



Overcoming measurement error in household consumption data: Using novel data to characterise consumption

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Declaration

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Abstract

The quality of household consumption data is declining, despite their centrality in answering important economic questions. As a result, a number of alternative approaches to gathering household consumption and expenditure data have been proposed in an attempt to address the declining quality of the data. The purpose of this paper is to contribute to the literature on the measurement and characterisation of household consumption through the use of novel data in the form of household municipal solid waste and retail store receipts. This paper theorises that household waste and store receipts can be used to construct more direct measures of consumption and expenditure, respectively, and in so doing address the measurement errors to which traditional sources of household consumption data are prone. On the premise that these alternative sources of data are not prone (or at least not as prone) to the same measurement errors characteristic of traditional sources of consumption data, it uses these measures to characterise household consumption behaviour of households in two towns in South Africa. The paper finds that, used together, the store receipts and household waste tell a congruent story. The results from this paper suggest that there is potential for the use of store receipts and household waste as a measure of expenditure and consumption, respectively.

Opsomming

Die gehalte van huishoudelike verbruiksdata is aan die afneem, ten spyte van die sentraliteit van hierdie data in die beantwoording van belangrike ekonomiese vrae. Gevolglik is 'n aantal alternatiewe benaderings tot die insameling van huishoudelike verbruik- en uitgawedata voorgestel in 'n poging om die dalende gehalte van die data aan te spreek. Die doel van hierdie artikel is om by te dra tot die literatuur oor die meting en karakterisering van huishoudelike verbruik deur die gebruik van nuwe data in die vorm van huishoudelike munisipale vaste afval en kleinhandelwinkelkwitansies. Hierdie artikel teoretiseer dat huishoudelike afval en winkelkwitansies gebruik kan word om meer direkte maatstawwe van onderskeidelik verbruik en uitgawes te konstrueer, en sodoende die meetfoute aan te spreek waartoe tradisionele bronne van huishoudelike verbruiksdata geneig is. Op die veronderstelling dat hierdie alternatiewe bronne van data nie geneig is (of ten minste nie so geneig) is tot dieselfde meetfoute wat kenmerkend is van tradisionele bronne van verbruiksdata nie, gebruik dit hierdie maatstawwe om huishoudelike verbruiksgedrag van huishoudings in twee dorpe in Suid-Afrika te karakteriseer. Die artikel vind dat die winkelkwitansies en huishoudelike afval gesamentlik 'n kongruente storie vertel. Die resultate van hierdie artikel dui daarop dat daar potensiaal is vir die gebruik van winkelkwitansies en huishoudelike afval as 'n maatstaf van onderskeidelik besteding en verbruik.

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We are wise to remember the importance of good data, and not to neglect the challenges that measurement continuously poses.

Deaton (2016)

1 Introduction

The formulation of sound policy relies on the availability of good data. Of the data available to economists, household consumption data are some of the most versatile, conveying information about nutrition, poverty, intra-household allocation, and saving habits (Deaton and Grosh, 1998). Some of the most important microeconomic and macroeconomic issues rely on household-level consumption data. How long will a recession persist? Has global poverty increased or decreased over the last ten years? Do people save enough for retirement? Arriving at an answer to these questions inevitably involves a consideration of the consumption behaviour of households.

At the same time, the reliability of household consumption data is deteriorating. The decline in quality has become so severe that some have labelled it a ‘crisis’ (Meyer, Mok and Sullivan, 2015). The doubt cast on the reliability and accuracy of the data has evoked a reconsideration of the traditional approaches to consumption measurement, and in particular the household consumption and expenditure survey. Although surveys represent the dominant approach to measuring household consumption, the trust in data obtained in this manner has been eroded by a decline in both the quantity and quality of responses. While there is a general decline in survey response rates (referred to as unit non-response), even households that do participate in surveys are selective of the questions they answer (referred to as item non-response), or answer less accurately (referred to as measurement error) (Meyer et al., 2015). To be clear, the search is not for error-free consumption data — such an endeavour would be in vain. Instead, the current concern with the deteriorating quality of household consumption data lies in the increase in measurement error, or rather, more specifically, the prevalence of non-random measurement error.

The mismeasurement of household consumption has particularly undermined the reliability of studies on intertemporal consumption choice, which is a fundamental component of the theory of consumption (Deaton, 1992). The prevailing approach to modelling consumption is the life-cycle framework, which broadly states that consumers save and dissave over periods to maintain a stable level of consumption. One implication of the theory is that, in the absence of changes to income, households are insensitive to the timing of normal, anticipated income. Yet there is mounting evidence that this is not how households behave in reality. Households — especially low-income households — appear to be excessively sensitive to the arrival of anticipated income (Aguila et al., 2017; Baugh et al., 2021). This sensitivity is manifested in sharp increases in consumption (by nearly all metrics) upon receipt of income and significant declines in consumption towards the end of the period.

However, an important and often overlooked limitation of these studies is their reliance on household consumption data gathered through error-prone measurement approaches (Stephens, 2003). More precisely, almost all studies on intertemporal consumption behaviour rely on consumption and expenditure surveys (Aguiar and Bils, 2015). The mismeasurement in these surveys, which is often due to issues such as recall error or respondent fatigue, results in survey respondents providing less accurate answers. As a result, declining consumption over the course

of a month is often attributed to short-run impatience or liquidity constraints, without consideration of the role of mismeasurement.

This paper attempts to reconcile the measurement error characteristic of consumption data with the evidence presented on intertemporal consumption choice. In order to overcome the measurement error to which household consumption data are usually prone, this paper uses novel data from the Clean Cities and Towns project. This project was conducted by the Chair in Society and Waste of the South African Research Chairs Initiative between 2019 and 2021. The aims of the project were to uncover the cause of widespread littering and dumping in South African cities, and to provide suggestions as to how the problem might be remedied. The project entailed the collection of household-level data from households in low-income areas in five municipalities in South Africa for a period of four weeks. Of the rich data set, which comprises both qualitative and quantitative data, the waste characterisation study and household receipts from retail store purchases are of relevance to the present study. Specifically, the household receipts are used as a measure of expenditure, while household municipal solid waste collected as part of the waste characterisation study is used as a measure of consumption. This paper theorises that these sources of data can be used to construct more direct measures of consumption and expenditure, and that they are not prone to the same measurement error characteristics of traditional sources of consumption and expenditure data, even though these alternative sources of data have distinct problems of their own.

A descriptive analysis is performed of the consumption and expenditure patterns of households over the period of four weeks. The results indicate that households are excessively sensitive to the arrival of normal, anticipated income. In the first week after the arrival of income, household consumption expenditure is highest, after which consumption declines over the following weeks. Consumption expenditure is lowest in the fourth week, suggesting that there is strong cyclical variation in consumption expenditure. The waste characterisation studies reflect the same pattern in household consumption, indicating that households not only spend more after receiving income, but also consume more.

This paper makes two important contributions: The first is that the paper attempts to circumvent, or at least decrease, the standard sources of measurement error in household consumption and expenditure data to more accurately characterise household consumption. It does so through the use of alternative measures of consumption and expenditure — household waste and store receipts — which are not prone (or not as prone) to the types of mismeasurement found in household surveys. Further, the attempt to measure actual consumption, instead of using expenditure as a proxy for consumption, is in itself unique. Although consumption and expenditure are often used interchangeably, and while both are useful measures of welfare, there is an important distinction between the terms: ‘Expenditure’ refers to the acquisition of consumption goods, and ‘consumption’ refers to the actual consumption or use of goods (Browning et al., 2014).

Secondly, this paper presents evidence on a novel approach to measuring consumption at a time when an overhaul of the traditional approaches is being contemplated (Browning et al., 2014). While the ‘big data’ revolution has ushered in the use of sophisticated data sets such as administrative data and satellite data, the use of such data sources for the measurement of con-

sumption and expenditure has been sporadic. Examples of instances where such data have been used include the use of credit card data (Gross and Souleles, 2002) or, popularly, scanner data from retail stores to measure expenditure (Hastings and Washington, 2010). But the use of alternative measurements have been exclusively applied to the measurement of expenditure. Very little progress has been made towards the improved measurement of consumption. Furthermore, as Pistaferri (2015:120) notes, there are various obstacles to implementing these measurement approaches in practice, but the “feasibility could at least be assessed by running experimental, small pilots”. This paper hopes to contribute to the literature by being one such experimental, small pilot.

The remainder of the paper is organised as follows. Section 2 provides an overview of the theory and empirical evidence on intertemporal consumption choice and the measurement of consumption. Section 3 contains a detailed description of the data used in this study. Section 4 describes the methodology used in the study. Section 5 presents a descriptive analysis of the consumption patterns uncovered in the data. Section 6 provides a discussion on the policy implications of the findings presented in this paper as well as some concluding remarks.

2 Literature Review

2.1 Empirical evidence on intertemporal consumption choice

The theoretical framework of intertemporal consumption choice is informed by the life-cycle hypothesis and permanent income hypothesis of consumption, as proposed by Modigliani and Brumberg (1954) and Friedman (1957), respectively. Broadly, these hypotheses posit that consumers with dynamically consistent preferences form consumption decisions on the basis of expectations regarding income over their entire life-time, and not on the basis of their present income. Simply put, this means that consumers prefer to maintain a stable level of consumption and therefore save and dissave during different periods to achieve such stability. While the life-cycle hypothesis and permanent income hypothesis have historically been treated as completely distinct, the last few decades have seen a synthesis of the theory. The result is a treatment of the models as neither distinct nor indistinct, but rather “well-defined special cases of the general theory of intertemporal choice” (Deaton, 1992:214). In fact, Browning and Crossley (2001) propose referring to the theoretical framework not as *the* life-cycle model, but rather as the life-cycle *framework*, emphasising the fact that the life-cycle and permanent income hypotheses are merely theoretical frameworks through which specific models are developed.

There is conflicting evidence as to whether the consumption behaviour predicted by the life-cycle framework is consistent with how consumption choices are made in reality. While many studies have found evidence to reject the predictions of the life-cycle framework (Hastings and Washington, 2010; Damon et al., 2013), others believe that the failure of the models is overstated (Attanasio and Weber, 1995; Attanasio and Browning, 1995; Browning and Crossley, 2001). A remaining point of contention is the framework’s prediction that consumers borrow out of future income in order to maintain smooth levels of consumption (Parker, 2017). Fuelling the debate is an increasingly large literature documenting intertemporal variation in consumption

over periods of only a few months and even within months and weeks (Troubat and Grunberger, 2017). This is often interpreted as evidence of excess sensitivity to the arrival of normal income (Aguila et al., 2017). That households are excessively sensitive to the arrival of income is demonstrated by households experiencing sharp increases in consumption expenditure over the days following the receipt of income, while expenditure decreases over the next few weeks until income is received again (Baugh et al., 2021).

However, fluctuations in expenditure alone are insufficient evidence against the life-cycle framework. Browning and Crossley (2001) stress that the life-cycle framework ought not to be interpreted as saying that consumption expenditure remains constant over all periods. Instead, the key idea is that consumers attempt to maintain constant marginal utility of income over their life-time. This means that although expenditure might vary over the period of a year, consumption smoothing implies that consumption expenditure remains independent of expected income over that same year. It is also for this reason that the distinction between consumption and expenditure is important. This is particularly true in the context of food, where expenditure on durable goods or bulk buying of food may spuriously lead to the conclusion that consumption smoothing is not taking place, whereas a consideration of actual consumption may reveal that consumption is being smoothed throughout the period. Additionally, spikes in expenditure will always occur at certain times of the month when large monthly expenses such as mortgage or rent payments are made (Stephens, 2003).

There is evidence, however, that the marginal utility of income is not constant: In one study, social assistance beneficiaries in the United States indicated that they would prefer a smaller immediate payment over a slightly larger payment one month later (Shapiro, 2005). Remarkably, the number of households indicating willingness to accept a smaller payment increased by 0.35 percentage points per day over the benefit cycle. In the last week of the benefit cycle (that is, one week before receiving another grant payment) households are most willing to make this trade.

An oft-cited explanation for cyclical variation in consumption is that the assumptions underpinning the life-cycle framework do not hold in practice. One assumption that has faced particular scrutiny is that consumers are not subject to liquidity constraints, meaning that consumers have access to credit markets and that these markets work perfectly (Deaton, 1992). In this sense, liquidity constraints — or illiquidity — refers to an inability by consumers to access credit, either completely or to a limited extent (Lusardi, 1996). As a consequence, consumers are unable to borrow in order to consume out of future income, and therefore experience greater variations in consumption (Baugh et al., 2021). The explanation that the assumption of liquidity constraints does not hold in practice is appealing in the context of low-income countries, as markets often do not exist and when they do, they do not work perfectly (Morduch, 1995).

However, the empirical evidence on the precise effect of liquidity constraints is ambiguous, due in part to the fact that it is difficult to determine with certainty whether households do in fact experience liquidity constraints (Gross and Souleles, 2002). It is furthermore difficult to determine whether causation exists between economic circumstances and consumption choice, and in which direction it operates, due to issues such as reverse causality bias (Carvalho et al., 2016). Additionally, Aguiar and Hurst (2005) observe excessive sensitivity to the arrival of

income even amongst households that are not subject to liquidity constraints, which suggests that cyclical variation might only be partially attributable to liquidity constraints — or not at all. The evidence is consistent for all measures of consumption, including food acquisition and actual food consumption, and implies a clear rejection of the life-cycle framework.

A particularly interesting development in the literature is the difference in consumption patterns of low-income households receiving public transfers and low-income households not receiving public transfers (Hamrick and Andrews, 2016). Various papers analysing the consumption patterns of beneficiaries of the Supplemental Nutrition Assistance Program (previously the Food Stamp Program) in the United States have found that beneficiaries spend significantly more at the start of their benefit cycle (Wilde and Ranney, 2002; Shapiro, 2005; Hamrick and Andrews, 2016; Hastings and Washington, 2010). Specifically, the scale and probability of spending increases following the receipt of a public transfer compared to the day prior to the transfer receipt. Perhaps unsurprisingly, the increase in spending is even larger for households for which the transfer constitutes a large share of the household's income. However, the same patterns are not found amongst non-recipients, irrespective of whether they are low-income or high-income households (Hastings and Washington, 2010). The consensus is that these findings are at least to some degree evidence of short-run impatience or hyperbolic discounting (Huffman and Barenstein, 2005).

These findings are robust even when considering durable and non-durable items. In fact, an almost universal finding across the literature is that an increase in food expenditure is also accompanied by an increase in actual food consumption. And not only is consumption correlated with expenditure, but the relationship is strong: In analysing the consumption patterns of Supplemental Nutrition Assistance Program beneficiaries, Shapiro (2005) estimates that the amount of calories consumed decreases by 0.45% per day over the month after the benefit is received. Many low-income households that rely on public transfers report that there are days towards the end of the benefit cycle during which they are unable to consume any food at all (Hamrick and Andrews, 2016). In other cases, households resort to inexpensive food, often of poorer quality and lesser nutritional value (Damon et al., 2013). The lack of short-term household consumption smoothing clearly extends beyond academic interest in the validity of the life-cycle framework — it has important implications for food security and nutrition.

Hastings and Washington (2010) consider two alternative explanations for the observed variation in consumption of food stamp beneficiaries. The first is that it is due to a desire for variety in consumption, and the second is that households optimise consumption by increasing consumption expenditure at times when prices are lower. Their analysis is facilitated by the use of detailed data comprising bar codes of items purchased from three stores of a large supermarket chain in the state of Nevada. As to the first hypothesis, they consider whether households substitute quantity for quality by increasing food expenditure at certain times of the month. They find no evidence in support of this hypothesis, concluding that the decline in food expenditure at the end of the month is wholly due to a decline in the quantity — not the quality of food purchased. As to the second hypothesis, they find that the variation in consumption is not a result of optimal behaviour on the part of households. Social assistance benefits are distributed to beneficiaries on the same day once a month, and Hastings and Washington (2010) find that stores respond

to the sharp increase in demand following benefit distribution by increasing prices slightly. In fact, they find that households would be able to save significantly if they smoothed consumption and spent later in the month when prices were lower. They conclude that this supports the idea that the observed cyclical variation in consumption is due to impatience on the part of recipients of social assistance. They acknowledge, however, that their results may be biased if decisions regarding where to purchase groceries are dependent on the time of the month and the supermarket chain they studied is consequently not frequented by consumers during certain times of the month.

A criticism of these findings is their use of food as a measure of consumption. Although many studies rely on food as a proxy for consumption when testing the life-cycle framework, Lusardi (1996) cautions against the practice, arguing that food expenditure only constitutes a small share of overall consumption expenditure and is generally responsible for a mere quarter of the observed variance in consumption. As a consequence, tests based on food consumption often fail to reject the life-cycle framework (Ziliak, 1998). Another issue is that using food as a measure of consumption implies that utility is additively separable from non-food consumption, which would mean that the Euler equation is not valid (Ziliak, 1998). However, Attanasio and Weber (1995) show that utility is in fact non-separable, and that food is a necessity. On the other hand, the fact that food is a necessary good that is relatively income inelastic, also implies that it may be a suitable measure of the sensitivity of consumption choice to income (Aguiar and Hurst, 2005). Further, Deaton and Grosh (1998) note that food expenditure comprises a larger share — approximately two-thirds or three-quarters — of the budget for low-income households.

Studies of intertemporal consumption such as in Parker (2017) and Stephens (2006) are subject to an important qualification in that they use expenditure as a proxy for consumption. However, consumption and expenditure are not synonymous (Browning et al., 2014). Furthermore, even in circumstances where consumption itself is used to characterise intertemporal consumption behaviour, the measurement approaches used to measure such consumption are often flawed and prone to significant measurement error (Aguiar and Bils, 2015).

2.2 Mismeasurement of consumption

The traditional sources of household-level data are consumption and expenditure surveys, an example of which is the National Income Dynamics Study in South Africa. But despite the widespread use of these surveys, they are notoriously burdensome, often requiring respondents to recall expenditure on a seemingly never-ending, but crucially finite, list of consumption goods (Browning et al., 2014). Consequently, responses are not only error-laden, but are also less detailed than other measurement approaches such as food diaries, as they contain a limited list of goods on which respondents may report expenditure. As an alternative to surveys, food diaries are considered the gold standard approach to collecting consumption data. This is largely because diaries are considered to induce less respondent fatigue while simultaneously not limiting the scope of consumption goods they are able to capture. Unfortunately, they are resource-intensive and therefore expensive (Gibson et al., 2015). As a result, large-scale studies using food diaries are rarely conducted in low-income countries (Troubat and Grunberger, 2017).

Attempts to lower the costs associated with studies using food diaries through administering unsupervised food diaries are often unproductive, in that the food diaries risk simply becoming self-administered recall surveys (Friedman et al., 2017). Although it is doubtful whether much benefit remains to using food diaries above surveys in this case, many studies studying inter-temporal consumption choice nevertheless rely on either unsupervised food diaries or recall surveys.

The estimation bias produced from errors arising in surveys is well-documented. Less well-documented is the nature and extent of the errors, particularly in developing countries (Sawada et al., 2019). This is because consumption data from surveys are difficult to verify, given that it is impossible — or at least very costly — to directly measure true values (Gibson et al., 2015). The measurement error arising from household surveys may be categorised as follows: Unit non-response, item non-response, and measurement error. The concern is generally with the latter category, as it is a source of non-random error. That is, measurement error in household surveys are often systematic in nature and therefore produce biased results. The degree to which measurement error arise are determined to a great extent by the features of household surveys, for example the length of the period of observation. Briefly, the following sources of mismeasurement are notable examples of non-sampling errors arising from specific survey designs (Friedman et al., 2017; Deaton and Grosh, 1998): Recall error (general misremembering of details related to consumption), telescoping (respondents recall consumption taking place outside of the reference period as falling within the reference period), social desirability bias (or ‘prestige’ errors), strategic responses, respondent fatigue, behavioural responses to observation (sometimes referred to as the ‘Hawthorne effect’), respondent effects (the identity of the respondent affects the response provided), and interviewer effects (the identity of the interviewer affects the response provided). The prevalence of food consumed away from home (also referred to as personal leave out error) is also increasing and is poorly captured by current approaches to measuring consumption (Zezza et al., 2017).

Among these sources of mismeasurement, error arising from misremembering consumption or expenditure is especially prevalent and difficult to correct for. Perhaps unsurprisingly, the extent of recall error and respondent fatigue is greatly influenced by survey design features such as the length of the reference period. For example, it is difficult to recall with precision the amount of milk and sugar consumed by one’s household in the last 30 days, as the National Income Dynamics Study requests respondents to do. Even so, milk and sugar are standard, frequently-used household products. The mismeasurement is even greater in cases where households are asked to recall expenditure on products that are consumed less frequently (Abate et al., 2022). Large-scale assessments of the reliability of household consumption and expenditure surveys have found that observation periods longer than two weeks result in an under-reporting of consumption due to recall error or mistakenly not recalling expenditure as falling within the observation period (Smith et al., 2014). At the same time, if the observation period is too short, poverty will also be exaggerated (Deaton and Grosh, 1998). For example, if households are only observed for one or two days, as is often the case with diaries, then those households which happened to not spend during that short period would be deemed to be poor. In this case, Deaton and Grosh (1998) prefer a longer reference period over a shorter one.

While various studies have attempted to quantify and mitigate the measurement error generated by household surveys (Aguiar and Bills, 2015; Browning et al., 2014), few have attempted to address mismeasurement while considering questions related to inter-temporal consumption behaviour. Increasingly, however, researchers are using alternative sources of data to measure consumption and expenditure in attempts to supplement the data or to replace traditional data sources altogether. Some salient examples include the use of credit card data (Gross and Souleles, 2002) and the use of scanner data from grocery stores to measure expenditure (Hastings and Washington, 2010). But these approaches are not silver bullets. In the case of scanner data, one caveat is that the expenditure is often limited to certain grocery stores and to items from grocery stores. As a result, there is a concern that studies using scanner data to measure expenditure suffer from issues related to representation, as they may be specific to certain types of households or certain types of products (Pistaferri, 2015).

3 Data

A rich dataset from the Clean Cities and Towns project is used to construct alternative measures of household consumption and expenditure. As part of the project, the researchers collected store receipts and household waste from 50 households in Calvinia, a town in the Northern Cape, and 50 households in Mankweng, a township in Limpopo. The rich data set comprises both quantitative and qualitative data, of which the household solid waste characterisation studies, store receipts and household surveys are of relevance to the present study.

3.1 Waste characterisation study

The waste characterisation study comprised the sorting, weighing, and categorising of household solid waste collected from households on a weekly basis. Household solid waste refers to the solid material discarded by households (Nell et al., 2022). The purpose of a household waste characterisation study is to characterise the composition, volume, and weight of household waste. The waste was sorted into the following categories: Plastic bottles, paper and cardboard, Tetra Pak (aseptic cartons used to package long-life milk, for example), food, plastic bags, sanitary products and diapers, glass bottles, cans, plastic product packaging, and store receipts.

While households had limited access to proper waste management supplies and infrastructure, they displayed enthusiasm towards sorting the waste (Schenck et al., 2022). The households were, however, concerned about potential health risks arising from storing certain items (notably disposable nappies) for a week. As a result, these items are not adequately represented in the waste data.

3.2 Store receipts

As part of the waste characterisation study, retail store receipts were collected along with household waste once a week. The receipts included information on the store at which the items were purchases, the date and time of the purchase, the types of products, the prices, and the quantities

of items purchased product. Additionally, the receipts generally indicated whether the items were sold at a discount as well as the size of the discount.

3.3 Household survey

The household survey contained questions pertaining to the socio-economic status of the household (such as income, employment status and whether any social grants are received). Calvinia and Mankweng are both characterised by poverty and grant dependence, which is an attribute the two towns share with the other areas selected for the study (Schenck et al., 2022). The survey revealed that the majority of the participating households are recipients of government social grants, most commonly the Child Support Grant and the Older Persons Grant. In Calvinia, just over 75% of the households participating in the study are grant-recipients. Households in Mankweng are even more reliant on grants, with nearly 90% of participating households receiving grants. Figure 1 shows the distribution of incomes in Calvinia and Mankweng. These incomes include any social grants received. The median and minimum incomes in Calvinia and Mankweng are equal, though there is clear variation in the distribution of income. A larger proportion of households in Calvinia earn an income of R3 500 and above compared to Mankweng.

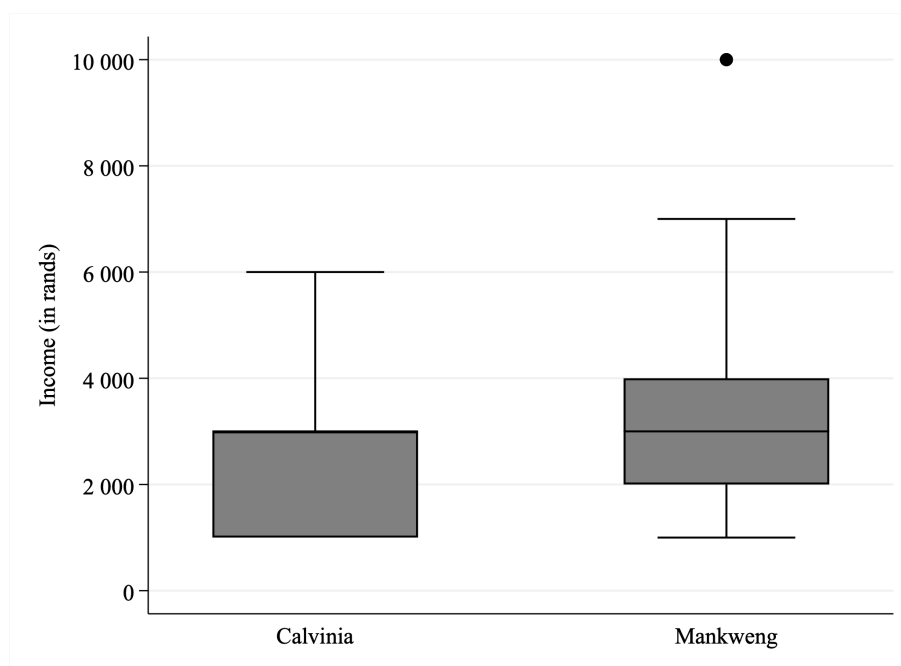


Figure 1: Distribution of household income

3.4 Limitations

A limitation of the study is that the sample is very small. Although five municipalities participated in the Clean Cities and Towns project, the comprehensiveness and reliability of the receipt data from certain areas was questionable, and therefore only Calvinia and Mankweng

were deemed to have sufficient data to be used for the present study. The number of households selected from each town is likely sufficiently large to be representative of the respective towns, but it is not certain whether the findings of the study may be generalised to other contexts.

A further shortcoming of the data is that the households surveyed comprise mostly grant-dependent households, and therefore the insufficient number of non-grant receiving households does not permit a robust comparison between grant-receiving and non-grant receiving households. This is unfortunate, given that the literature suggests potentially interesting differences in consumption patterns between grant-dependent and non-grant dependent households.

The households were selected through connections the researchers had to community members. An attempt was made to geographically stratify the households. Though the approach was mostly successful, snowball and convenience sampling did occur to some extent, as households admitted to the study would recruit neighbours or family members from other households to participate.

4 Methodology

The approach of the present study comprises a descriptive analysis of the expenditure and consumption patterns of households over the weeks following the receipt of income, the purpose of which is to arrive at a measure of households' sensitivity to the arrival of anticipated income. As the majority of participating households are recipients of social assistance grants, and grants are distributed at a specified date each month, the approximate date on which households receive income is known. This permits the analysis of expenditure and consumption during the weeks following receipt of income, and the patterns across the weeks are compared to arrive at a measure of how sensitive households' consumption and expenditure choices are to the arrival of income. To this end, the physical weight of household municipal solid waste is used as a measure of consumption, whereas the monetary value of retail stores purchases indicated on store receipts is used as a measure of expenditure.

4.1 Measurement of expenditure

Household expenditure is calculated weekly by summing the amounts indicated on household receipts. The sampling period did not start at the same time in the different towns and in some towns the project did not start at the beginning of the month or exactly at the same time grants were distributed. However, given that the concern is with the patterns of consumption and expenditure during the weeks following the receipt of income, which for grant-dependent households is at the time of grant distribution, the data are presented as starting from one week since the payment of grants. As a result, the first week of data from Calvinia and the fourth week of data from Mankweng do not form part of the study.

Further, the Classification of Individual Consumption According to Purpose is used to categorise each item on a store receipt (United Nations, 2018). The purpose of categorising each receipt item is to separate different types of expenditure. It is also useful to separate food expenditure into different categories. Broadly, these are grains and grain-products; meat; seafood;

dairy products and eggs; oils and fats; fruits and nuts; vegetables; sugar and desserts; and ready-made food as well as other miscellaneous food products. By separating food expenditure into different categories, comparisons between durable and non-durable consumption can be made.

The household survey revealed that the composition of households in Mankweng was distinct from that of households in Calvinia, in that a disproportionate number of households in Mankweng comprised older persons living with young children. This has two important implications for income. The first is that many households in Mankweng received both Child Support and Older Persons grants, whereas households in Calvinia usually only received either a Child Support Grant or an Older Persons Grant. In Mankweng, about 58% of households received the Older Persons Grant, compared to only 29% of households in Calvinia. This is relevant because it means that grant-dependent households in Mankweng received a greater amount of income from grants each month than households in Calvinia, as the Older Persons Grant is larger than the Child Support Grant. Given that grants often comprise a large share of household income, if households in Calvinia and Mankweng are sensitive to the arrival of anticipated income, this may result in households in Mankweng experiencing a larger variation in consumption and expenditure. The second implication is that remittances from family members working in nearby Polokwane were commonplace in Mankweng. Together, this suggests that households in Mankweng may not have received their income once-off, but rather in portions — grant income once a month and remittance income once a month — which may have a bearing on whether these households experience significant variation in consumption and expenditure between weeks.

There are various advantages to using store receipts to measure expenditure. The first, most obvious advantage, is that receipts measure expenditure directly. In contrast to household consumption and expenditure surveys, where respondents are asked to recall and recount expenditure, receipts do not present the opportunity for mismeasurement due to recall error or telescoping. This does not mean that the collection of store receipts requires no effort from participants. Some effort is still required, as participants need to remember to keep all receipts and submit them weekly. However, compared to consumption and expenditure surveys, receipts are far less likely to induce respondent fatigue. In fact, there is some evidence from the Clean Cities and Towns project which appears to confirm that the households did not find it burdensome to retain receipts. A misunderstanding by some households as to the collection of store receipts provided some insight into the behaviour of households in relation to receipts: In some of the towns, households submitted receipts from months and even years outside of the study period. In fact, some households submitted receipts from as long ago as ten years. That households kept receipts from not only recent months but also years, may reasonably be interpreted as an indication that these households have a natural inclination towards retaining receipts from purchases. This suggests that storing receipts from recent purchases for a mere week is unlikely to prove so burdensome as to induce respondent fatigue. However, measurement error may still arise from human error (such as households losing receipts, neglecting to take a receipt from a cashier or not being issued a receipt by an informal vendor) or even ‘prestige’ errors (such as households intentionally not submitting receipts from alcohol purchases).

On the other hand, receipts have the potential to reduce some aspects of human error. In the Clean Cities and Towns project, households occasionally neglected to submit receipts in

the appropriate weeks, but rectified their error by submitting the receipts in subsequent weeks. Given that the date of purchase is indicated on each receipt, the expenditure could easily be allocated to the appropriate week when capturing the receipts. Figure 2 shows the total recovered expenditure, where recovered expenditure refers to expenditure captured by receipts that were submitted during weeks within the study period, but that do not correspond to when the expenditure actually occurred. For example, if expenditure from week one is recovered in week two, such expenditure is captured as belonging to week one. Although the impact of this approach is most evident for non-grant households in Calvinia, expenditure was recovered for all households across both towns.

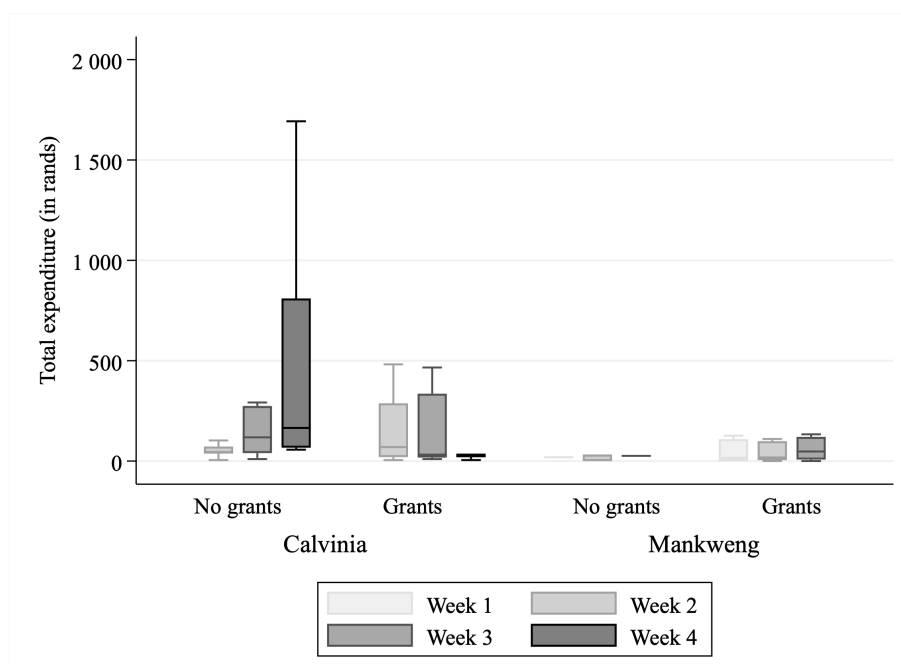


Figure 2: Distribution of total expenditure recovered

A second advantage is that the receipts contain detailed information on the items purchased, notably the price of each item and whether an item was purchased at a discount. Although perhaps not significant at face value, this information is notoriously difficult to obtain through survey data and prices often need to be imputed, which further increases the potential for error. Household surveys usually navigate this obstacle by using price indices. However, one concern with this approach is that there is variation in the prices faced by different households, both across space and time, which means that the use of price indices may overestimate or underestimate poverty (Deaton and Grosh, 1998). For example, rural households may face lower prices than more urban households, but price surveys are seldom conducted in rural areas. In contrast, the prices faced by each household are provided directly through the receipts, therefore requiring no imputation of prices. This, along with the information on whether or not items were purchased at a discount, is useful for determining drivers of consumption choice, as in Hastings and Washington (2010). A comparison of cyclical variation in consumption and prices may

reveal whether households are driven by impatience (for example, spending more after receiving income even if prices are higher) or whether they are behaving optimally (for example, by buying in bulk when prices are lower and stockpiling food).

A third advantage to using receipts as a measure of expenditure is that unlike scanner data, the receipts are specific to households and not to certain stores or to certain products. If the decision by households to visit certain stores or to purchase certain products is non-random — for instance, if it is dependent on the time of month or whether certain stores have discounts — then results from scanner data would be biased.

4.2 Measurement of consumption

One of the main advantages to using household municipal waste as a measure of consumption, is that waste approximates actual consumption. Household waste captures packaging and food discarded by households, which, when coupled with the expenditure data, provides an opportunity to track the movement of goods from the shopping cart to the waste bin. Although not as direct a measure as is the case with receipts and expenditure, waste provides some insight into the patterns of actual consumption that is not possible when expenditure is used as a proxy for consumption. Household waste is able to measure whether (and to what extent) consumption is related to expenditure, which provides an indication of whether households stockpile food. For example, if some products are bought, but do not appear in the waste during the weeks following expenditure, this indicates that while households may not be smoothing expenditure, they may be smoothing consumption. Likewise, if households have practised bulk buying just before the start of the observation period, expenditure from such purchases would not be captured. However, the consumption of the purchased products may be apparent in household waste.

In the present study, household waste also serves the purpose of supplementing the receipt data. Households, and especially poorer households, sometimes obtain a considerable amount of consumption from sources beyond the market (Deaton and Grosh, 1998). Some extra-market sources of consumption include goods received as payment-in-kind or from own production (Smith et al., 2014). As the household survey did not ask households to report how much of their consumption is obtained from outside the market, a failure to consider these sources of consumption may result in household waste being able to paint a more complete picture of total consumption.

There is one important caveat to the use of waste as a measure of consumption: The weight of household waste is not necessarily proportional to the weight of food, meaning that a greater amount of heavy materials such as glass in the waste during one week may spuriously lead to an inference that consumption was higher during that week. For instance, a glass jar which may have contained 300 grams of peanut butter would weigh more than a plastic bag which may have carried two kilograms of oranges. At the same time, the weight of food is not necessarily proportional to the caloric value of such food. Therefore, though the weight of household waste is a primitive measure of consumption, it does provide some indication as to the overall patterns of consumption.

5 Results

5.1 Expenditure indicated by store receipts

Figure 3 shows the distribution of total household expenditure in Calvinia and Mankweng. In Calvinia, median expenditure for households not receiving grants is lowest in the first week and peaks in the last week. The trend for grant-receiving households is exactly the opposite. The median total expenditure for grant-receiving households is the highest in the first week and declines as the weeks progress, reaching its lowest point in the last week. In the case of grant recipients, this trend paints a clear picture of excessive sensitivity to the arrival of income.

It is significant that there is such a stark and immediate contrast in the spending habits of grant-recipients and those not receiving grants in Calvinia. A simple explanation is that the date of income receipt differs for grant and non-grant households. Grants are generally distributed in the first week of the month, whereas salaries are paid towards the end of the month. The difference in the timing of expenditure is then merely due to a difference in the timing of income receipt. The implication is that non-grant recipients are likely not markedly more or less sensitive to the arrival of normal income than are grant-recipients.

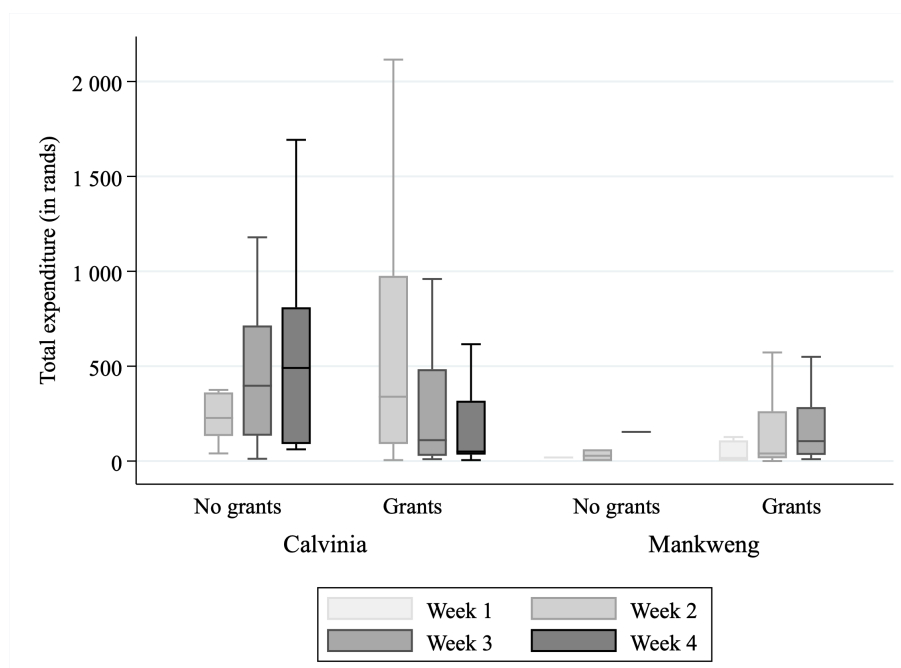


Figure 3: Distribution of total expenditure

In Mankweng, the trend for grant-receiving households follows the same trend seen amongst non-grant receiving households in Calvinia, albeit less starkly. The median expenditure for grant-receiving households in Mankweng only increases from barely above zero in the first week, to about R100 in the third week. It is striking that expenditure in Mankweng is significantly lower than in Calvinia, whether considering grant-receiving households or non-grant receiving households. The lack of distribution in the expenditure for non-grant receiving house-

holds is due to the fact that there are very few households in Mankweng that are not dependent on grants. It is puzzling, however, that total expenditure for non-grant households in Mankweng is lower by all measures than even grant-receiving households in Calvinia. A potential reason for this observation is revealed in the food expenditure behaviour of households in Mankweng.

Figure 4 shows the distribution of food expenditure of households. In Calvinia, it is immediately apparent that the patterns of food expenditure differ from the patterns uncovered for total expenditure. Median food expenditure for grant-receiving households is the highest in the first week, with R250 being the median household expenditure on food. The distribution of food expenditure for grant-receiving households in Calvinia, especially in the first week, appears as skew as the distribution of total expenditure for the same group, with the bottom quartile spending nothing and the top quartile spending between about R750 and R1 250. The median household food expenditure declines in the second week and in the third week. Notably, median food expenditure is lower than median total expenditure in the third week. For grant-receiving households in Calvinia, the expenditure trends appear to be similar irrespective of whether total expenditure or food expenditure is used. This likely indicates that a significant proportion of total expenditure comprises expenditure on food.

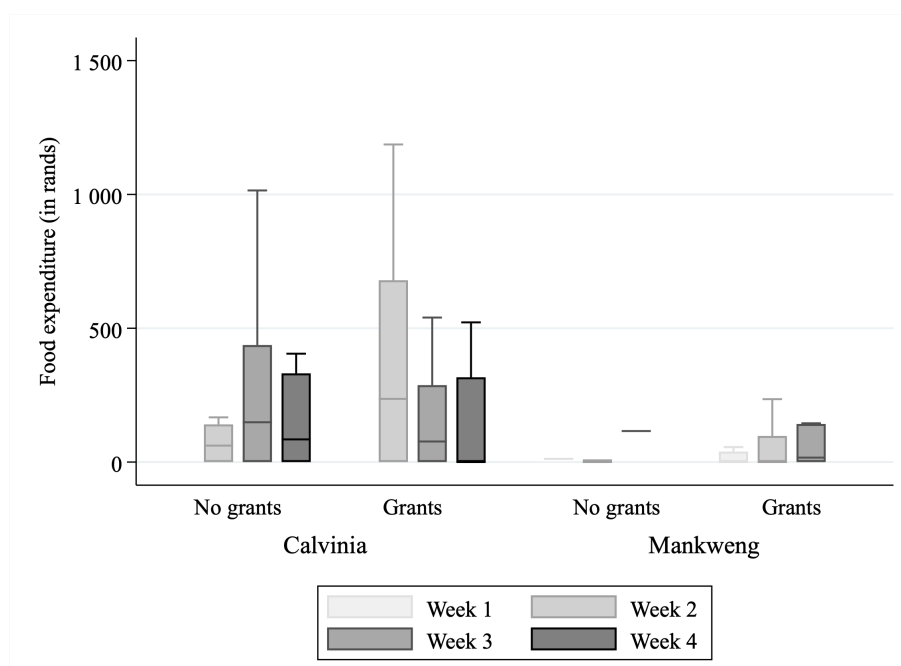


Figure 4: Distribution of food expenditure

Grant-recipients in Mankweng appear to spend little on food in the first week since grant payments, while the median food expenditure increases in the second week and further increases slightly in the third week. The pattern of food expenditure is the same amongst non-grant households. However, as with total expenditure, there is almost no distribution of food expenditure amongst non-grant households in Mankweng, given that there are very few households not dependent on grants.

In both Calvinia and Mankweng, the researchers of the Clean Cities and Towns project observed that it was the habit of households to purchase food with cash. This habit is at least partially owing to the fact that street vendors and informal stores often only accept cash as a form of payment. Further, these vendors typically do not have sophisticated point-of-sale devices that are able to provide customers with receipts for their purchases. As a result, the number of grocery store receipts submitted by households were not only sometimes much lower than expected, but seemingly reflected impossibly low levels of expenditure which would indicate extreme levels of poverty and food insecurity. These vendors were especially popular amongst households in Mankweng, where researchers observed that households would spend more at these vendors at the beginning of the month, particularly on fresh food such as fruits and vegetables (Schenck et al., 2022). This observation helps to explain why the receipt data reflects very low levels of expenditure at the beginning of the month in Mankweng. More importantly, it indicates that the consumption behaviour of households in Mankweng — in terms of where they buy and what they buy — is very sensitive to the timing of income.

A potential explanation for the cyclical variation in expenditure could be that households practice bulk buying and then stockpile food. If households in these towns do not live close to grocery stores, buying in bulk could be an optimisation strategy for households, through which they minimise transaction costs or transportation costs by purchasing in large quantities and minimising trips to the store. But this explanation is unlikely, as the households in the study are all situated rather centrally. In Calvinia, the stores are all within walking distance, and the research team observed that frequent trips to the grocery store are commonplace. Households generally do not buy in bulk in Calvinia, except perhaps at the beginning of the month when most stores sell ‘hampers’ at times when social grants are distributed. The hampers typically contain a standard offering of essential goods in large quantities, such as sugar, flour and maize. In Mankweng, households live slightly further from major grocery stores than in Calvinia. Most households in Mankweng live approximately 10 to 15 kilometres from the Paledi Mall, where the majority of households go to do their grocery shopping. However, even though households needed to make use of public transport to reach the nearest major shopping centre or grocery store, bulk buying was not common in Mankweng.

Another potential explanation for the cyclical variation in expenditure, as Hastings and Washington (2010) theorised, is that households optimise expenditure to coincide with times during which store prices are discounted. Figure 5 shows the distribution of the total value of discounts. The first observation is that there is no data for Mankweng. As with the lack of store receipts, a likely reason for the lack of data is that households in Mankweng prefer to purchase food from informal vendors and therefore any potential discounted items purchased are not captured in, given that informal vendors do not issue receipts.

In Calvinia, on the other hand, the discounts are informative of the intertemporal expenditure patterns of households. In the case of non-grant households, no discounts are indicated in the first week, whereas the value of total discounts increases as the weeks progress. However, the value of the discounts is small, with R20 being the maximum discount value. Further, the increase in discounts coincides with an increase in expenditure. This means that the increase in discounts may simply be a result of households spending more overall and incidentally also

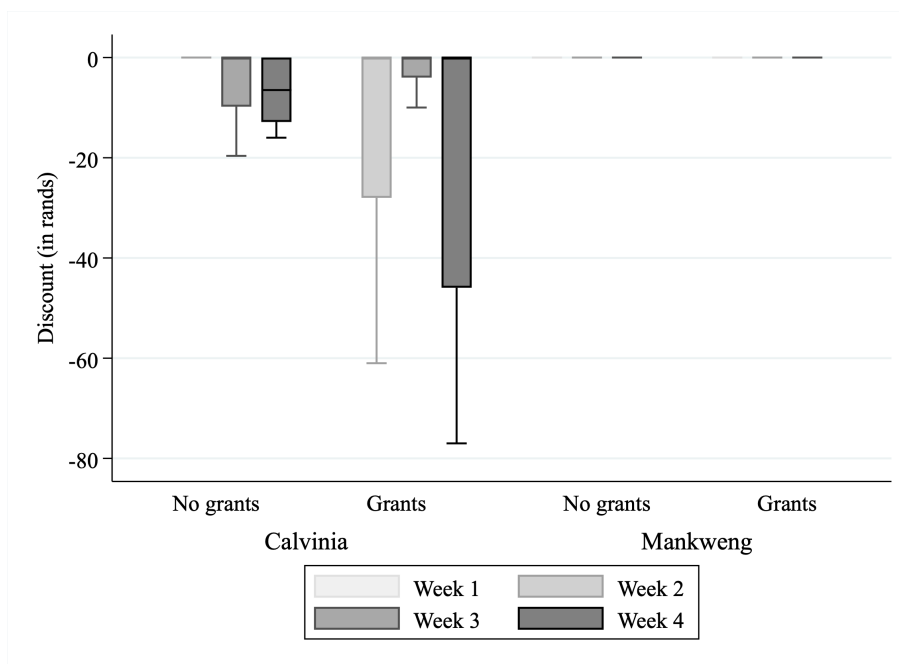


Figure 5: Distribution of discount

buying more discounted items. Along with the small value of discounts, this suggests that the timing of expenditure is not a deliberate, strategic decision based on the timing of store discounts. Discounts therefore do not substantially impact the intertemporal expenditure decisions of non-grant households.

In the case of grant-recipients, the value of discounts is higher overall than for non-grant households and increases markedly towards the end of the month. At the same time, grant dependent households spend less towards the end of the month. The increase in the value of discounts towards the end of the grant issuance cycle along with a simultaneous decrease in expenditure suggests that grant-receiving households are potentially substituting quality for quantity towards the end of the month.

5.2 Consumption indicated by household waste

Figure 6 shows the total household waste in kilograms per week since the payment of grants. The waste characterisation studies largely support the patterns seen in the receipt data. In particular, the waste data revealed that Mankweng produced the least amount of waste across all of the areas studied (Schenck et al., 2022). The researchers suggested that this may be due to Mankweng being more rural than the other areas and consequently purchasing more produce from informal vendors who had access to nearby farms. Given that the products sold by informal vendors are generally not wrapped in packaging, the greater propensity to purchase from informal vendors therefore translates into less waste in the form of packaging.

In Calvinia, the pattern of waste disposal appears to be mostly consistent amongst grant and non-grant recipients. The median weight of household waste increases between the first and

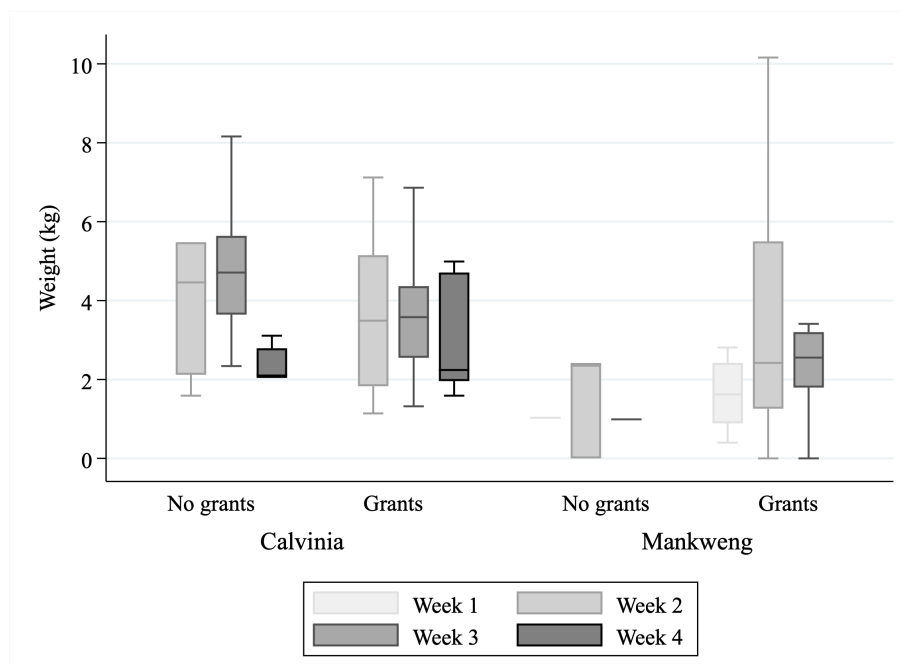


Figure 6: Distribution of total household waste

second week and declines sharply in the third week. This suggests that consumption is highest in the first two weeks and lowest in the third week. The waste therefore appears to confirm the expenditure patterns uncovered through receipts, namely that household expenditure increases immediately following the arrival of income. The household waste further indicates that the increase in expenditure is also accompanied by an increase in consumption, confirming that the cyclical variation in consumption and expenditure is not due to stockpiling.

In Mankweng, the pattern looks slightly different. For grant-receiving households, the median weight of household waste increases over the three weeks following grant payments. In the first week following grant payments, median household waste is at its lowest around 1.5 kilograms and the distribution is very even. In contrast, the distribution of waste during the second week is rather skewed, with the minimum being (a somewhat unlikely) zero kilograms and the maximum being more than ten kilograms. The median weight during the second week is noticeably higher at about 2.5 kilograms and increases only slightly in the third week to just over 2.5 kilograms. However, the weight is skewed towards the bottom of the distribution, with a measly maximum of just over 3 kilograms.

The waste characterisation studies also revealed differences in the waste composition of the two towns. Whereas each household in Calvinia consumes eight plastic grocery bags per week on average, Mankweng households consume only one bag per week. In the same vein, households in Calvinia throw away nine bread bags per week, while households in Mankweng throw away only one. The waste characterisation studies further revealed a significantly higher prevalence of fruit and vegetable peels in the waste of households in Mankweng. Together, these

findings support the conclusion that households in Mankweng have a preference for informal vendors over large grocery chains, and also purchase more fresh produce as a result.

Figure 7 shows the distribution of total household food waste in kilograms. Median household food waste is the highest in Mankweng over all weeks. The lower prevalence of food waste in Calvinia is most likely due to the habit of households to feed food waste to pets or livestock (Schenck et al., 2022). Food waste is therefore not a reliable measure of consumption of food in Calvinia, as much of household food waste was repurposed. Most households in Mankweng, however, did not report sharing in the practice of repurposing food waste.

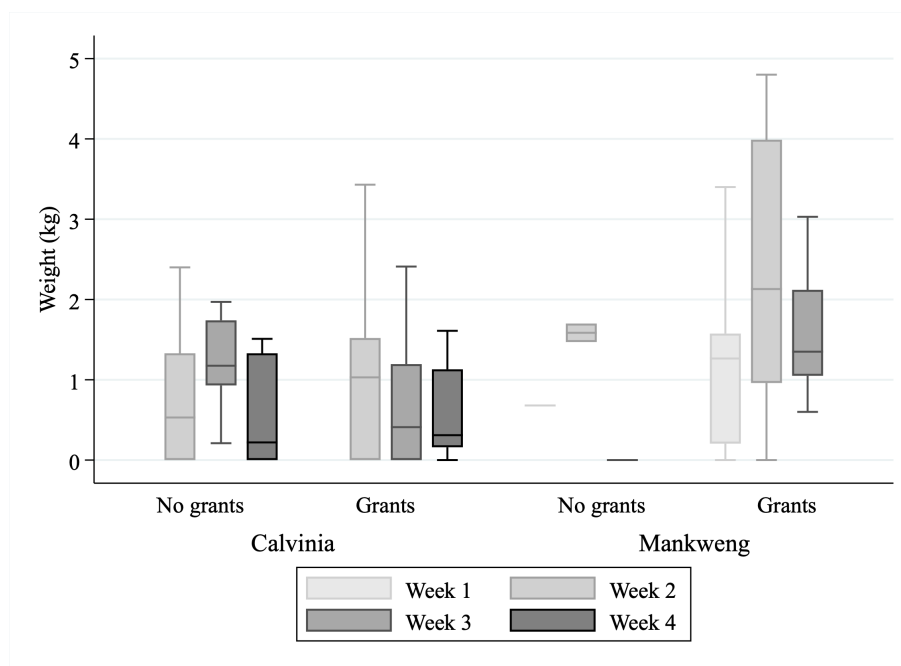


Figure 7: Distribution of total household food waste

In Mankweng, food waste follows a similar pattern to overall household waste. It increases from the first to the second week where it peaks before declining in the third week. Most importantly, the food waste patterns in Mankweng serve as a confirmation that the receipts are not an accurate reflection of food expenditure in Mankweng.

6 Conclusion

The purpose of this paper is to reconcile the measurement error characteristic of consumption data with the evidence presented on intertemporal consumption choice. In the context of the 'big data' revolution and the ushering in of novel, alternative approaches to measuring consumption and expenditure, this paper contributes to the literature by serving as a small, experimental pilot using household waste and store receipts as measures of consumption and expenditure. The aim of the paper is to determine the feasibility of using these alternative measurement approaches and, specifically, whether measurement error in household consumption data could

potentially be minimised. The paper theorises that store receipts minimise the mismeasurement of expenditure through directly measuring expenditure, whereas household waste provides an indirect measure of consumption.

The results indicate that, together, the store receipts and household waste tell a congruent story. The combination of surveys, receipts and waste paints a plausible picture of household consumption and expenditure behaviour, each serving as an audit of the information provided by the other. The importance of not relying solely on receipt data is illustrated well in Mankweng, where household waste proved crucial in uncovering the expenditure behaviour of households not adequately captured by store receipts. The results from this paper suggest that there is potential for the use of household waste and store receipts as alternative measures of consumption and expenditure. Separately, each is useful. But used together, these sources of data offer the ability to track the flow of goods from the shopping cart through to the wastebin. While receipts measure expenditure directly and enable the determination of the precise date of expenditure, consumption is measured indirectly through the timing of the product ending up in the wastebin.

Using the store receipts, along with the household waste, a clear picture emerges of sensitivity to the arrival of normal income amongst grant-receiving households, and potentially also amongst non-grant receiving households. Both household consumption and expenditure increase markedly upon grant receipt, following which consumption and expenditure decrease towards the end of the grant issuance cycle. These findings are consistent with the consumption behaviour of social assistance benefits documented in the literature. Though it is not the main purpose of the paper, potential explanations for the cyclical variation in consumption and expenditure are briefly contemplated. The paper finds that it is unlikely that the lack of intertemporal consumption and expenditure smoothing is due to strategic behaviour in response to the timing of store discounts or due to stockpiling of food. Grant-receiving households purchase more discounted items than non-grant households and save more in discounts towards the end of the grant issuance cycle. This may be interpreted as an indication that grant-recipients are willing to substitute quality for quantity, purchasing more discounted items the further they are from income receipt. As to stockpiling, an analysis of household waste reveals that an increase in expenditure is accompanied by an increase in consumption, confirming that households smooth neither expenditure nor consumption.

The observation of cyclical variations in consumption has important implications for the timing of cash transfers, given that this paper echoes the literature in concluding that household consumption choice is excessively sensitive to the payment of social assistance grants and that cyclical variation in consumption has significant welfare consequences. Analysing the effects of non-contributory pension programmes in Mexico, Aguila et al. (2017) find that monthly transfers result in greater consumption smoothing than is the case under transfers paid every two months. However, they also find that bimonthly transfers increase the probability of owning durable goods such as technological devices and bicycles. Some beneficiaries of social assistance in the United States have indicated a desire for smaller, more frequent payments (Wilde and Ranney, 2000). In particular, focus groups of beneficiaries expressed a desire for benefit payments at the beginning of the month and in the middle of the month. However, more frequent payments would increase the administration costs associated with the payment of social

assistance. The benefits of smaller, more frequent payments would have to be assessed against the cost of administering such payments.

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