0.358]	[0.532]	[0.236]
Bond	-0.523	-0.232	0.341	0.348
	[0.170]***	[0.334]	[0.225]	[0.177]*
Summer/Autumn	-1.721	-0.802	0.772	0.784
	[0.463]***	[0.897]	[0.525]	[0.493]
Autumn/Winter	-0.754	-0.375	0.352	0.357
	[0.567]	[0.598]	[0.274]	[0.336]
	[0.055]**			

IsiNdebele	-0.132	-0.561		
	[0.160]	[0.369]		
IsiZulu		-4.658		
		[2.923]		
SiSwati		-2.112		
		[1.605]		
Afrikaans		0.030		
		[0.930]		
				[0.249]
Constant	-16.512	-2.024	-9.106	-1.634
	[4.073]***	[7.812]	[4.626]*	[6.833]
R^2	0.93	0.69	0.94	0.85
N	135	365	163	359

Note: Coefficients and standard errors (in parenthesis) from fixed effects estimation of household expenditure function are reported. The dependent variable is the logarithm of household items, equipment and services described in Section 3.1.2.. Explanatory variables included in this table are the logarithm of household income and the sector indicator variable, in in different formulations representing different provincial groups and area types, explained in Section 4.2. All demographic and household characteristics can be found in Appendix 1 and are controlled for but are not presented.
p<0.10*, p<0.05**, p<0.01***

Table 16: OLS regression results across for the expenditure equations in Table 9

	2012	2014/15	2017
Sector Variable	0.149	0.187	0.200
	[0.244]	[0.189]**	[0.198]*
Log of Income	0.505	0.553	0.500
	[0.180]***	[0.228]**	[0.243]**
Eastern Cape	0.934	0.205	-0.628
	[0.462]**	[0.364]	[0.356]*
Northern Cape	0.422	0.172	0.182
	[0.438]	[0.418]	[0.427]
Free State	-1.400	0.204	-0.321
	[0.554]**	[0.567]	[0.596]
KZN	-0.085	-0.551	-0.989
	[0.524]	[0.516]	[0.602]
North West	0.178	0.612	0.245
	[0.501]	[0.559]	[0.651]
Gauteng	-0.166	0.543	0.260
	[0.411]	[0.434]	[0.422]
Mpumalanga	-0.396	0.200	0.107
	[0.546]	[0.603]	[0.581]
Limpopo	-1.190	0.015	0.383
	[0.636]*	[0.507]	[0.518]
Age	-0.032	-0.117	-0.140
	[0.082]	[0.080]	[0.103]
Age^2	0.000	0.001	0.002
	[0.001]	[0.001]	[0.001]
Years of education	-0.054	-0.086	0.022
	[0.043]	[0.046]*	[0.047]
Coloured	-0.731	-0.268	-0.576
	[0.602]	[0.542]	[0.661]
Asian/Indian	1.211	0.429	1.656
	[1.273]	[0.838]	[0.975]*
White	-1.571	-0.258	0.521
	[0.647]**	[0.682]	[0.651]
Male	-0.042	-0.011	0.114
	[0.206]	[0.241]	[0.225]
Private households	-0.133	-1.484	-1.098
	[0.688]	[0.634]**	[0.697]
Agriculture, hunting, forestry and fish	-0.953	-1.256	-1.459
	[0.632]	[0.655]*	[0.587]**
Mining and Quarrying	-0.489	-1.604	-0.407
	[0.854]	[0.647]**	[0.670]
Manufacturing	-0.374	-0.703	-1.046
	[0.734]	[0.671]	[0.624]*
Electricity, gas and water supply	-0.589	-1.119	-0.524
	[0.717]	[0.605]*	[0.623]
Construction	-2.122	-0.802	-1.449
	[0.969]**	[0.750]	[0.796]*
Wholesale and Retail trade; repair etc;	-0.886	-0.845	-0.554

	[0.624]	[0.684]	[0.552]
Transport, storage and communication	-0.609	-0.864	-0.820
	[0.680]	[0.642]	[0.604]
Financial intermediation, insurance, re	-0.380	-0.857	-0.039
	[0.673]	[0.614]	[0.663]
Living with partner	-0.505	-0.281	0.235
	[0.253]**	[0.348]	[0.403]
Widow/widower	0.016	-0.242	0.029
	[0.733]	[0.426]	[0.465]
Divorced/ separated	0.396	-0.080	0.140
	[0.711]	[0.457]	[0.391]
Never Married	-0.297	-0.624	-0.256
	[0.244]	[0.260]**	[0.251]
Health: Very good	0.326	0.197	-0.026
	[0.186]*	[0.225]	[0.247]
Health: Good	0.477	-0.028	0.078
	[0.245]*	[0.227]	[0.250]
Health: Fair	-0.147	0.277	0.164
	[0.524]	[0.445]	[0.564]
Health: Poor	1.470	-0.436	0.778
	[0.536]***	[0.844]	[0.741]
IsiXhosa	0.187	2.678	2.620
	[0.474]	[0.657]***	[0.699]***
IsiZulu	0.317	3.280	2.783
	[0.350]	[0.577]***	[0.543]***
Sepedi	0.310	2.317	2.015
	[0.592]	[0.535]***	[0.629]***
Sesotho	1.665	2.794	2.995
	[0.605]***	[0.674]***	[0.737]***
Setswana	0.004	2.279	2.215
	[0.619]	[0.602]***	[0.725]***
SiSwati	1.062	2.419	2.335
	[0.536]**	[1.018]**	[0.896]***
Tshivenda	1.498	4.318	2.246
	[0.933]	[0.867]***	[0.862]***
IsiTsonga	0.889	2.421	1.970
	[0.541]	[1.034]**	[0.798]**
Afrikaans	0.332	2.988	2.481
	[0.711]	[0.702]***	[0.873]***
English	-0.335	2.709	2.681
	[1.018]	[0.675]***	[0.874]***
Trust	0.335	0.391	0.430
	[0.479]	[0.325]	[0.343]
Secondary Occupation	-0.628	0.655	-2.015
	[0.601]	[0.480]	[0.793]**
Urban	0.127	-0.398	-0.010
	[0.273]	[0.266]	[0.291]
Household Size	-0.028	0.005	0.047
	[0.043]	[0.045]	[0.047]
Vehicle	-0.405	0.084	0.616

	[0.291]	[0.232]	[0.255]**
Landline	0.679	-0.095	-1.424
	[0.360]*	[0.494]	[0.582]**
Cellphone	-0.025	-0.266	0.285
	[0.335]	[0.435]	[0.351]
Washing Machine	0.201	0.129	-0.288
	[0.263]	[0.232]	[0.254]
TV	-0.193	0.520	0.097
	[0.357]	[0.283]*	[0.444]
Fridge	0.348	0.198	-0.158
	[0.292]	[0.299]	[0.461]
Computer	0.476	0.289	-0.013
	[0.242]*	[0.253]	[0.238]
Own dwelling	-0.181	0.181	0.065
	[0.198]	[0.276]	[0.274]
Rent	0.160	0.518	0.029
	[0.196]	[0.248]**	[0.310]
Bond	0.272	0.273	0.272
	[0.373]	[0.314]	[0.344]
Summer/Autumn	0.543	-0.398	-0.305
	[0.236]**	[0.299]	[0.248]
Autumn/Winter	0.195	-0.647	-0.410
	[0.251]	[0.467]	[0.320]
Winter/Spring		-0.024	-0.500
		[0.245]	[0.329]
Constant	2.911	5.487	4.499
	[2.403]	[2.389]**	[3.167]
R^2	0.40	0.32	0.36
N	337	417	353

Note: Coefficients and standard errors (in parenthesis) from OLS estimation of household expenditure function are reported. The dependent variable is the logarithm of household items, equipment and services described in Section 3.1.2.. Explanatory variables included in this table are the logarithm of household income and the sector indicator variable. Estimations are performed on Waves 3, 4 and 5 of NIDS. All demographic and household characteristics can be found in Appendix 1 and are controlled for but are not presented.

p<0.10*, p<0.05**, p<0.01***

Table 17: Quantile Regression Results for Quantiles 0.1, 0.25, 0.5, 0.75 and 0.9

	0.1	0.25	0.5	0.75	0.9
Sector Variable	0.14	0.20	0.27	0.33	0.42
	[0.22]	[0.14]*	[0.11]***	[0.14]**	[0.22]*
Log of Income	0.67	0.73	0.83	0.97	1.03
	[0.16]***	[0.10]***	[0.08]***	[0.10]***	[0.15]***
Western Cape	0.96	0.80	0.67	0.53	0.38
	[0.07]***	[0.04]***	[0.03]***	[0.04]***	[0.07]***
Eastern Cape	8.04	6.48	5.15	3.75	2.28
	[0.12]***	[0.07]***	[0.05]***	[0.07]***	[0.12]***
Northern Cape	6.93	5.59	4.45	3.25	1.99
	[0.34]***	[0.21]***	[0.17]***	[0.21]***	[0.33]***
Free State	5.91	4.79	3.85	2.84	1.79
	[0.33]***	[0.21]***	[0.16]***	[0.21]***	[0.32]***
KZN	5.18	4.24	3.45	2.60	1.72
	[0.46]***	[0.30]***	[0.23]***	[0.29]***	[0.45]***
North West	3.35	2.69	2.13	1.54	0.93
	[0.46]***	[0.30]***	[0.23]***	[0.29]***	[0.45]**
Gauteng	2.35	1.90	1.52	1.11	0.69
	[0.50]***	[0.32]***	[0.25]***	[0.32]***	[0.49]
Mpumalanga	1.28	1.09	0.92	0.75	0.56
	[0.38]***	[0.25]***	[0.19]***	[0.25]***	[0.37]
Age	0.00	0.01	0.01	0.01	0.01
	[0.07]	[0.04]	[0.03]	[0.04]	[0.07]
Age^2	0.00	-0.00	-0.00	-0.00	-0.00
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Years of education	-0.00	-0.00	0.00	0.00	0.01
	[0.03]	[0.02]	[0.02]	[0.02]	[0.03]
African	0.73	0.51	0.32	0.12	-0.09
	[0.27]***	[0.17]***	[0.13]**	[0.17]	[0.26]
Coloured	2.21	1.51	0.92	0.29	-0.37
	[0.05]***	[0.03]***	[0.02]***	[0.03]***	[0.05]***
Asian/Indian	1.04	0.74	0.50	0.23	-0.04
	[0.47]**	[0.31]**	[0.24]**	[0.30]	[0.46]
Male	-0.28	-0.15	-0.04	0.08	0.20
	[0.20]	[0.13]	[0.10]	[0.13]	[0.19]
Private	-0.48	-0.29	-0.14	0.03	0.20

households					
	[0.16]***	[0.10]***	[0.08]*	[0.10]	[0.16]
Agriculture, hunting, forestry and fish	-5.43	-3.47	-1.82	-0.07	1.76
	[0.15]***	[0.08]***	[0.06]***	[0.08]	[0.15]***
Mining and Quarrying	-3.64	-2.20	-0.99	0.30	1.64
	[1.32]***	[0.85]***	[0.66]	[0.85]	[1.28]
Manufacturing	-2.90	-1.60	-0.50	0.66	1.88
	[1.14]**	[0.73]**	[0.57]	[0.73]	[1.11]*
Electricity, gas and water supply	-2.38	-1.35	-0.48	0.45	1.42
	[1.03]**	[0.66]**	[0.52]	[0.66]	[1.00]
Construction	-2.17	-1.25	-0.47	0.36	1.23
	[0.88]**	[0.56]**	[0.44]	[0.56]	[0.85]
Wholesale and Retail trade; repair etc;	-1.70	-1.07	-0.53	0.03	0.63
	[0.68]**	[0.44]**	[0.34]	[0.43]	[0.66]
Transport, storage and communication	-2.08	-1.39	-0.81	-0.18	0.47
	[1.01]**	[0.65]**	[0.51]	[0.65]	[0.98]
Financial intermediation, insurance, re	-0.36	-0.13	0.06	0.26	0.48
	[0.42]	[0.27]	[0.21]	[0.27]	[0.41]
Married	0.57	0.51	0.46	0.41	0.35
	[0.06]***	[0.04]***	[0.03]***	[0.04]***	[0.05]***
Living with partner	1.98	1.83	1.71	1.59	1.45
	[0.01]***	[0.01]***	[0.00]***	[0.01]***	[0.01]***
Widow/widower	1.45	1.31	1.18	1.05	0.92
	[0.27]***	[0.18]***	[0.14]***	[0.17]***	[0.26]***
Divorced/ separated	0.77	0.85	0.92	0.99	1.06
	[0.38]**	[0.25]***	[0.19]***	[0.25]***	[0.37]***
Health: Excellent	0.20	0.37	0.53	0.69	0.85
	[0.20]	[0.13]***	[0.10]***	[0.13]***	[0.20]***

Health: Very good	0.83	1.43	1.93	2.46	3.02
	[0.05]***	[0.02]***	[0.02]***	[0.03]***	[0.05]***
Health: Good	0.67	1.06	1.39	1.75	2.12
	[0.27]**	[0.17]***	[0.13]***	[0.17]***	[0.26]***
Health: Fair	0.51	0.69	0.84	1.01	1.18
	[0.42]	[0.27]**	[0.21]***	[0.27]***	[0.41]***
IsiXhosa	1.11	0.70	0.35	-0.02	-0.40
	[0.13]***	[0.08]***	[0.06]***	[0.08]	[0.12]***
IsiZulu	11.03	7.40	4.34	1.09	-2.30
	[0.28]***	[0.15]***	[0.11]***	[0.15]***	[0.28]***
Sepedi	8.23	5.19	2.62	-0.11	-2.96
	[0.95]***	[0.60]***	[0.47]***	[0.60]	[0.92]***
Sesotho	7.55	4.71	2.32	-0.23	-2.89
	[0.83]***	[0.53]***	[0.41]***	[0.53]	[0.81]***
Setswana	7.00	4.35	2.11	-0.28	-2.76
	[0.78]***	[0.50]***	[0.39]***	[0.50]	[0.76]***
SiSwati	4.51	2.63	1.05	-0.63	-2.38
	[0.73]***	[0.47]***	[0.36]***	[0.46]	[0.71]***
Tshivenda	3.96	2.47	1.21	-0.12	-1.52
	[0.68]***	[0.43]***	[0.34]***	[0.43]	[0.66]**
IsiTsonga	4.47	3.14	2.02	0.83	-0.42
	[1.27]***	[0.82]***	[0.63]***	[0.81]	[1.23]
Afrikaans	1.95	0.71	-0.34	-1.45	-2.61
	[0.80]**	[0.51]	[0.40]	[0.51]***	[0.77]***
English	1.35	0.81	0.36	-0.12	-0.63
	[0.84]	[0.54]	[0.42]	[0.53]	[0.81]
Trust	-0.09	-0.11	-0.13	-0.16	-0.18
	[0.34]	[0.22]	[0.17]	[0.22]	[0.33]
Secondary Occupation	0.46	0.27	0.11	-0.05	-0.23
	[0.74]	[0.48]	[0.37]	[0.47]	[0.72]
Urban	0.23	0.22	0.20	0.19	0.17
	[0.23]	[0.15]	[0.12]*	[0.15]	[0.23]
Household Size	-0.03	-0.02	-0.01	-0.00	0.01
	[0.04]	[0.02]	[0.02]	[0.02]	[0.04]
Vehicle	0.33	0.17	0.05	-0.09	-0.23
	[0.22]	[0.14]	[0.11]	[0.14]	[0.22]
Landline	-0.66	-0.41	-0.19	0.04	0.28
	[0.43]	[0.27]	[0.21]	[0.27]	[0.41]

Cellphone	-0.17	-0.02	0.10	0.23	0.37
	[0.29]	[0.19]	[0.15]	[0.19]	[0.29]
Washing Machine	-0.17	-0.13	-0.09	-0.05	-0.01
	[0.22]	[0.14]	[0.11]	[0.14]	[0.21]
TV	-0.10	-0.06	-0.03	-0.00	0.03
	[0.30]	[0.19]	[0.15]	[0.19]	[0.29]
Fridge	-0.11	-0.18	-0.24	-0.31	-0.38
	[0.28]	[0.18]	[0.14]*	[0.18]*	[0.28]
Computer	-0.31	-0.26	-0.22	-0.18	-0.14
	[0.23]	[0.15]*	[0.11]*	[0.15]	[0.22]
Own dwelling	-0.27	-0.22	-0.18	-0.14	-0.10
	[0.22]	[0.14]	[0.11]*	[0.14]	[0.21]
Rent	-0.22	-0.20	-0.19	-0.17	-0.16
	[0.23]	[0.15]	[0.12]	[0.15]	[0.23]
Bond	-0.07	-0.03	0.01	0.04	0.08
	[0.37]	[0.24]	[0.19]	[0.24]	[0.36]
Summer/Autumn	-0.33	-0.29	-0.26	-0.22	-0.18
	[0.09]***	[0.06]***	[0.05]***	[0.06]***	[0.09]**
Autumn/Winter	-1.19	-1.00	-0.84	-0.66	-0.49
	[0.01]***	[0.01]***	[0.01]***	[0.01]***	[0.01]***
Winter/Spring	-0.45	-0.43	-0.41	-0.39	-0.38
	[0.21]**	[0.13]***	[0.10]***	[0.13]***	[0.20]*
N	1,108	1,108	1,108	1,108	1,108

Note: Coefficients and standard errors (in parenthesis) from fixed effects quantile regression estimation of household expenditure function are reported. The dependent variable is the logarithm of household items, equipment and services described in Section 3.1.2.. Explanatory variables included in this table are the logarithm of household income and the sector indicator variable. Estimations are done for 20 quantiles but only five are presented here. The full table can be found in Appendix 3. All demographic and household characteristics can be found in Appendix 1 and are controlled for but are not presented.
p<0.10*, p<0.05**, p<0.01***

Appendix 3

Table 18: Level of underreporting across the distribution

Quantile	0.5	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95
$\boldsymbol{\gamma_1}$	0.15	0.67	0.17	0.19	0.73	0.22	0.24	0.24	0.25	0,83	0.28	0.29	0.3	0.32	0,97	0.37	0.39	1,03	0.41
	[0.28]	[0.16]***	[0.19]	[0.16]	[0.10]***	[0.13]**	[0.12]**	[0.12]**	[0.11]***	[0.08]***	[0.11]***	[0.12]***	[0.12]***	[0.13]***	[0.10]***	[0.16]**	[0.18]**	[0.15]***	[0.21]**
$\boldsymbol{\delta'_1}$	0.66	0,14	0.67	0.7	0,20	0.76	0.78	0.79	0.81	0,27	0.84	0.86	0.895	0.9	0,33	0.95	0.98	0,42	1.02
	[0.20]**	[0.22]	[0.13]***	[0.11]***	[0.14]*	[0.09]***	[0.09]***	[0.08]***	[0.08]***	[0.11]***	[0.08]***	[0.08]***	[0.09]***	[0.09]***	[0.14]**	[0.11]***	[0.12]***	[0.22]*	[0.15]***
$\bar{\boldsymbol{\mu}}$	0.23	0.21	0.25	0.27	0,27	0.29	0.31	0.30	0.31	0,33	0.33	0.34	0.34	0.36	0,34	0.39	0.40	0,41	0.41
$\widehat{\boldsymbol{\sigma_\eta^2}}$	0.02	0,05	0.01	0.003	0,00	0.02	0.02	0.02	0.02	0,01	0.02	0.02	0.06	0.02	0,07	0.03	0.02	0,02	0.02
$\bar{\boldsymbol{\theta}}$	1.27	1.27	1.30	1.31	1.32	1.35	1.37	1.37	1.38	1.39	1.41	1.42	1.44	1.44	1.46	1.50	1.50	1.51	1.52
Underreporting (%)	26.78	26.97	29.53	31.38	31.60	34.91	37.40	36.86	37.53	39.14	40.96	41.51	44.08	44.13	45.53	49.85	50.37	51.17	52.38

Note: Parameters of interest and standard errors (in parenthesis) from fixed effects quantile regression estimation of household expenditure function are reported. The dependent variable is the logarithm of household items, equipment and services described in Section 3.1.2.. Explanatory variables included in this table are the logarithm of household income and the sector indicator variable. Estimations are done for 20 quantiles. All demographic and household characteristics can be found in Appendix 1 and are controlled for but are not presented.

$\bar{\mu}$ is calculated through formula (6): $\delta'_1 = \gamma_1 \bar{\mu}$. The level of underreporting can be calculated based on formula (9): $\bar{\theta} = exp(\bar{\mu} + \frac{1}{2}\widehat{\sigma_\eta^2})$ where $\widehat{\sigma_\eta^2}$ is estimated using equation (8): $var(\kappa_i)_{public} - var(\kappa_i)_{private} = \sigma_\eta^2 + [var(lnY)_{public} - var(lnY)_{private}]$

p<0.10*, p<0.05**, p<0.01***