Income shocks and Intra-household Bargaining: Theory and Evidence from South Africa*

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Abstract

This study analyses the impact of a large cash transfer on intra-household bargaining as proxied by the *sharing rule*. The methodology for deriving bounds on the sharing rule when individual consumption data is incomplete is extended from two to m decision makers. The large cash transfer in the form of the South African Older Persons Grant is a plausibly exogenous income shock and its impact on the sharing rule bounds is analysed within a fuzzy regression discontinuity design framework. The cash transfer significantly increases the sharing rule bound by 8.4% to 8.5% for the recipient and the corresponding income elasticity of the sharing rule is between 0.15 and 0.16. Receipt of the cash transfer reduces employment and labour force participation for recipients and other household members.

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1 Introduction

At its core, economics is the study of allocating scarce resources. The household is arguably the most fundamental unit of economic cooperation and how households allocate resources has been the topic of much attention in the development literature (see Doss (2013) for a review). The microeconomic theory of intra-household allocation moved away from considering the household as *unitary* towards a *collective* model through seminal contributions by Chiappori (1988, 1992). The proposed *sharing rule* has become a ubiquitous measure for the relative bargaining power within a household and explicitly takes potentially different preferences for consumption within households into account. Applying the theory of the sharing rule to empirical questions often suffers from data limitations, which is particularly true in lower income settings. The lack of individual-level consumption data does not preclude the identification of bounds on the sharing rule, however, as Cherchye et al. (2015) show.

In addition to how existing resources are allocated within a household, income and other shocks may impact this distribution in significant ways. Over the last three decades, cash transfers to individuals and households have become an effective and increasingly popular tool in combating poverty in lower income countries. The literature also shows that their impacts are often dependent on recipient characteristics. Duflo (2003) shows that in the case of the South African Older Persons Grant, the gender of the recipient plays a significant role in the diffusion of the benefits of the cash transfer within the household, with girls benefiting especially when the the recipient is a woman. Some cash transfer programmes make receipt conditional on meeting certain criteria. The Mexican poverty relief programme *Oportunidades* (previously known as *PROGRESA*),[1] for example, only pays benefits to women and makes these payments conditional on meeting a range of development criteria for their children. Since these cash transfers are directed at poor households, even small amounts may act as large relative income shocks due to the presence of liquidity and credit constraints (Berg, 2013).

Recent global reviews and meta-analyses (Banerjee et al., 2017; Kabeer and Waddington, 2015; Evans and Popova, 2017) find that unconditional cash transfers

[1] see Parker and Todd (2017) for a recent review.

generally have small or null effects on adult labour supply, though context and programme design matter. Country-specific evidence from Africa (Haushofer and Shapiro, 2016; Blattman et al., 2014; Egger et al., 2022) similarly points to limited negative effects on work effort. However, in South Africa, where the pension is large relative to typical incomes and unemployment is high, studies have found reductions in labour force participation among both recipients and other household members (Abel, 2019; Bhorat and Köhler, 2024).

This paper draws on these literatures and investigates the effect of a cash transfer on the bargaining power of the recipient. The main contribution of this analysis is twofold. First, intra-household bargaining power, proxied by the *sharing rule*, is calculated based on the methodology proposed by Cherchye et al. (2015), where bounds on the sharing rule are derived for situations where consumption data is not available at the individual level for all goods. This methodology is extended to m household decision makers, which better reflects reality in lower income countries such as South Africa. This sharing rule approach provides a more nuanced measure of changes in bargaining power, compared to the extensive margin nature of measures derived from survey responses. Second, the impact of a cash transfer on the sharing rule is estimated. The cash transfer in question is the South African Older Persons Grant or *pension*, which is akin to an exogenous income shock for recipients due to the above-mentioned presence of liquidity and credit constraints. Take-up is not complete, however, and age-eligibility is used to instrument for pension receipt.

In practice, the sharing rule is calculated using a non-linear optimisation programme and the effect of the pension on the sharing rule is estimated by way of a fuzzy regression discontinuity design. The results indicate a significant impact of the pension on the sharing rule, with an average increase of between 4.2 and 4.3 percentage points, which translates to an increase of 8.4% to 8.5% in bargaining power, respectively. Individual income increases by 53.9% upon pension receipt with an elasticity of 0.15 to 0.16. Additional results show that the presence of children and other adults in the household increase the bargaining power of the recipient compared to households with no children and only two adults present.

This paper is structured as follows. Section 2 presents an overview of the South African Older Persons Grant (the cash transfer analysed in this study) and related literature. Section 3 derives the sharing rule bounds and presents conditions for its empirical identification. Section 4 describes the data used in the analysis and Section 5 illustrates the empirical approach to calculating and estimating the effects of the cash transfer on the sharing rule bounds. Section 6 presents the sharing rule bounds and the effects of the pension on those bounds, as well as possible mechanisms through which these effects may materialise. Section 7 provides a discussion of the results and concludes.

2 Background

Since the fall of the oppressive apartheid regime in the early 1990s, the South African Older Persons Grant (colloquially, the *pension*) has become a key feature of the social security system in South Africa. The pension is a non-contributory, means-tested cash transfer, currently available from age 60. In the most recent year of data used for this analysis, the maximum inflation-corrected amount of the pension was R1,341 per month.[2] This is around 80% of the median individual income,[3] a non-trivial amount for those that receive it. The means test considers income and assets, however, in practice only income is assessed (McEwen et al., 2009). Furthermore, the pension is designed as a sliding scale, however, as can be seen in Table 1, average pension income is very close to the maximum amount available. Since the income and asset thresholds for pension eligibility are relatively generous, a large percentage of the population qualifies and receives the pension upon reaching the eligibility age. As with most studies based on the pension, this analysis focuses on the Black African population for two reasons: First, 86% of the Black Africans that qualify take up the pension (McEwen et al., 2009). Since this population group makes up 80% of South Africa's population, pension receipt is almost ubiquitous among this population group. Second, other population groups are under-sampled in the data, which may cause problems when using survey weights in the analysis (McEwen et al., 2009).

The pension has a significant effect on not only the recipient, but also on children and other adults present in the household. Studies have found improvements

[2] This is equivalent to € 66 or US$ 74 in April 2025.
[3] see Table 1 in Section 4 for more details.

in children's health and nutritional status (Duflo, 2000, 2003), children's schooling (Edmonds, 2006), as well as both positive (Ardington et al., 2009) and negative (Bertrand et al., 2003; Abel, 2019) labour supply effects for other household members.

Ambler (2016), which is most closely related to this study, investigates the changes in bargaining power due to pension receipt along this dimension and finds stronger effects when a woman is the pension recipient. These results depend on large changes in intra-household bargaining power to induce a switch in decision maker status within a household, precluding an analysis of impacts along the intensive margin of the bargaining power dimension. The results are only robust using the first wave of data, however, since a change in survey protocol[4] created a bias in who is deemed the main decision maker in the household. This highlights an additional drawback of using stated survey responses in determining intra-household bargaining power.

Another measure of intra-household allocation, and the focus of this analysis, is the so-called *sharing rule*. Following from the seminal work on the collective household model of Chiappori (1988, 1992), the sharing rule provides a simple measure of the resource allocation within a household. The derivation of the sharing rule depends on the individual demand schedules of each household decision maker, which can be estimated from consumption data. Whilst acknowledging the well known biases inherent in survey data, the sharing rule seeks to provide a potentially more objective measure of each individual's resource share within the household, as well as providing a measure for intra-household bargaining power along the intensive margin. The sharing rule, as a percentage of household income, allows for a simple interpretation and the potential to derive elasticities from responses to exogenous shocks.

[4] Ambler (2016) notes that in wave 1 of the NIDS survey, the questions on decision maker status were asked to the household head, whereas in subsequent waves, the oldest female was the respondent. As a result, there is a larger share of older women listed as the main decision maker in the household compared to wave 1.

3 The Sharing Rule

3.1 Theory

This section presents the theoretical background on deriving bounds on the sharing rule drawing on Cherchye et al. (2015) and using the most general collective household model (Browning and Chiappori, 1998; Chiappori and Ekeland, 2006, 2009) and revealed preference theory. First, the collective household model for m decision makers is presented and subsequently the resulting sharing rule bounds methodology as in Cherchye et al. (2015) is extended to finite m household decision makers.

3.1.1 The Collective Household Setting

The collective model, in which the household is seen as a *collective* of individuals with their own sets of preferences, is preferred to the unitary household model in this application, since the primary unit of analysis is the individual. Indeed, Browning and Chiappori (1998) highlight significant theoretical concerns with the unitary model. First, the symmetry of the Slutsky substitution matrix, is incompatible with household data (Pashardes and Blundell, 1993; Browning and Meghir, 1991). Second, the income pooling hypothesis of the unitary model, which states that the source of household income is irrelevant to intra-household allocation as soon as it is conditioned on expenditure, is rejected.

The formal definition of the collective model for this analysis proceeds as follows. Each household decision maker m gains utility

$$U^i\big(\mathbf{x}^1, \cdots, \mathbf{x}^m, \mathbf{x}^H\big), \quad i \in M,$$

where $U^i(\cdot)$ are concave and differentiable functions. Note that decision maker i's utility depends on decision maker j's ($i \neq j$) consumption, although $U^i(\cdot)$ does not have to be increasing in $\mathbf{x}^j$ for $j \neq i$. This general formulation allows for selfishness, spite or negative consumption externalities in addition to altruism and positive externalities within the household (Browning and Chiappori, 1998).

Let the n-vector $\mathbf{x} \in \mathbb{R}^{|N|}_{+}$ be a quantity bundle of n consumption goods as a function of n prices $\mathbf{p} \in \mathbb{R}^{|N|}_{++}$ and income $w \in \mathbb{R}_{++}$. For a finite m decision maker household, household demand is[5]

$$\mathbf{d}(\mathbf{p}, w) = \mathbf{x} = \sum_{c \in C} \mathbf{x}^c \quad \text{where} \quad \mathbf{x}^c \in \mathbb{R}_+^{|N|}, \quad c \in (1, \cdots, m, H).$$

Total household consumption[6] is the sum of private consumption of the m household decision makers $(\mathbf{x}^1, \mathbf{x}^2, \cdots, \mathbf{x}^m)$ as well as public consumption within the household $(\mathbf{x}^H)$. Indeed, element n of each consumption vector may be non-zero if good n is consumed both privately and publicly. As an example, public consumption of a good is enjoying a meal with the family, whereas private consumption of a good is one household decision maker eating the leftovers at midnight while the rest of the household is sleeping (this may also lead to a negative externality once the other household decision makers find out). To aid exposition, define the set $C = \{1, \cdots, m, H\}$ to index private $(1, \cdots, m)$ and public (H) consumption and define the set $M = \{1, \cdots, m\}$ to index the individual household decision makers. Since the current model does not include a time dimension, in the optimisation programme that follows, w is the contemporaneous expenditure of the household for that period. This fits the current application especially well, considering the population being analysed is highly liquidity and credit constrained (Berg, 2013) and there is assumed to be no inter-temporal movement of expenditures.

As a final step, assume that the allocation of resources within the household is the product of a bargaining process and Pareto efficient. Following Browning and Chiappori (1998), efficiency may be achieved by agents engaging in a repeated game with symmetric information, which is not especially unrealistic in a collective household setting. They further note that the repeated nature of the game allows agents to find mechanisms to support efficient allocations and that cooperation often obtains as a long run equilibrium even within non-cooperative frameworks.

[5] Superscripts indicate whether the consumption vector (in bold) belongs to a specific household decision maker $(1, \cdots, m)$ or is part of public consumption (H) in the household. As an example: if there were three household decision makers and the first consumption good is food, the first elements in the respective consumption vectors $\mathbf{x}^i$ $(\imath \in M)$ would be the amount of food each decision maker consumes privately $(x^1_{food}, x^2_{food}, x^3_{food})$, and the first element in $\mathbf{x}^H$ would be the amount of food consumed by all decision makers when eating together.

[6] The empirical application in this analysis considers households with additional adults and children who are not decision makers. The current model only considers the allocation of income between the decision makers whereas the further allocation to non-decision makers and children within the household is beyond the scope of this analysis.

Assuming that there exists a Pareto efficient intra-household allocation, there exists a Pareto weight $\mu^i(\mathbf{p}, w) \in \mathbb{R}_{++}$ (zero-homogeneous in $\mathbf{p}$ and w), which determines the relative bargaining power within the household. Normalising $\mu^1(\cdot) = 1$, $\mu^i(\cdot)$ is an expression for the bargaining power of decision maker i relative to decision maker 1 in the household. The household's preferred consumption bundle $\mathbf{x}^1, \cdots, \mathbf{x}^m, \mathbf{x}^H$ is then Pareto efficient and solves

$$\begin{aligned} &\max_{\mathbf{x}^1, \cdots, \mathbf{x}^m, \mathbf{x}^H} \sum_{i \in M} \mu^i(\mathbf{p}, w) \cdot U^i\big(\mathbf{x}^1, \cdots, \mathbf{x}^m, \mathbf{x}^H\big) \\ &\text{s.t.} \quad \mathbf{p}' \sum_{c \in C} \mathbf{x}^c \leq w \quad \text{with} \quad \mathbf{x}^c \in \mathbb{R}_+^{|N|}, \quad c \in C, \end{aligned} \tag{1}$$

with the Pareto weight summarising the decision process by determining where the household locates itself on the Pareto frontier. The Pareto frontier is defined by the budget constraint of the household given the utility functions $U^1, \cdots, U^m$ and household consumption bundle $\mathbf{x}^1, \cdots, \mathbf{x}^m, \mathbf{x}^H$ (Chiappori and Ekeland, 2009).

Now, a sharing rule representation of the household optimisation problem can be described. Note that household behaviour consistent with Pareto efficiency can be interpreted as the outcome of a two-step process. First, household income $w = \sum_{i \in M} w^i$ is distributed to the household decision makers according to a sharing rule. Second, individual household decision makers maximise their utility subject to their income w^i and their marginal willingness to pay (Lindahl price) for each private and public consumption good. For each private good, the Lindahl price is the individual's willingness to pay for that particular good, whereas for public goods the Lindahl price is the sum of the household decision makers' respective marginal willingness to pay for that good.

Let $\mathbf{d}^i\big(\mathbf{p}^{i,1}, \cdots, \mathbf{p}^{i,m}, \mathbf{p}^{i,H}, w^i\big)$ be an individual demand function for household decision maker $i \in M$ with Lindahl prices $\mathbf{p}^{i,c} \in \mathbb{R}_+^{|N|}$ and income share $w^i \in \mathbb{R}_{++}$, where

$$\mathbf{x}^i = \mathbf{d}^i\big(\mathbf{p}^{i,1}, \cdots, \mathbf{p}^{i,m}, \mathbf{p}^{i,H}, w^i\big) = \sum_{c \in C} \mathbf{x}^{i,c}.$$

The sharing rule is defined as the construction of $w^1, \cdots, w^m$ solving

$$
\begin{aligned}
\left(w^1, \cdots, w^m\right) = \underset{\mathbf{x}^1, \mathbf{x}^2, \cdots, \mathbf{x}^m}{\arg\max} & \sum_{i \in M} \mu^i(\mathbf{p}, w) \cdot U^i \left[\mathbf{d}^i\left(\mathbf{p}^{i,1}, \cdots, \mathbf{p}^{i,m}, \mathbf{p}^{i,H}, w^i\right)\right] \\
\text{s.t.} \quad & \sum_{i \in M} w^i \leq w.
\end{aligned} \tag{2}
$$

In the second step, individual household decision makers solve the following optimisation problem:

$$
\begin{aligned}
\left(\mathbf{x}^1, \cdots, \mathbf{x}^m, \mathbf{x}^H\right) = & \underset{\mathbf{q}^1, \cdots, \mathbf{q}^m, \mathbf{q}^H}{\arg\max} \; U^i\left(\mathbf{q}^1, \cdots, \mathbf{q}^m, \mathbf{q}^H\right) \\
\text{s.t.} \quad & \sum_{c \in C} \left(\mathbf{p}^{i,c}\right)' \mathbf{q}^c \leq w^i, \quad \mathbf{q}^c \in \mathbb{R}_+^{|N|}
\end{aligned} \tag{3}
$$

Let $\mathbf{x}^1, \cdots, \mathbf{x}^m, \mathbf{x}^H$ be a solution to (1) where $\mathbf{x} = \sum_{c \in C} \mathbf{x}^c$. This is also a solution to (3) if

$$
\mathbf{p}^{i,c} = \frac{U^i_{\mathbf{x}^c}}{\lambda^i} \tag{4}
$$

and $\mathbf{x} = \mathbf{x}^i$ $(i \in M)$.[7] $U^i_{\mathbf{x}^c}$ is the gradient of the decision maker utility function at quantity bundle $\mathbf{x}^c$ $(c \in C)$. λ^i is the optimal value of the Lagrange multiplier in (1), i.e. the amount by which household decision maker i's utility would increase with a marginal increase in household income. λ^{i+1} is the corresponding value for household decision maker $i+1$, where $\lambda^{i+1} = \frac{\lambda^i}{\mu^{i+1}}$. Thus, each vector $\mathbf{p}^{i,c} \in \mathbb{R}_+^{|N|}$ is household decision maker i's marginal willingness to pay for quantity bundle $\mathbf{x}^c$, where $\sum_{i \in M} \mathbf{p}^{i,c} = \mathbf{p}$ $(c \in C)$ by construction.

In this context, the sharing rule can be interpreted as the relative bargaining power within the household, where the higher the share of income $\frac{w^i}{w}$ accruing to decision maker i $(i \in M)$, the higher their relative bargaining power within the household.

Ideally, individual demand functions $\mathbf{d}^i(\mathbf{p}^i, w^i)$ and individual income shares w^i are present in the data used to analyse intra-household allocation. In many data sources, including that used in this analysis, however, information is only available at an aggregate level. As such, only $\mathbf{d}$ and w are available. The aim of

[7] See Appendix A for a proof of this result.

the following is to recover bounds on the sharing rule (i.e. find upper and lower bounds on w^i given $\mathbf{d}(\mathbf{p}, w)$).

Start by defining the budget for each household decision maker i:

$$B\big(\mathbf{p}^{i,1}, \cdots, \mathbf{p}^{i,m}, \mathbf{p}^{i,H}, w^i\big) = \left\{ \mathbf{x} \in \mathbb{R}_+^{|N|} \quad | \quad \mathbf{x} = \sum_{c \in C} \mathbf{x}^c, \quad \sum_{c \in C} \big(\mathbf{p}^{i,c\prime}\big)\mathbf{x}^c \leq w^i \right\}.$$

Next, define the revealed preference relation $\succ^i$ for demand function $\mathbf{d}^i$:

Definition 1. [Direct Revealed Preference] Let $\mathbf{d}^i$ be an individual demand function. The direct revealed preference relation associated with $\mathbf{d}^i$ is defined by:

$$\begin{aligned} \forall \quad \mathbf{x}, \mathbf{z} \in \mathbb{R}_+^{|N|} : \quad & \mathbf{x} \succ^i \mathbf{z}, \\ & \text{if there exists} \quad \mathbf{p}^{i,c} \in \mathbb{R}_+^{|N|} \quad (c \in C) \quad \text{and} \quad w^i \in \mathbb{R}_{++}, \\ & \text{such that} \quad \mathbf{x} = \mathbf{d}^i\big(\mathbf{p}^{i,1}, \cdots, \mathbf{p}^{i,m}, \mathbf{p}^{i,H}, w^i\big) \\ & \text{and} \quad \mathbf{z} \in B\big(\mathbf{p}^{i,1}, \cdots, \mathbf{p}^{i,m}, \mathbf{p}^{i,H}, w^i\big), \\ & \text{with} \quad \mathbf{x} \neq \mathbf{z}. \end{aligned}$$

In the Weak Axiom of Revealed Preference (WARP) sense (Samuelson, 1938), $\mathbf{x}$ is revealed preferred via $\succ^i$ to $\mathbf{z}$ because it was chosen despite $\mathbf{z}$'s presence in B. The only difference to the standard definition is that the revealed preference relation is at the individual, not the household, level. This requires consideration of the preferences over the disaggregated quantity bundles evaluated at their respective Lindahl prices $\mathbf{p}^{i,1}, \cdots, \mathbf{p}^{i,m}, \mathbf{p}^{i,H}$, with the disaggregated quantity bundles resulting from the definition of budget set $B\big(\mathbf{p}^{i,1}, \cdots, \mathbf{p}^{i,m}, \mathbf{p}^{i,H}, w^i\big)$. The precise definition of WARP for this setting is as follows:

Definition 2 (WARP)**.** Let $\mathbf{d}^i$ be an individual demand function. $\mathbf{d}^i$ satisfies WARP if the relation $\succ^i$ is asymmetric, i.e. for all $\mathbf{x}$, $\mathbf{z} \in B$, if $\mathbf{x} \succ^i \mathbf{z}$ then $\mathbf{z} \not\succ^i \mathbf{x}$.

As stated above, $\mathbf{d}^i$ generally remains unobserved. As such, a definition of all possible $\mathbf{d}^i$ is required. This set of so-called *admissible* demand functions must be consistent with the observed household demand function $\mathbf{d}$.

Definition 3 (Admissible Individual Demands)**.** For a given household demand function $\mathbf{d}$, the individual demand functions $\mathbf{d}^i$ are admissible if, for all $\mathbf{p}$ and w,

$$\mathbf{d}(\mathbf{p}, w) = \mathbf{d}^i\big(\mathbf{p}^{i,1}, \cdots, \mathbf{p}^{i,m}, \mathbf{p}^{i,H}, w^i\big),$$

for some $\mathbf{p}^{i,c}$ with $i \in M$, $c \in C$ and w^i such that

$$\sum_{i \in M} w^i = w \quad \text{and} \quad \sum_{i \in M} \mathbf{p}^{i,c} = \mathbf{p} \quad \text{with} \quad w^i \in \mathbb{R}_{++} \quad \text{and} \quad \mathbf{p}^{i,c} \in \mathbb{R}_{+}^{|N|}.$$

In addition, let $X(\mathbf{d})$ represent the set of all admissible individual demand functions $\mathbf{d}^i$:

$$X(\mathbf{d}) = \Big\{\big(\mathbf{d}^1, \cdots, \mathbf{d}^m\big) \quad \big| \quad \mathbf{d}^1, \cdots, \mathbf{d}^m \text{ are admissible for the household demand function } \mathbf{d}\Big\}.$$

Collective rationalisation requires that for a given household demand function $\mathbf{d}$ there must exist at least one set of admissible individual demand functions that solves (2).

Definition 4 (Collective Rationalisation)**.** Let $\mathbf{d}$ be a household demand function. A set of utility functions U^i $(i \in M)$ provide a collective rationalisation of $\mathbf{d}$ if there exist admissible demand functions $\mathbf{d}^i \in X(\mathbf{d})$ such that, for all i,

$$\mathbf{d}^i\big(\mathbf{p}^{i,1}, \cdots, \mathbf{p}^{i,m}, \mathbf{p}^{i,H}, w^i\big) = \sum_{c \in C} \mathbf{x}^c$$

for

$$\begin{aligned} \big(\mathbf{x}^1, \cdots, \mathbf{x}^m, \mathbf{x}^H\big) = & \underset{\mathbf{q}^1, \cdots, \mathbf{q}^m, \mathbf{q}^H}{\arg\max} \; U^i\big(\mathbf{q}^1, \cdots, \mathbf{q}^m, \mathbf{q}^H\big) \\ \text{s.t.} \quad & \sum_{c \in C} \big(\mathbf{p}^{i,c}\big)'\mathbf{x}^c \leq w^i. \end{aligned}$$

From the above, formulate the following proposition, which characterises the collective household model using revealed preference theory:

Proposition 1. Consider a household demand function $\mathbf{d}$. If there exists a set of utility functions $(U^1, \cdots, U^m)$ that provides a collective rationalisation of $\mathbf{d}$, then the admissible individual demand functions $\left(\mathbf{d}^1, \cdots, \mathbf{d}^m\right) \in X(\mathbf{d})$ satisfy WARP.

This extends Proposition 1 in Cherchye et al. (2015) to m decision makers. A proof of Proposition 1 is presented in Appendix A.

3.2 Identification

Consider a household demand function $\mathbf{d}(\mathbf{p}_O, w_O)$ in situation O characterised by prices $\mathbf{p}_O$ and household income w_O. The goal is to identify bounds on the individual income shares w_O^i that satisfy a collective rationalisation of the observed household demand $\mathbf{d}$. These bounds then provide an indication of how household income is distributed among decision makers within the household. Lower and upper bounds are defined as follows:

$$w_O^{li} < w_O^i < w_O^{ui} \tag{5}$$

where w_O^{li} is the lower bound and w_O^{ui} is the upper bound for household decision maker $i \in M$ and applies to all possible specifications of admissible demand functions.

Supposing that the upper bounds are known, the corresponding lower bounds are then defined as:

$$w_O^{li} = w_O - \sum_{j=1, j \neq i}^{m} w_O^{uj} \quad i \in M. \tag{6}$$

Minimising the difference between the upper and lower bounds $(w_O^{ui} - w_O^{li})$ for each household decision maker i will result in the tightest bounds on the individual income share. Substituting the right hand side of (6) into this difference results in

$$\sum_{i \in M} w_O^{ui} - w_O,$$

which defines the objective function for household decision maker i's individual income share. Since w_O is a constant, we can ignore it in the subsequent optimisation programme. In order to implement the optimisation programme, an expression for w_O^{ui} is required. From Definition 2 it follows that:

$$w_O^i < \left[\sum_{c \in C} (\mathbf{p}_O^{i,c})' \mathbf{x}_i^c | \mathbf{x}_i \succ^i \mathbf{x}_O \right], \tag{7}$$

where the right hand side of (7) provides the upper bound for w_O^i.

As alluded to in Section 3.1, individual demand functions are generally unobserved. This empirical disadvantage is somewhat mitigated by the theoretical result that these individual demands must be admissible. Letting $w_O = \mathbf{d}(\mathbf{p}, w) = \sum_{i \in M} \mathbf{d}^i \left(\mathbf{p}_O^{i,1}, \cdots, \mathbf{p}_O^{i,m}, \mathbf{p}_O^{i,H}, w_O^i \right)$, a necessary condition for the admissibility of the demand function $\mathbf{d}^i$ is:

$$w_O^i \leq \inf_{\mathbf{x}^1, \cdots, \mathbf{x}^m, \mathbf{x}^H} w_O^{ui} \tag{8}$$

where w_O^i is less than or equal to the greatest lower bound of the respective share of income evaluated at the respective Lindahl prices under the condition that the chosen consumption bundle ($\mathbf{x}_i$) is revealed preferred to $\mathbf{x}_O$.[8]

The optimisation programme takes the following form:

$$\sup_{\mathbf{d}^i \in X(\mathbf{d})} \quad \inf_{\mathbf{x}_i^1, \cdots, \mathbf{x}_i^m, \mathbf{x}_i^H} \quad \sum_{i \in M} w_O^{ui} \tag{9}$$

$$\text{s.t.} \qquad w_O^{ui} = \sum_{c \in C} (\mathbf{p}_O^{i,c})' \mathbf{x}_i^c, \tag{9a}$$

$$\mathbf{x}_i \succ^i \mathbf{x}_O \tag{9b}$$

$$\text{where} \qquad i \in M, \quad c \in C.$$

The supremum operator guarantees that the tightest bound (given by the infimum operator) is valid for all $\mathbf{d}^i$. In the case where the solution to (9) does not exceed w_O, the collective household model is rejected for $\mathbf{d}$, i.e. no income shares w_O^i can be specified that satisfy (8).

Although it is theoretically possible to construct bounds by enumerating every

[8]The infimum operator selects the lowest upper bound w_O^{ui}, which may include w_O^i.

element of $X(\mathbf{d})$ and evaluating the entire set of sharing rules consistent with each of the elements of $X(\mathbf{d})$, such an exercise is intractable. As a result, a different approach is required and forms the basis for Proposition 2 below, which extends Proposition 2 in Cherchye et al. (2015) from two to m decision makers.[9].

Proposition 2. Let $\mathbf{d}$ be a household demand function. If, for all $j \in M$, $\mathbf{x}_j = \mathbf{d}(\mathbf{p}_j, w_j)$ such that

$$w_j \geq \mathbf{p}_j' \left(\mathbf{x}_O + \sum_{\substack{k \in M \\ k \neq j}} \mathbf{x}_k \right),$$

then $\mathbf{x}_j \succ^{l_j} \mathbf{x}_O$ for all admissible individual demand functions $(\mathbf{d}^1, \cdots, \mathbf{d}^m) \in X(\mathbf{d})$ that satisfy WARP such that for all $i, j, l_i, l_j \in M$, if $\mathbf{x}_j \succ^{l_j} \mathbf{x}_O$ and $\mathbf{x}_i \succ^{l_i} \mathbf{x}_O$ with $i \neq j$, then $l_i \neq l_j$.

The upper bounds can be computed with the following modified optimisation programme:

$$\min_{\mathbf{p}_i, w_i} \sum_{i \in M} w_O^{ui} \tag{10}$$

$$\text{s.t.} \qquad w_O^{ui} = \mathbf{p}_O' \mathbf{x}_i, \tag{10a}$$

$$w_i \geq \mathbf{p}_i' \left(\mathbf{x}_O + \sum_{\substack{j \in M \\ j \neq i}} \mathbf{x}_j \right) \tag{10b}$$

$$\mathbf{x}_i = \mathbf{d}(\mathbf{p}_i, w_i). \tag{10c}$$

Similarly to (9), $\mathbf{x}_i$ is chosen according to (10c) to minimise the sum of the upper bounds. By Walras' Law $w_i = \mathbf{p}_i' \big(\sum_{i \in M} \mathbf{x}_i \big)$ and invoking Proposition 2, constraint (10b) implies $\mathbf{x}_i \succ^i \mathbf{x}_O$ (or $\mathbf{x}_i \succ^j \mathbf{x}_O$ with $i \neq j$). Without loss of generality, $\mathbf{x}_i \succ^i \mathbf{x}_O$ is assumed and

[9]See Appendix A for a proof.

$$w_O^i < \sum_{c \in C} (\mathbf{p}_O^{i,c})' \mathbf{x}_i^c, \tag{11}$$

following (7). For any $\mathbf{p}_O^{i,c}$ and $\mathbf{x}_i^c$

$$\sum_{c \in C} (\mathbf{p}_O^{i,c})' \mathbf{x}_i^c \leq \mathbf{p}_O' \mathbf{x}_i \tag{12}$$

by construction. Due to (12), $\mathbf{p}_O^{i,c}$ and $\mathbf{x}_i^c$ need not be specified. The upper bound $w_O^{ui} = \mathbf{p}_O' \mathbf{x}_i$ can be used instead. Along with the fact that different specifications of the individual demand functions $\mathbf{d}^i$ need not be considered in optimisation programme (10), this provides empirical tractability.

Many data sources contain information which allows the assignment of consumption to a specific household decision maker. For example, female hygiene products may be reliably assigned to female household decision makers' consumption. Furthermore, consumption of certain goods can reasonably seen as exclusive to a particular household decision maker. As in Cherchye et al. (2015), leisure is assumed to be consumed only be the household decision maker to which it accrues, since at least one good must be assignable to each decision maker to derive sufficiently tight bounds on the sharing rule. In addition, assignable or exclusive goods may not be associated with any externalities within the household and, therefore, do not enter the utility functions of other household decision makers.

Private goods without externalities Let N_P be the subset of goods without externalities and let N_E be the subset of other goods such that $N = N_P \cup N_E$ with $N_P \cap N_E = \emptyset$. For any $n \in N_P$ the following condition enters the set of collective rationalisation conditions from Definition 4:

$$\left(\mathbf{p}^{i,c}\right)_n = 0 \quad \left[\text{or} \quad \left(\mathbf{p}^{i,i}\right)_n = (\mathbf{p})_n\right] \quad \text{for every} \quad n \in N_P \quad \text{and} \quad i, c \in M, \quad c \neq i.^{10} \tag{13}$$

With no externalities from the consumption of good n, household decision maker i's willingness to pay for decision maker j's consumption of that good is zero. This

[10] The subscript n denotes the n^{th} entry of the respective vector.

condition stems from the definition of $\mathbf{p}^{i,c}$ in (4). The minimisation programme (10) can now be written as:

$$\min_{\mathbf{p}_i, w_i} \sum_{i \in M} w_O^{ui} \tag{14}$$

$$\text{s.t.} \qquad w_O^{ui} = \sum_{n \in N_P} (\mathbf{p}_O)_n \big(\mathbf{x}_i^i\big)_n + \sum_{n \in N_E} (\mathbf{p}_O)_n (\mathbf{x}_i)_n, \tag{14a}$$

$$w_i \geq \mathbf{p}_i' \left(\mathbf{x}_O + \sum_{\substack{j \in M \\ j \neq i}} \mathbf{x}_j \right) \tag{14b}$$

$$(\mathbf{x}_i)_n = \sum_{\substack{i \in M \\ n \in N_P}} \big(\mathbf{x}_i^i\big)_n, \tag{14c}$$

$$\mathbf{x}_i = \mathbf{d}(\mathbf{p}_i, w_i).$$

As before, (14b) implies $\mathbf{x}_i \succ^i \mathbf{x}_O$ and condition (13) obtains.

Now, if $n \in N_P$,

$$\begin{aligned} \big(\mathbf{p}_O^{i,i}\big)_n \big(\mathbf{x}_i^i\big)_n &= (\mathbf{p}_O)_n \big(\mathbf{x}_i^i\big)_n \quad \text{and} \\ \big(\mathbf{p}_O^{i,c}\big)_n \big(\mathbf{x}_i^i\big)_n &= 0 \quad (c \neq i), \end{aligned}$$

and if $n \in N_E$,

$$\sum_{c \in C} \big(\mathbf{p}_O^{i,c}\big)_n' (\mathbf{x}_i^c)_n \leq (\mathbf{p}_O)_n (\mathbf{x}_i)_n.$$

With

$$\sum_{c \in C} \big(\mathbf{p}_O^{i,c}\big)' \mathbf{x}_i^c \leq \sum_{n \in N_P} (\mathbf{p}_O)_n \big(\mathbf{x}_i^i\big)_n + \sum_{n \in N_E} (\mathbf{p}_O)_n (\mathbf{x}_i)_n$$

providing (14a) versus (10a) previously. The privately consumed quantities $(\mathbf{x}_i^i)_n$ for $n \in N_P$ are only defined within programme (14) subject to (14c).

Exclusivity Let $N_{P_i} \subseteq N_P$ be the set of goods that are exclusive to decision maker i. Then, if $n \in N_{P_i}$

$$\left(\mathbf{x}_k^i\right)_n = (\mathbf{x}_k)_n$$

which extends Proposition 2 above and in Cherchye et al. (2015) from two to m decision makers as follows:

Proposition 3. Let $\mathbf{d}$ be a household demand function. If, for all $j \in M$, $\mathbf{x}_j = \mathbf{d}(\mathbf{p}_j, w_j)$ such that either

$$\begin{gathered} w_j \geq \mathbf{p}_j' \left(\mathbf{x}_O + \sum_{k=1, k\neq j}^{m} \mathbf{x}_k \right) \qquad \text{and} \\ \sum_{\substack{n \in N_{P_k} \\ k \neq j}} (\mathbf{p}_k)_n (\mathbf{x}_k)_n \geq \mathbf{p}_k' \mathbf{x} - \sum_{\substack{n \in N_{P_j} \\ j \neq k}} (\mathbf{p}_k)_n (\mathbf{x})_n \\ \text{for} \quad \mathbf{x} = \mathbf{x}_O, \mathbf{x}_j \quad (j \in M, j \neq k) \end{gathered} \tag{15}$$

or

$$\begin{gathered} \sum_{\substack{n \in N_{P_j} \\ j \neq k}} (\mathbf{p}_j)_n (\mathbf{x}_j)_n \geq \mathbf{p}_j' \mathbf{x}_O - \sum_{\substack{n \in N_{P_k} \\ k \neq j}} (\mathbf{p}_j)_n (\mathbf{x}_O)_n \\ \text{for} \quad j, k \in M \quad (j \neq k) \end{gathered} \tag{16}$$

hold, then $\mathbf{x}_j \succ^{l_j} \mathbf{x}_O$ for all admissible individual demand functions $\left(\mathbf{d}^1, \cdots, \mathbf{d}^m\right) \in X(\mathbf{d})$ that satisfy WARP such that for all $i, j, l_i, l_j \in M$, if $\mathbf{x}_j \succ^{l_j} \mathbf{x}_O$ and $\mathbf{x}_i \succ^{l_i} \mathbf{x}_O$ with $i \neq j$, then $l_i \neq l_j$.

From this proposition, additional conditions (15) and (16) are added to optimisation programme (14) for deriving the sharing rule bounds in the empirical application, replacing condition (14b). This is the extension of Proposition 3 in Cherchye et al. (2015) from two to m decision makers and the proof can be found in Appendix A.

3.3 The Quadratic Almost Ideal Demand System (QUAIDS)

The calculation of individual income shares from leisure, food, housing, and non-food consumption using the approach in Section 3.1 requires the estimation of household level demands. Similarly to Cherchye et al. (2015), these demands are estimated using the *Quadratic Almost Ideal Demand System* (QUAIDS) as presented in Banks et al. (1997), which incorporates the potentially nonlinear nature of demand as income increases. Demands are estimated with so-called *tasteshifters*[11] as well as imposing the SRk restriction from Browning and Chiappori (1998) in order to be compatible with the collective household framework. This condition states that for household demand function $\mathbf{g}$ to be consistent with the collective household model the resulting pseudo-Slutsky matrix can be decomposed into the sum of a symmetric, negative semi-definite matrix Σ and a matrix $\mathbf{R}$ with rank equal to the number of decision-makers minus one.

The QUAIDS is based on the indirect utility function:

$$\ln V(\mathbf{p}, m) = \left[\left\{ \frac{\ln m - \ln a(\mathbf{p})}{b(\mathbf{p})} \right\}^{-1} + \lambda(\mathbf{p}) \right], \tag{17}$$

which, by Roy's identity, provides the budget shares:

$$w_c = \alpha_c + \beta_c \ln\left(\frac{y}{a(\mathbf{p})}\right) + \frac{\lambda_c}{b(\mathbf{p})} \left\{ \ln\left(\frac{y}{a(\mathbf{p})}\right) \right\}^2 + \sum_{d \in C} \gamma_{cd} \ln p_d \quad (c \neq d) \tag{18}$$

[11] In the two decision maker case, the tasteshifters are age of the oldest decision maker and a dummy for homeownership, whereas in the three decision maker case the age of the second oldest decision maker is added.

where p_d is the d^{th} element of $\mathbf{p}$. In addition:

$$\ln a(\mathbf{p}) = \alpha_0 + \sum_{c\in C} \alpha_c \ln p_c + \frac{1}{2}\sum_{c\in C}\sum_{d\in C} \gamma_{cd} \ln p_c \ln p_d \tag{18a}$$

$$b(\mathbf{p}) = \prod_{c\in C} p_c^{\beta_c} \tag{18b}$$

$$\lambda(\mathbf{p}) = \sum_{c\in C} \lambda_c \ln p_c \tag{18c}$$

$$\alpha_c = \alpha_{c,0} + \alpha_{c,1} t_1 + \alpha_{c,2} t_2 \tag{18d}$$

As described in Banks et al. (1997), (18a) is a price index and (18b) a Cobb-Douglas price aggregator. (18c) is a differentiable, homogeneous function of degree zero in prices, which, when independent of prices (i.e. when $\lambda_c = 0\ \forall c$), reduces the system to original the AIDS model (Deaton and Muellbauer, 1980). (18d) implements taste shifters to account for observable heterogeneity. The budget shares w of the commodities c are derived by estimating α_c, β_c, λ_c, and γ_{cd} $(\forall c, d)$, with $\sum_c \alpha_c = 1$, $\sum_c \beta_c = 0$, and $\sum_c \gamma_{cd} = 0$ $(\forall d)$. Homogeneity of demand is imposed by requiring $\sum_d \gamma_{cd} = 0$ $(\forall c)$ and the whole system is estimated in terms of deflated prices and full income y.

As alluded to above, the so-called SRk condition is imposed, with $k = m - 1$ when the model is extended to finite m household members (Browning and Chiappori, 1998). This condition is necessary for consistency of the demand function $\mathbf{g}$ with the collective model (see Browning and Chiappori (1998)). In the collective model with m decision makers, the pseudo-Slutsky matrix $\mathbf{S} = \frac{\partial \mathbf{g}(\mathbf{p},y)}{\partial \mathbf{p}'} + \frac{\partial \mathbf{g}(\mathbf{p},y)}{\partial y}\mathbf{g}(\mathbf{p}, y)'$ can be decomposed into the sum of a symmetric negative semi-definite matrix and a matrix of rank no greater than $m - 1$ (see Proposition 5 in Browning and Chiappori (1998)). In the QUAIDS model, this holds if and only if the same composition applies to the matrix $\Gamma = (\gamma_{cd})$. This requires the rank of the antisymmetric matrix $\mathbf{L} = \Gamma - \Gamma'$ to be at most m. Lemma 3 of Browning and Chiappori (1998), letting l_{ik} denote an element of $\mathbf{L}$ and assuming without loss of generality that $l_{12} \neq 0$, shows that the rank condition holds if and only if for all (i, k) such that $k > i > 2$:

$$l_{ik} = \frac{l_{1i}l_{2k} - l_{1k}l_{2i}}{l_{12}} \quad (19)$$

The system is estimated by means of non-linear least squares under the assumption of additive errors. The estimate of the quantity of a particular good is then found by multiplying its estimated budget share by full income divided by the commodity's own price.

4 Data

The data for the analysis come from the National Income Dynamics Study (NIDS), South Africa's first nationally representative household panel survey. Starting in 2008, the study has collected five waves of data from an initial starting sample of around 28,000 individuals and 7,300 households (Southern Africa Labour and Development Research Unit, 2018). The current data set contains over 189,000 individual observations over five waves.

Table 1: Summary statistics

Variable	Sample	Mean	Median	SD	Min	Max	N
Age (years)	Full	44.88	43.00	15.80	15	113	34,917
	Sharing rule	51.73	51.00	16.04	15	113	12,656
	Estimation	50.29	47.00	16.89	15	108	4,725
Black African	Full	0.89	1.00	0.32	0	1	34,916
	Sharing rule	0.86	1.00	0.35	0	1	12,656
	Estimation	1.00	1.00	0.00	1	1	4,725
Coloured	Full	0.07	0.00	0.26	0	1	34,916
	Sharing rule	0.10	0.00	0.30	0	1	12,656
	Estimation	0.00	0.00	0.00	0	0	4,725
Indian/Asian	Full	0.01	0.00	0.10	0	1	34,916
	Sharing rule	0.01	0.00	0.11	0	1	12,656
	Estimation	0.00	0.00	0.00	0	0	4,725
White	Full	0.03	0.00	0.17	0	1	34,916
	Sharing rule	0.03	0.00	0.17	0	1	12,656
	Estimation	0.00	0.00	0.00	0	0	4,725
Female	Full	0.48	0.00	0.50	0	1	34,912
	Sharing rule	0.54	1.00	0.50	0	1	12,655
	Estimation	0.53	1.00	0.50	0	1	4,725
Pension recipient	Full	0.16	0.00	0.37	0	1	34,366
	Sharing rule	0.33	0.00	0.47	0	1	12,371
	Estimation	0.33	0.00	0.47	0	1	4,725
Less than primary school	Full	0.30	0.00	0.46	0	1	34,785

Table 1: Summary Statistics *(continued)*

Variable	Sample	Mean	Median	SD	Min	Max	N
	Sharing rule	0.41	0.00	0.49	0	1	12,625
	Estimation	0.40	0.00	0.49	0	1	4,725
Primary school	Full	0.56	1.00	0.50	0	1	34,785
	Sharing rule	0.50	1.00	0.50	0	1	12,625
	Estimation	0.50	0.00	0.50	0	1	4,725
High school and above	Full	0.14	0.00	0.35	0	1	34,785
	Sharing rule	0.09	0.00	0.29	0	1	12,625
	Estimation	0.10	0.00	0.30	0	1	4,725
Married/Civil union	Full	0.34	0.00	0.47	0	1	17,063
	Sharing rule	0.51	1.00	0.50	0	1	6,457
	Estimation	0.51	1.00	0.50	0	1	2,358
Urban area	Full	0.06	0.00	0.23	0	1	34,917
	Sharing rule	0.06	0.00	0.24	0	1	12,656
	Estimation	0.05	0.00	0.23	0	1	4,725
Homeowner	Full	0.62	1.00	0.48	0	1	34,850
	Sharing rule	0.75	1.00	0.43	0	1	12,636
	Estimation	0.77	1.00	0.42	0	1	4,719
HH size	Full	3.30	3.00	2.54	1	39	34,917
	Sharing rule	4.64	4.00	2.19	2	19	12,656
	Estimation	3.93	4.00	1.51	2	8	4,725
Adults	Full	2.23	2.00	1.46	1	22	34,917
	Sharing rule	3.02	3.00	1.19	2	11	12,656
	Estimation	2.56	2.00	0.72	2	4	4,725
Children	Full	1.07	0.00	1.46	0	17	34,917
	Sharing rule	1.61	1.00	1.52	0	14	12,656
	Estimation	1.37	1.00	1.20	0	4	4,725
HH income (R)	Full	3,215.61	2,732.24	2,164.89	0	14,271	34,917
	Sharing rule	4,021.19	3,526.65	2,192.23	156	14,271	12,656
	Estimation	3,469.34	3,090.45	1,868.95	309	13,446	4,725
HH food expenses (R)	Full	839.79	709.80	657.35	4	23,465	34,619
	Sharing rule	951.74	821.11	636.18	9	17,882	12,564
	Estimation	854.56	768.34	532.64	9	6,261	4,691
HH non-food expenses (R)	Full	1,401.24	702.17	3,321.01	0	139,842	34,619
	Sharing rule	1,469.95	853.78	2,933.26	0	139,842	12,564
	Estimation	1,319.63	732.51	3,537.98	0	139,842	4,691
HH housing expenses (R)	Full	641.13	385.61	847.67	1	12,860	34,715
	Sharing rule	644.28	391.54	805.04	2	11,299	12,595
	Estimation	526.06	350.44	615.57	2	11,299	4,705
Individual income (R)	Full	2,137.75	1,465.20	1,755.55	1	19,695	29,231
	Sharing rule	1,775.70	1,234.57	1,310.31	4	12,302	12,656
	Estimation	1,570.85	1,226.99	1,064.39	47	9,256	4,725
Pension income (R)	Full	1,184.42	1,213.35	101.48	1	1,341	9,143
	Sharing rule	1,187.77	1,213.35	92.83	117	1,341	5,263
	Estimation	1,189.75	1,209.78	78.72	117	1,273	1,979
Hours worked p/w	Full	40.70	40.00	18.40	1	112	15,324
	Sharing rule	40.92	40.00	18.36	1	112	5,580

Table 1: Summary Statistics *(continued)*

Variable	Sample	Mean	Median	SD	Min	Max	N
	Estimation	41.94	40.00	18.29	1	112	2,135
Wage (R/h)	Full	19.86	12.65	28.99	0	901	15,187
	Sharing rule	16.00	10.59	22.92	0	443	5,580
	Estimation	13.08	8.90	22.13	1	443	2,135
Labour force participation	Full	0.64	1.00	0.48	0	1	33,426
	Sharing rule	0.57	1.00	0.50	0	1	12,249
	Estimation	0.60	1.00	0.49	0	1	4,582
Employed	Full	0.51	1.00	0.50	0	1	33,426
	Sharing rule	0.49	0.00	0.50	0	1	12,249
	Estimation	0.51	1.00	0.50	0	1	4,582
Unemployed	Full	0.20	0.00	0.40	0	1	17,951
	Sharing rule	0.13	0.00	0.34	0	1	6,057
	Estimation	0.14	0.00	0.35	0	1	2,353

Notes: Summary statistics shown for the full data set, the subset for the sharing rule calculation, and the sample for the estimation of the effect of an income shock on the sharing rule. Statistics shown for the decision maker in the household with the highest centred age (age in years minus pension eligibility age). All income and expenditure variables are in South African Rand (R) per month, and have been corrected for inflation. On the 24th of April 2021, one Euro was equal to R17, one Swiss Franc was equal to R16, and one US dollar was equal to R14. All statistics weighted to account for survey design.

This rich data includes information on individual household decision makers' individual and household income, hours worked, as well as a large set of individual and household characteristics. Table 1 presents descriptive statistics for the three samples described in the following. In order to provide a comparison from the full data set to the sample used for calculating the sharing rule and the sample for estimating the effect of pension receipt on the sharing rule, the descriptive statistics are shown for the decision maker with the highest centred age (age in years minus pension eligibility age). This is the "full" sample. The empirical application uses a subset of the data for which all variables are available to derive sharing rule bounds, as well as only considering those observations that satisfy the income eligibility threshold for pension receipt. This is the "sharing rule" sample. In estimating the effect of pension receipt on the sharing rule bounds, the sample is restricted to households with at most one pension recipient to prevent confounding of the effect. In addition, the sample is restricted to households with a minimum of two and a maximum of four adults and at most four children. Observations for which the absolute difference between the upper and lower sharing rule bound is greater than 2.5 percentage points, as well as with survey weights above the 99.5th percentile are discarded.[12] This is the "estimation" sample. Table B.1 shows the same descriptive statistics for the other decision makers in the household.

For the Quadratic Almost Ideal Demand System (QUAIDS) and Sharing Rule analysis the focus is primarily on the wage rate (i.e. the price of leisure), expenditures on food, housing, and other non-food consumption. Due to the fact that prices for the these goods are not readily available, some additional steps are taken to calculate these. Individual wage rates are calculated by dividing individual-specific income by hours worked. In some cases the sum of hours worked is unrealistic and for this reason, the working week is capped at 112 hours.[13] To increase the power in the sample, individuals with income and no recorded hours are assigned the median number of weekly hours worked in the sample. The prices for food, housing, and non-food consumption come from the official South African Consumer Price Indices (CPI) from Statistics South Africa (Statistics South Africa, 2018). Specifically, the price of food is the CPI for *Food and non-alcoholic beverages*, the price for housing is the CPI for *Owner's equivalent rent*, and the price of non-food consumption is the CPI for *Miscellaneous goods and services.* The CPI distinguishes between rural and urban regions, however, the distinction is only available from January 2013 and for food and non-food consumption. The prices for rural observations are then those for the whole country up until December 2012 and specifically for rural areas from January 2013 onward, where available. For the urban observations the prices are for urban areas for the entire period. The quantities consumed of these goods per household are then the expenditures divided by the prices from the CPI.

As mentioned in Section 2, pension receipt is very high amongst Black Africans, who also make up the vast majority of South Africa's population. Thus, as is customary in much of the literature on the Older Persons Grant, this analysis focuses on Black Africans.

[12]Less restrictive criteria result in qualitatively similar results, however at the cost of noisier estimates. In addition, one would expect the effect of pension receipt to be decreasing in the number of household members until indistinguishable from zero. Even after imposing the above restrictions, the resulting estimation sample is still very similar to the full sample along most dimensions.

[13]A week has 168 hours and, as is customary in the literature, subtracting 8 hours per day for sleep and/or rest leaves a maximum of 112 hours available for work and/or leisure per week.

5 Empirical Methodology

This section first presents the empirical approach to deriving bounds on the sharing rule, which depend on the estimation of demands using the QUAIDS framework. Subsequently, the identification strategy for the effect of pension receipt on the sharing rule and other outcomes is described.

5.1 Sharing Rule Calculation

The sharing rule for both two and three decision maker households is calculated within a constrained optimisation framework. The objective function maximises the sum of the upper bounds for the income shares subject to the constraints explained above. The upper and lower bounds are computed using R (Core R Team, 2019) and the nonlinear optimisation suite *nloptr* (Ypma, 2014), which is the R implementation of the open source *nlopt* nonlinear optimisation framework (Johnson, 2014). The code builds on that for the two household decision maker QUAIDS estimation and sharing rule calculation provided by Cherchye et al. (2015) in Matlab. The optimisation uses the *sequential least-squares quadratic programming* (SLSQP) algorithm (Kraft, 1988, 1994), which, in addition to inequality and equality constraints, requires the Jacobians of the objective and constraints. The algorithm starts with a vector of initial values for the parameters and searches for the optimal set of parameters along a grid. The objective function is then minimised with respect to the constraints specified in Programme (14).

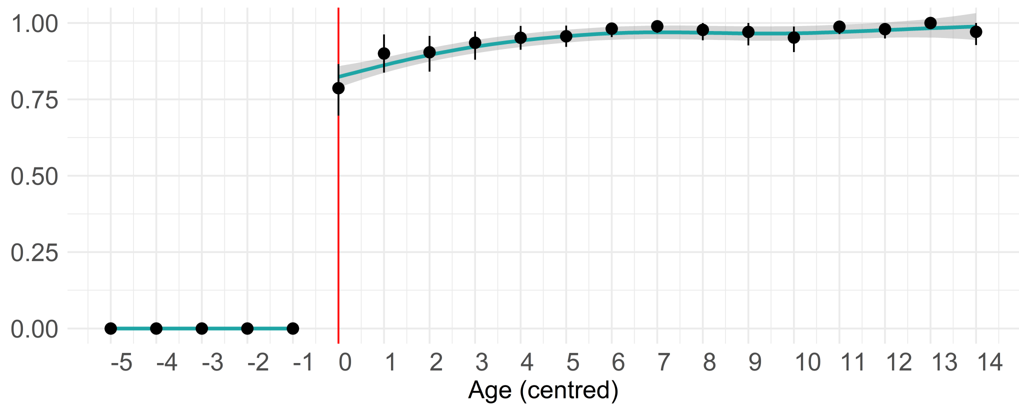
5.2 Effect of pension receipt on the sharing rule and other outcomes

This section presents the empirical approach to identifying the impact of a cash transfer on the sharing rule.

5.2.1 Fuzzy regression discontinuity design

This analysis is based on a fuzzy regression discontinuity design (FRD), in which there is a discrete change in the probability of receiving a treatment once a specific

Figure 1: Pension take-up



Notes: Pension take-up share is defined as the number of pensioners divided by the number of age- and income-eligible individuals. Centred age eligibility is the individual's age minus the age at which they become eligible for the pension.

threshold is crossed. Here, the treatment is receiving the pension and the threshold is reaching the eligibility age whilst meeting the means test requirements.

As mentioned in Section 2, pension take-up is not complete. As a result, the reduced form effect is scaled by the estimated change in the probability of treatment at the cut-off to arrive at the local average treatment effect on the treated (LATET). The probability of treatment is the share of eligible individuals who take up the pension at a given age-eligibility year. Eligibility, defined as being above the age cut-off, as well as total household income (earned and unearned) below an income eligibility threshold is a strong predictor for pension receipt and is the treatment indicator in (20) below. Only age eligibility and its interaction with centred age are used to determine the LATET at the cut-off.[14] Estimation is by way of two stage least squares (2SLS) and takes the following form:

[14]In order to avoid potential bias from individuals strategically reducing income just before pension age-eligibility, the estimation sample is restricted to individuals that satisfy this income means test both below and above the cut-off.

$$D_{idt} = \rho_0 + \phi_1 Z_i + \rho_1 X_i + \rho_2 X_i Z_i + C_i'\gamma + \delta_d + \lambda_t + u_{idt} \tag{20}$$

$$Y_{idt} = \beta_0 + \tau_1 \widehat{D}_i + \beta_1 X_i + \beta_2 X_i \widehat{D}_i + C_i'\kappa + \delta_d + \lambda_t + \varepsilon_{idt} \tag{21}$$

where subscript i denotes the individual, d the magisterial district of residence, and t the interview year. In (20), D_i is the indicator for pension receipt, Z_i is the indicator for age- and income-eligibility, and X_i is age in years minus pension-eligibility age, such that X_i is zero at pension-eligibility age for individual i. ϕ is the estimated pension take-up share. In (21), τ is the LATET, and both estimation equations include managerial district (δ) and interview year (λ) fixed effects, while standard errors are clustered at the managerial district level. C_i is a vector of pre-determined characteristics, which enter to increase the precision of the LATET estimates. u_{idt} and ε_{idt} are the respective idiosyncratic error terms. The interactions $X_i Z_i$ and $X_i \widehat{D}_i$ allow for different slopes either side of the cut-off.

As mentioned before, the probability of receiving the pension jumps discontinuously at age-eligibility year 0, with pension receipt increasing thereafter. Figure 1 provides visual confirmation and Table 2 provides regression estimates for this discontinuity in pension take-up.[15] The coefficient on the eligibility indicator is highly significant and indicates the share of pension recipients or *compliers* in the estimation sample.

5.2.2 Identification

The key identifying assumption in the FRD design is that observed units are, except for treatment status, essentially identical within a certain bandwidth either side of the eligibility threshold. The treatment is then, conditional on covariates, *as good as* randomly assigned (Lee and Lemieux, 2010).

The key threat to this assumption is manipulation of the running variable.

[15]Officially, it should not be possible to draw the pension before reaching the eligibility age, however, there is some evidence that this is indeed the case for a small number of individuals and Ambler (2016) shows that this is more so the case for men than for women. Due to the fact that the estimation sample satisfies income-eligibility by construction, pension take-up for these individuals cannot be proxied by age-eligibility and, therefore, they are excluded from the analysis.

Table 2: First stage results (Pension receipt)

	Pension receipt	Pension receipt	Pension receipt	Pension receipt	Pension receipt	Pension receipt
Eligibility	0.757***	0.786***	0.758***	0.785***	0.758***	0.789***
	(0.074)	(0.052)	(0.062)	(0.042)	(0.063)	(0.043)
Eligibility * Age (centred)		0.022		0.022		0.024
		(0.022)		(0.023)		(0.023)
Bandwidth	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)
Clustered SE	District	District	District	District	District	District
Year & District FE	No	No	Yes	Yes	Yes	Yes
Controls	No	No	No	No	Yes	Yes
N	718	718	718	718	718	718
First stage F-stat	103.56	216.22	149.82	238.15	142.92	234.51

Notes: ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$, ': $p < 0.1$. Standard errors in parentheses. The first stage F-statistic is the Kleibergen Paap Wald F-stat for joint instrument relevance. Additional controls are gender and a dummy for less than primary school education. All models include weights to account for survey design.

Specifically, if observed units are able to sort below or above the cut-off in order to manipulate treatment status, this is no longer randomly assigned. A complete absence of manipulation of the running variable is not required for a valid FRD design, rather the manipulation should not be *perfect* (Lee, 2008; Lee and Lemieux, 2010). McCrary (2008) develops a test for manipulation of the running variable, however, this has some undesirable properties if the running variable is discrete (Frandsen, 2017). In order to test whether there is a discontinuity in the density of the running variable in this study, the procedure developed in the *rddensity* package in R (Cattaneo et al., 2019, 2018, 2021, 2020) is used. Figure B.1 presents the density plot for the full data set restricted along various dimensions to ensure comparability with the estimation sample. The test statistic fails to reject the null of no discontinuity in the age density at the cut-off.

A further check for local randomisation is whether predetermined covariates are balanced below and above the cut-off, since these characteristics should not differ depending on treatment status. Table B.2 presents regression estimates and Figure B.2 presents visual evidence for the effect of crossing the age-eligibility threshold on a set of covariates. For the covariates used in the analysis (gender and the dummy for less than primary school education), there is no indication of significant differences in these characteristics below and above the age-eligibility cut-off. Although these may be influenced by pension receipt, additional covariates such as household size, number of adults and children in the household, marital status, and homeownership status are presented for completeness.

An identification concern arises in the FRD setting where age (or some function thereof) is the running variable: inevitable treatment. In short, if potential treatment status is inevitable, as is often the case with age-related policies, the estimated effect may be biased. In the case of pension receipt, for example, individuals know that they will (hopefully) reach the pension eligibility age at some stage. Pension receipt is, therefore, not exogenous and most individuals include this fact in their calculus of current and future consumption and savings behaviour. This would invalidate the current analysis if not for the fact that the individuals being studied here are highly credit and liquidity constrained Berg (2013). As a result, even though pension receipt is well-anticipated, individuals cannot easily shift (monetary) resources across time periods through common means such as saving and taking on debt. Thus, pension receipt can be seen as akin to an exogenous income shock, which results in an *as good as randomly* assigned treatment.

6 Results

This section presents the empirical results for the impact of a cash transfer on intra-household bargaining power. First, the sharing rule calculations for the two and three decision maker cases using the methodology introduced in Sections 3 and 3.3 are presented. Second, the impact of the cash transfer on the sharing rule and potential heterogeneity in the effect is analysed using the FRD framework described in Section 5.2.1. Finally, changes in labour market outcomes are investigated as possible mechanisms through which changes in the sharing rule materialise.

6.1 Sharing rule results

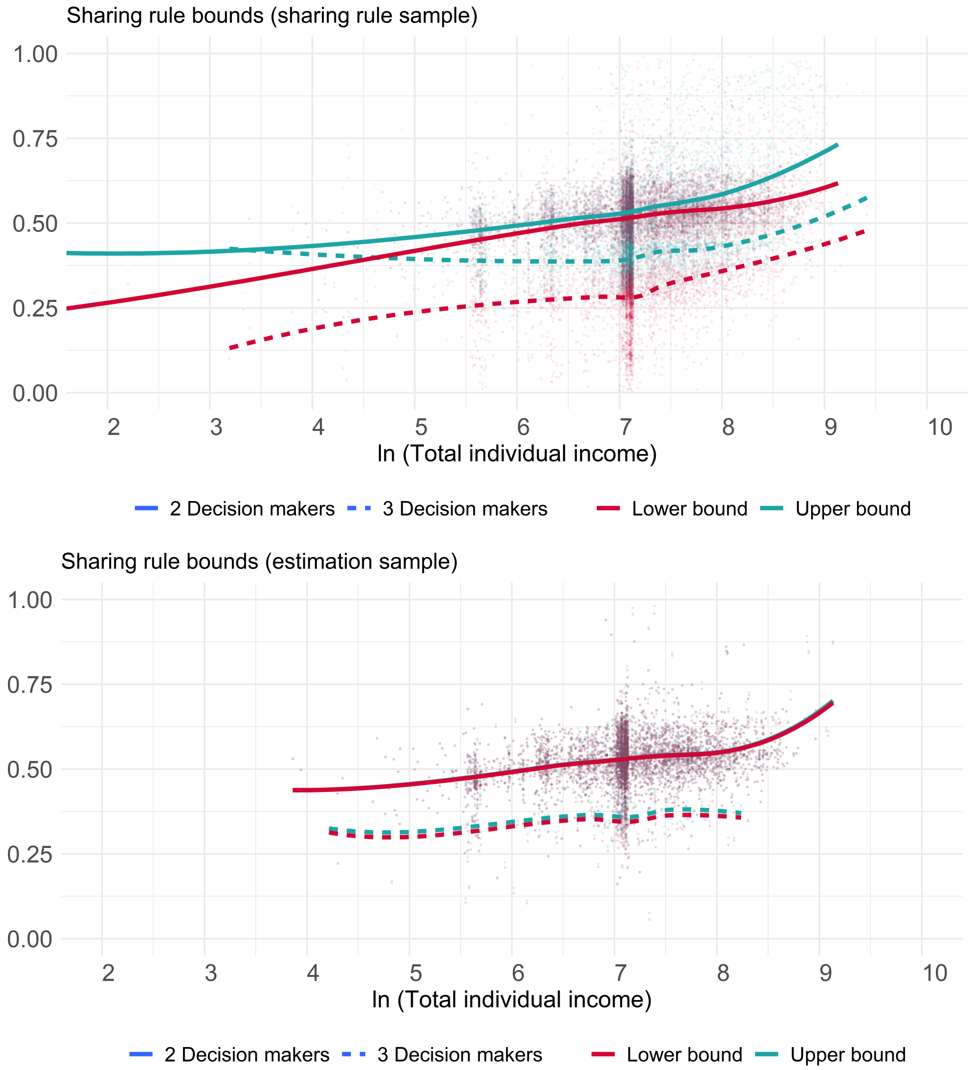
Table 3 presents a summary of the sharing rule results as calculated with the methodology presented in Section 5. The *trivial lower bound* constitutes a decision maker's own leisure consumption as a share of household full income, i.e. the decision maker does not consume any other goods. In contrast, the *trivial upper bound* is a decision maker's own leisure consumption and the entire household consumption minus the leisure consumption of the other household decision makers as a share of full income. Ideally, the *best* bounds are tighter than the

Table 3: Sharing rule results summary

	Upper bound					Lower bound					Upper - Lower		
Sharing rule bound	Mean	Median	SD	Min	Max	Mean	Median	SD	Min	Max	Estimate	SE	N
2 Decision makers													
Sharing rule													
Best	0.547	0.533	0.103	0.051	0.995	0.518	0.525	0.093	0.006	0.980	0.029	0.002	9,178
Trivial	0.712	0.704	0.124	0.303	1.000	0.343	0.335	0.126	0.000	0.766	0.369	0.003	9,178
Estimation													
Best	0.528	0.529	0.073	0.076	0.980	0.527	0.528	0.073	0.057	0.958	0.001	0.002	4,540
Trivial	0.697	0.691	0.094	0.328	1.000	0.325	0.322	0.096	0.000	0.766	0.372	0.003	4,540
Estimation (5 yr. bw.)													
Best	0.535	0.531	0.077	0.150	0.980	0.534	0.530	0.077	0.135	0.958	0.001	0.006	688
Trivial	0.698	0.696	0.085	0.375	0.997	0.335	0.331	0.088	0.017	0.692	0.364	0.006	688
3 Decision makers													
Sharing rule													
Best	0.407	0.406	0.071	0.238	0.960	0.302	0.314	0.096	0.004	0.725	0.105	0.003	3,478
Trivial	0.590	0.592	0.113	0.240	0.960	0.240	0.234	0.112	0.002	0.725	0.350	0.005	3,478
Estimation													
Best	0.361	0.365	0.043	0.241	0.530	0.347	0.346	0.043	0.227	0.513	0.014	0.006	185
Trivial	0.572	0.572	0.071	0.359	0.725	0.217	0.219	0.074	0.026	0.370	0.354	0.010	185
Estimation (5 yr. bw.)													
Best	0.375	0.371	0.038	0.287	0.436	0.363	0.367	0.038	0.267	0.419	0.012	0.016	30
Trivial	0.594	0.579	0.060	0.395	0.724	0.261	0.263	0.061	0.069	0.370	0.333	0.019	30

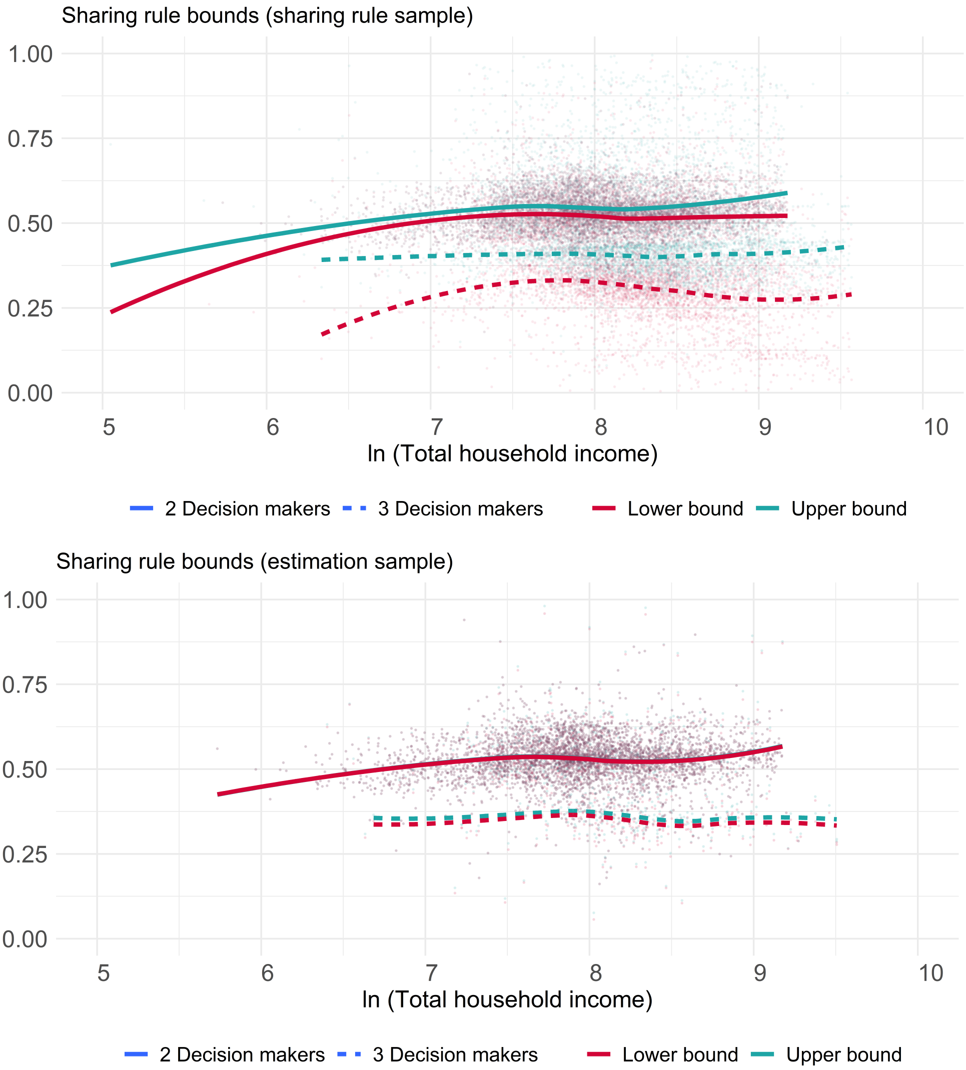
Notes: Summary statistics for the sharing rule of the household decision maker with the highest centred age (i.e. age in years minus pension eligibility age) for the full sharing rule sample, the estimation sample, and the estimation sample restricted to a bandwidth of five years around the age-eligiblity cutoff (i.e. the preferred specification sample). The trivial lower bound is this decision maker's assignable consumption (i.e. leisure) as a share of full income. The trivial upper bound is total household consumption minus the other household decision makers' leisure consumption as a share of full income. All statistics weighted to account for survey design.

Figure 2: Sharing rule and individual income



Notes: This figure shows the upper and lower sharing rule bounds (mint and red, respectively) for decision makers with the highest centred age (age in years minus pension eligibility age) in the household. The fitted lines are loess smooths (corrected for survey weights) for two and three decision maker households (solid and dashed lines, respectively) over the natural logarithm of total individual income.

Figure 3: Sharing rule and household income



Notes: This figure shows the upper and lower sharing rule bounds (mint and red, respectively) for decision makers with the highest centred age (age in years minus pension eligibility age) in the household. The fitted lines are loess smooths (corrected for survey weights) for two and three decision maker households (solid and dashed lines, respectively) over the natural logarithm of total household income.

trivial bounds and provide a more informative proxy for relative intra-household bargaining power. We see an average best upper bound of 54.7% and 40.7% for individuals with the highest centred age in the sharing rule sample in two and three decision maker households, respectively. The corresponding average best lower bounds are 51.8% and 30.2%, respectively. Comparing the best bounds with the trivial bounds for the sharing rule sample, there is a marked improvement in the tightness of the bounds, with an average difference of around 2.9 and 10.5 percentage points compared to 36.9 and 35 percentage points for two and three decision makers in the sharing rule sample, respectively. The bounds become even tighter for the estimation sample, with essentially point estimates in the two decision maker case and a difference of 1.4 percentage points for the three decision maker case. The difference between the upper and lower best bounds is also relatively constant along the individual and household income distribution in the sharing rule sample, as Figures 2 and 3 show, with the bounds tighter where there are more observations. The estimation sample shows a similar pattern. The results are generally in agreement with those for the two decision maker case in Cherchye et al. (2015), where the authors find a similar positive relationship between individual income and sharing rule bounds and no relationship between sharing rule bounds and household income. Although the number of three decision maker households are relatively small in comparison with two decision maker households,[16] the results have a "proof of concept" quality, since the derivation of informatively tight bounds are shown to be empirically possible with more than two decision makers in a household.

6.2 Effect of pension receipt on the sharing rule

Table 4 presents the main FRD results for the effect of pension receipt on the sharing rule. These constitute the central results of this analysis. A graphical representation of the reduced form results is provided in Figure B.3. There is a significant, positive effect of pension receipt on the sharing rule for the estimation sample, with an increase of 4.2 and 4.3 percentage points for the upper and

[16]This is due to the criterion that for a three decision maker household all three decision makers must have data on earned and unearned income. In the current data set this is a rather small share of households.

Table 4: Main results (Sharing rule bounds)

	(1)		(2)		(3)	
	Upper	Lower	Upper	Lower	Upper	Lower
Pension receipt	0.047*	0.049*	0.043*	0.044*	0.042*	0.043*
	(0.025)	(0.026)	(0.025)	(0.026)	(0.025)	(0.025)
Bandwidth	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)
Clustered SE	District	District	District	District	District	District
Year & District FE	No	No	Yes	Yes	Yes	Yes
Controls	No	No	No	No	Yes	Yes
N	718	718	718	718	718	718
First stage F-stat	216.22	216.22	238.15	238.15	234.51	234.51

Notes: ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$, ': $p < 0.1$. Standard errors and p-values calculated with 1000 bootstrap replications. The estimated coefficient is the effect of pension receipt on the recipient's sharing rule bounds. Additional controls are gender and a dummy for less than primary school education. The first stage F-statistic is the Kleibergen Paap Wald F-stat for joint instrument relevance. All models include weights to account for survey design.

lower bounds, respectively. The results confirm the hypothesis that a plausibly exogenous increase in income results in an increase in bargaining power within the household, i.e. the recipient is able to assign a larger share of household resources to their preferred consumption bundle. The first stage F-statistics are all well above the rule of thumb value of 10, which suggests that crossing the age-eligibility threshold is strongly correlated with pension receipt. These results are from the preferred specification with a bandwidth of 5 years either side of the cut-off. The specification includes year and managerial district fixed effects, dummies for gender and less than primary school education as control variables, as well as standard errors clustered at the managerial district level to account for the sampling procedure. The following sections analyse the heterogeneity and potential drivers of these effects.

Table 5: Heterogeneity: Gender

	Female		Male	
	Upper	Lower	Upper	Lower
Pension receipt	0.077**	0.078**	−0.036	−0.035
	(0.033)	(0.034)	(0.035)	(0.036)
Bandwidth	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)
Clustered SE	District	District	District	District
Year & District FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
N	465	465	253	253
First stage F-stat	140.39	140.39	51.22	51.22

Notes: ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$, ’: $p < 0.1$. Standard errors and p-values calculated with 1000 bootstrap replications. The estimated coefficient is the effect of pension receipt on the pension recipient’s sharing rule bounds. The sample is split into female and male pension recipients. The first stage F-statistic is the Kleibergen Paap Wald F-stat for joint instrument relevance. All models include weights to account for survey design.

6.3 Effect heterogeneity

Since the literature on the pension has found that the gender of the recipient has an effect on the outcomes of other individuals (Duflo, 2003), it is useful to look at the whether the impact of the pension on the sharing rule differs depending on gender. Table 5 provides clear evidence that the sharing rule increases more for female than male pensioners. This suggests that bargaining power is already “priced in” for males and that females may significantly improve their bargaining position within the household by bringing additional income into the fold.

Looking at household composition, there is no clear evidence that the pension affects the sharing rule significantly more in households where children are present (Table B.3). The number of adults in the household also do not appear to drive any heterogeneity in the effect of pension receipt on the sharing rule (Table B.4).

The education level of a pension recipient may also be a source of heterogeneity, however, Table B.5 suggests there is no difference in the effect between recipients

Table 6: Effect of pension receipt on income

	Indiv. income	Indiv. income	Indiv. income	HH income	HH income	HH income
Pension receipt	0.544*	0.554'	0.539'	0.142	0.140	0.121
	(0.269)	(0.280)	(0.274)	(0.187)	(0.178)	(0.171)
Bandwidth	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)
Clustered SE	District	District	District	District	District	District
Year & District FE	No	Yes	Yes	No	Yes	Yes
Controls	No	No	Yes	No	No	Yes
N	718	718	718	718	718	718
First stage F-stat	216.22	238.15	234.51	216.22	238.15	234.51

Notes: ***: p < 0.001, **: p < 0.01, *: p < 0.05, ': p < 0.1. Standard errors in parentheses. The estimated coefficient is the effect of pension receipt on the natural logarithm of the pensioner's own income and household income, respectively. Additional controls are gender and a dummy for less than primary school education. The first stage F-statistic is the Kleibergen Paap Wald F-stat for joint instrument relevance. All models include weights to account for survey design.

with a primary school education and those without.

6.4 Effect of pension receipt on income and labour market outcomes

Since individual income, i.e. the price of leisure, is the only assignable good in deriving the sharing rule, relative changes in income are a key driver of changes in the sharing rule. This section presents results for the effect of pension receipt on income and additional labour market outcomes in order to uncover the magnitude of the changes in income and labour supply that drive the change in the sharing upon pension receipt.

Table 6 presents the FRD results with individual and household income as the dependent variables. The results suggest that individual income increases significantly by over 54% for pension recipients, whereas household income does not appear to be affected. Changes in income for recipients do not appear be dependent on gender, since although the coefficient for female recipients is highly significant, the magnitude of the coefficient for males is of a similar magnitude albeit imprecisely measured (see Table B.6). For other decision makers, the coefficient for the effect is negative, but not significantly different from zero (Table B.7), and heterogeneity along the recipient's gender does not seem apparent (Table B.8). Since the effect of pension receipt is an 8.3% to 8.5% increase in the sharing

Table 7: Effect of pension receipt on labour market outcomes

	LFP	Emp. rate	Unemp. rate	Hours
Pension receipt	−0.428**	−0.431**	0.144	5.199
	(0.128)	(0.130)	(0.165)	(9.063)
Bandwidth	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)
Clustered SE	District	District	District	District
Year & District FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
N	704	704	247	260
First stage F-stat	246.68	246.68	27.42	33.43

Notes: ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$, ’: $p < 0.1$. Standard errors in parentheses. The estimated coefficient is the effect of pension receipt on the pension recipient's following labour market outcomes: labour force participation rate, employment rate, unemployment rate, and hours worked. Additional controls are gender and a dummy for less than primary school education. The first stage F-statistic is the Kleibergen Paap Wald F-stat for joint instrument relevance. All models include weights to account for survey design.

rule[17] and income increases by 53.9%, the income elasticity of the sharing rule is 0.15 and 0.16 for the upper and lower bounds, respectively.

Looking at the labour market outcomes sheds some light on why household income remains unchanged upon pension receipt. In these models, the labour market outcomes are defined according to the International Labour Organization's definitions for employment statistics (International Labour Organization, 2021) and are dummies for being in the labour force (as a share of respondents over 15 years old), employed (as a share of respondents over 15 years old), and unemployed (strict and broad definition combined, as a share of respondents over 15 in the labour force), respectively. Hours worked are the same as described above for the sharing rule, however, excluding those individuals for which this was imputed. The only extensive margin outcomes not conditional on being employed or seeking employment

[17] The average increase in the sharing rule is the effect of pension receipt on the sharing rule (4.2 and 4.3 percentage points for the upper and lower bounds, respectively) divided by the average sharing rule level before pension receipt (50.8% and 50.6% for the upper and lower bounds, respectively).

are labour force participation and being employed, which means the effects on unemployment presented here are only of an informative nature. The same is true for the intensive margin measure of hours worked. Tables 7 and B.10 show that labour force participation and the employment rate decrease significantly upon pension receipt by 42.8 and 43.1 percentage points for recipients, respectively, and by 20.3 and 18.5 percentage points for other decision makers in the household, respectively. When looking at the gender of the recipients in Table B.9, the decrease in labour force participation and employment is significant, however the effects for males are almost double that of the effects for females.

Combined with the increase in individual income upon pension receipt, this result suggests that recipients are leaving very low paying employment which is more than made up for by pension income, i.e. their reservation wage increases. Household income remains constant since other household decision makers are also leaving employment, albeit at a lower rate. In the South African context, Abel (2019) finds similar results for prime-aged adults, while Bhorat and Köhler (2024) show that labour supply effects may be positive in the short run for unemployed workers, but dissipate over time in a high-unemployment setting.

Focusing on recipient gender provides additional evidence for the hypothesis that female pensioners are more altruistic than males. Table B.11 suggests that labour force participation and the employment rate decreases for other decision makers when a female is the recipient, whereas no such effect is evident when a male is the pension recipient. These results suggest that female pensioners share more of their additional resources with other household members, allowing them to exit the labour market. However, it may be the case that male pensioners facilitate labour market access for other decision makers, which may be a preferred outcome for these individuals. Without more information on how pensioners distribute the additional income within the household (or not), the labour market effects cannot confirm nor refute the female altruism hypothesis.

6.5 Robustness checks

This section provides additional evidence to show that the estimated effects are robust to different model specifications. The main results presented Table 4 already

Table 8: Robustness: Different bandwidths

	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
Pension receipt	0.061	0.066'	0.028'	0.028'	0.021	0.021	0.007	0.008	0.008	0.008
	(0.040)	(0.041)	(0.021)	(0.021)	(0.018)	(0.018)	(0.015)	(0.015)	(0.013)	(0.014)
Bandwidth	(-3, 3)	(-3, 3)	(-7, 7)	(-7, 7)	(-10, 10)	(-10, 10)	(-15, 15)	(-15, 15)	(-20, 20)	(-20, 20)
Clustered SE	District	District	District	District	District	District	District	District	District	District
Year & District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	410	410	1.058	1.058	1.519	1.519	2.326	2.326	3.079	3.079
First stage F-stat	42.7	42.7	516.23	516.23	810.58	810.58	349.92	349.92	655.04	655.04

Notes: ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$, ': $p < 0.1$. Standard errors and p-values calculated with 1000 bootstrap replications. The estimated coefficient is the effect of pension receipt on the pensioner's sharing rule bounds. Additional controls are gender and a dummy for less than primary school education. The first stage F-statistic is the Kleibergen Paap Wald F-stat for joint instrument relevance. All models include weights to account for survey design.

show that the main effects are robust to including fixed effects and additional control variables. Table 8 presents the main FRD specification with varying bandwidths, ranging from 3 to 20 years around the age-eligibility cut-off. These results are qualitatively consistent with those from the preferred specification in Section 6.2. The fact that the effect of the pension washes out with larger bandwidths provides further justification for using the smaller bandwidths, since a linear functional form is less likely to approximate the true regression functional form as the bandwidth widens.

As an additional check on whether the results depend on the parametric functional form chosen, Table 9 presents estimates for the effect of pension receipt on the sharing rule using a robust, bias corrected local linear FRD specification implemented in R in the package *rdrobust* (Calonico et al., 2014a, 2015, 2017, 2018, 2019, 2020). The bandwidth selection procedure is the default mean squared error optimal bandwidth selector as proposed in Calonico et al. (2014b). The estimated effect of pension receipt on the sharing rule is higher in the nonparametric analysis at 5.7 and 6 percentage points for the upper and lower sharing rule bounds, however, qualitatively, the results are similar to the parametric results in Table 4.

7 Conclusion

This study investigates the impact of the South African pension on intra-household resource allocation and labour supply. By extending the sharing rule framework to households with more than two decision makers, this study addresses a key

Table 9: Robustness: Nonparametric specification

	Upper	Lower	Upper	Lower	Upper	Lower
Pensioner	0.052*	0.055*	0.057*	0.059*	0.057*	0.060*
	(0.025)	(0.026)	(0.026)	(0.027)	(0.026)	(0.027)
Bandwidth (left, right)	(-8.3, 8.3)	(-8.04, 8.04)	(-7.73, 7.73)	(-7.62, 7.62)	(-7.73, 7.73)	(-7.61, 7.61)
Clustered SE	District	District	District	District	District	District
Year & District FE	No	No	Yes	Yes	Yes	Yes
Controls	No	No	No	No	Yes	Yes
N (left, right)	425, 878	425, 878	361, 790	361, 790	361, 790	361, 790

Notes: ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$, ': $p < 0.1$. Standard errors and p-values calculated with 1000 bootstrap replications. The estimated coefficient is the effect of pension receipt on the recipient's sharing rule bounds. Additional controls are gender and a dummy for less than primary school education. Models estimated with the package "rdrobust" using a data-driven optimal bandwidth selection procedure. All models include weights to account for survey design.

gap in the literature, allowing for a more realistic analysis of bargaining power in large, multi-generational households that are common in South Africa and many lower income settings. This extension enables a more nuanced and theoretically grounded assessment of how exogenous income shocks, such as the pension, influence the distribution of resources within households.

The empirical results provide evidence that pension receipt is associated with a substantial and statistically significant increase in the recipient's share of household resources, as measured by the sharing rule bounds. The estimated increase of 8.4 to 8.5 percent in the sharing rule, together with an income elasticity of 0.15 to 0.16, points to a meaningful shift in bargaining power towards the pension recipient. The presence of children and additional adults in the household appears to amplify these gains, suggesting that household composition plays an important role in shaping the effects of cash transfers.

In terms of labour supply, the findings indicate that pension receipt is linked to a reduction in both employment and labour force participation, not only for recipients but also for other household members. These effects are robust across different model specifications and are consistent with a strong income effect, where the pension reduces the necessity or incentive to engage in paid work. The increased bargaining power of the pension recipient may also lead to a reallocation of household resources towards immediate consumption, rather than towards investments in human capital or job search activities. This is supported by evidence that only a small proportion of pension income is directed towards education or training, with most being used for basic needs (Case and Deaton, 1998; Duflo, 2003; Bertrand et al., 2003).

The analysis does not find support for the hypothesis that pension receipt enables other household members, such as mothers, to increase their labour market participation through mechanisms like increased childcare provision. Instead, the concentration of resource control with the elderly recipient may reinforce patterns of dependency within the household. This dynamic suggests that the pension may inadvertently contribute to labour market exclusion.

While these findings are robust within the context of this study, some caution is warranted in generalising the results. The effects of unconditional cash transfers on intra-household dynamics and labour supply may differ in settings with lower unemployment or alternative household structures. Moreover, the long-term implications for household welfare and intergenerational mobility remain uncertain, as the observed shifts in resource allocation and labour supply could have both positive and negative consequences over time.

Given these results, there is a strong case for integrating active labour market policies with cash transfer programmes. Policymakers may wish to consider complementing the pension with job training, employment services, or incentives for human capital investment, in order to offset potential reductions in labour supply and promote longer-term economic inclusion. Regular monitoring of intra-household resource allocation could help identify unintended consequences for vulnerable groups, especially in multi-generational households. Ultimately, the broader context of high structural unemployment in South Africa limits the potential for cash transfers alone to promote sustainable economic inclusion. Expanding formal employment opportunities remains essential if the full benefits of social protection are to be realised.

In summary, this study demonstrates that the pension substantially increases the bargaining power of elderly recipients and reduces labour supply within recipient households. These findings highlight the importance of considering both the direct and indirect effects of large, unconditional transfers, as well as the need for methodological approaches that can capture the complexity of real-world household structures. Complementary interventions and context-sensitive policy design are likely to be important for maximising the effectiveness of social protection programmes in South Africa and similar settings.

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A Proofs

Equivalence of collective household optimisation problem and the sharing rule representation

Collective Household Model.

$$\max_{\mathbf{x}^c} \sum_{i \in M} \mu^i(\mathbf{p}, w) \cdot U^i\big(\mathbf{x}^1, \cdots, \mathbf{x}^m, \mathbf{x}^H\big) + \lambda \cdot \Big[w - \sum \mathbf{p}'\mathbf{x}^c\Big]$$

$$\partial \mathbf{x}^c \quad \Rightarrow \quad \sum_{i \in M} \mu^i(\mathbf{p}, w) \cdot \frac{\partial U^i}{\partial \mathbf{x}^c} = \lambda \cdot \mathbf{p} \quad \forall c \in C \tag{22}$$

Sharing Rule Representation.

$$\forall i \in M: \quad \max_{\widetilde{\mathbf{x}}^c} U^i\Big(\widetilde{\mathbf{x}}^1, \cdots, \widetilde{\mathbf{x}}^m, \widetilde{\mathbf{x}}^H\Big) + \lambda^i \cdot \left[w^i - \sum_{i \in M} \big(\mathbf{p}^{i,c}\big)'\widetilde{\mathbf{x}}^c\right]$$

$$\partial \widetilde{\mathbf{x}}^c \quad \Rightarrow \quad \frac{\partial U^i}{\partial \widetilde{\mathbf{x}}^c} = \lambda^i \cdot \mathbf{p}^{i,c} \quad \forall c \in C, i \in M \tag{23}$$

Equivalence.

Let $\lambda^i \cdot \mu^i(\mathbf{p}, w) = \lambda$:

$$\begin{aligned}
\sum_{i \in M} \mu^i(\mathbf{p}, w) \cdot \frac{\partial U^i}{\partial \widetilde{\mathbf{x}}^c} &= \sum_{i \in M} \mu^i(\mathbf{p}, w) \cdot \lambda^i \cdot \mathbf{p}^{i,c} \qquad \text{by (23)} \\
&= \lambda \cdot \sum_{i \in M} \mathbf{p}^{i,c} \\
&= \sum_{i \in M} \mu^i(\mathbf{p}, w) \cdot \frac{\partial U^i}{\partial \mathbf{x}^c} \qquad \text{by (22)} \\
\Rightarrow \quad \sum_{i \in M} \mu^i(\mathbf{p}, w) \cdot \left(\frac{\partial U^i}{\partial \widetilde{\mathbf{x}}^c} - \frac{\partial U^i}{\partial \mathbf{x}^c}\right) &= 0 \\
\frac{\partial U^i}{\partial \widetilde{\mathbf{x}}^c} &= \frac{\partial U^i}{\partial \mathbf{x}^c} \\
\widetilde{\mathbf{x}}^c &= \mathbf{x}^c \quad \text{(by strong concavity)}
\end{aligned}$$

□

Proposition 1

Consider a household demand function $\mathbf{d}$. If there exists a set of utility functions $(U^1, \cdots, U^m)$ that provides a collective rationalisation of $\mathbf{d}$, then the admissible individual demand functions $\left(\mathbf{d}^1, \cdots, \mathbf{d}^m\right) \in X(\mathbf{d})$ satisfy WARP.

Proof of Proposition 1.

Definition 4 states that utility functions U^i provide a collective rationalisation of $\mathbf{d}$ if there exist admissible demand functions $\mathbf{d}^i \in Q(\mathbf{d})$ such that, for all i:

$$\mathbf{d}^i\left(\mathbf{p}^{i,1}, \cdots, \mathbf{p}^{i,m}, \mathbf{p}^{i,H}, w^i\right) = \sum_{c \in C} \mathbf{x}^c$$

for

$$\left(\mathbf{x}^1, \cdots, \mathbf{x}^m, \mathbf{x}^H\right) = \arg \max_{\mathbf{q}^1, \cdots, \mathbf{q}^m, \mathbf{q}^H} U^i\left(\mathbf{q}^1, \cdots, \mathbf{q}^m, \mathbf{q}^H\right)$$
$$\text{s.t.} \quad \sum_{c \in C} \left(\mathbf{p}^{i,c}\right)' \mathbf{x}^c \leq w^i$$

there must exist a utility function U^i for each i, such that $\mathbf{d}^i$ solves the corresponding maximisation problem for all prices $\mathbf{p}^{i,c}$ and income w^i. Following Samuelson (1938), this result only obtains if $\mathbf{d}^i$ satisfies WARP in Definition 2. □

Proposition 2

Let $\mathbf{d}$ be a household demand function. If, for all $j \in M$, $\mathbf{x}_j = \mathbf{d}(\mathbf{p}_j, w_j)$ such that

$$w_j \geq \mathbf{p}_j' \left(\mathbf{x}_O + \sum_{\substack{k \in M \\ k \neq j}} \mathbf{x}_k \right),$$

then $\mathbf{x}_j \succ^{l_j} \mathbf{x}_O$ for all admissible individual demand functions $(\mathbf{d}^1, \cdots, \mathbf{d}^m) \in X(\mathbf{d})$ that satisfy WARP such that for all $i, j, l_i, l_j \in M$, if $\mathbf{x}_j \succ^{l_j} \mathbf{x}_O$ and $\mathbf{x}_i \succ^{l_i} \mathbf{x}_O$ with $i \neq j$, then $l_i \neq l_j$.

Proof of Proposition 2.

1. First, if for all $j \in M$, $w_j \geq \mathbf{p}_j' \left(\sum_{\substack{k \in M \\ k \neq j}} \mathbf{x}_k \right)$ then there exist $l_j \in M$ s.t. $\mathbf{x}_j \succ^{l_j} \mathbf{x}_k$ for all $k \in M$, $k \neq j$. Moreover, if $\mathbf{x}_j \succ^{l_j} \mathbf{x}_k$ $(k \neq j)$ and $\mathbf{x}_i \succ^{l_i} \mathbf{x}_k$, $(k \neq i)$ with $i \neq j$, then $l_i \neq l_j$. Hence

$$w_j \geq \mathbf{p}_j' \left(\sum_{\substack{k \in M \\ k \neq j}} \mathbf{x}_k \right)$$

$$\Rightarrow \sum_{i \in M} \sum_{c \in C} (\mathbf{p}_j^{i,c})' \mathbf{x}_j^c \geq \sum_{i \in M} \sum_{c \in C} (\mathbf{p}_j^{i,c})' \left(\sum_{\substack{k \in M \\ k \neq j}} \mathbf{x}_k^c \right)$$

   and thus, there must exist $l_j \in M$ such that $\sum_{c \in C} \left(\mathbf{p}_j^{l_j,c}\right)' \mathbf{x}_j^c \geq \sum_{c \in C} \left(\mathbf{p}_j^{l_j,c}\right)' \left(\sum_{\substack{k \in M \\ k \neq j}} \mathbf{x}_k^c \right)$. For all $k \in M$, $k \neq j$,

$$\sum_{c \in C} \left(\mathbf{p}_j^{l_j,c}\right)' \mathbf{x}_j^c \geq \sum_{c \in C} \left(\mathbf{p}_j^{l_j,c}\right)' \mathbf{x}_k^c,$$

   which holds because all components of $\mathbf{x}_k^c$ are positive for $k \in M$, $c \in C$.

For all $j \in M$, this implies $\mathbf{x}_j \succ^{l_j} \mathbf{x}_k$ for all $k \in M$, $k \neq j$.[18] Moreover, for $i, j \in M$, $\mathbf{x}_j \succ^{l_j} \mathbf{x}_i$ and $\mathbf{x}_i \succ^{l_i} \mathbf{x}_j$. Since $\left(\mathbf{d}^1, \cdots, \mathbf{d}^m\right) \in X(\mathbf{d})$ satisfy WARP, if $i \neq j$ then $l_i \neq l_j$.

2. Second, for all $j \in M$, let $l_j \in M$, such that

   - $\mathbf{x}_j \succ^{l_j} \mathbf{x}_k$ for all $k \in M$, $k \neq j$
   - for $i, l_i \in M$, if $\mathbf{x}_j \succ^{l_j} \mathbf{x}_i$ and $\mathbf{x}_i \succ^{l_i} \mathbf{x}_j$, $i \neq j$, then $l_i \neq l_j$

   For all $j, l_j \in M$, if for all $k, l_k \in M$ such that $k \neq j$, $\mathbf{x}_k \succ^{l_k} \mathbf{x}_j$ and $w_j \geq \mathbf{p}_j\left(\mathbf{x}_O + \sum_{\substack{k \in M \\ k \neq j}} \mathbf{x}_k\right)$, then $\mathbf{x}_j \succ^{l_j} \mathbf{x}_O$. Because $\left(\mathbf{d}^k\right)$ satisfy WARP, for all $k, l_k \in M$, $k \neq j$:

$$\sum_{c \in C}\left(\mathbf{p}_j^{l_k,c}\right)' \mathbf{x}_k^c > \sum_{c \in C}\left(\mathbf{p}_j^{l_k,c}\right)' \mathbf{x}_j^c. \tag{24}$$

   Moreover:

$$\begin{aligned} w_j &\geq \mathbf{p}_j'\left(\mathbf{x}_O + \sum_{\substack{k \in M \\ k \neq j}} \mathbf{x}_k\right) \\ \Rightarrow \sum_{i \in M}\sum_{c \in C}(\mathbf{p}_j^{i,c})'\mathbf{x}_j^c &\geq \sum_{i \in M}\sum_{c \in C}(\mathbf{p}_j^{i,c})'\left(\mathbf{x}_O^c + \sum_{\substack{k \in M \\ k \neq j}} \mathbf{x}_k^c\right) \\ &\geq \sum_{c \in C}\left(\mathbf{p}_j^{l_j,c}\right)'\mathbf{x}_O^c + \sum_{\substack{i \in M \\ i \neq j}}\sum_{c \in C}(\mathbf{p}_j^{i,c})'\mathbf{x}_i^c \end{aligned}$$

   and thus,

$$\sum_{\substack{i \in M \\ i \neq j}}\sum_{c \in C}(\mathbf{p}_j^{i,c})'\mathbf{x}_j^c + \sum_{c \in C}\left(\mathbf{p}_j^{l_j,c}\right)'\mathbf{x}_j^c \geq \sum_{c \in C}\left(\mathbf{p}_j^{l_j,c}\right)'\mathbf{x}_O^c + \sum_{\substack{i \in M \\ i \neq j}}\sum_{c \in C}(\mathbf{p}_j^{i,c})'\mathbf{x}_i^c.$$

[18] This is due to $\mathbf{x}_j = \mathbf{d}(\mathbf{p}_j, w_j) = \mathbf{d}\left(\mathbf{p}_j^{l_j,1}, \cdots, \mathbf{p}_j^{l_j,H}, w_j\right)$ and $\mathbf{x}_k \in B(\cdot)$.

From Equation (24), this inequality implies

$$\sum_{c \in C} \left(\mathbf{p}_j^{l_j,c}\right)' \mathbf{x}_j^c > \sum_{c \in C} \left(\mathbf{p}_j^{l_j,c}\right)' \mathbf{x}_O^c$$

or

$$\mathbf{x}_j \succ^{l_j} \mathbf{x}_O \quad \forall \quad j, l_j \in M$$

Without loss of generality, let $l_j = j$. Then

$$\mathbf{x}_j \succ^{j} \mathbf{x}_O \quad \forall \quad j \in M.$$

as required.

□

Proposition 3

Let $\mathbf{d}$ be a household demand function. If, for all $j \in M$, $\mathbf{x}_j = \mathbf{d}\big(\mathbf{p}_j, w_j\big)$ such that either

$$\begin{gathered} w_j \geq \mathbf{p}_j' \left(\mathbf{x}_O + \sum_{k=1, k\neq j}^{m} \mathbf{x}_k \right) \qquad \text{and} \\ \sum_{\substack{n \in N_{P_k} \\ k \neq j}} (\mathbf{p}_k)_n (\mathbf{x}_k)_n \geq \mathbf{p}_k' \mathbf{x} - \sum_{\substack{n \in N_{P_j} \\ j \neq k}} (\mathbf{p}_k)_n (\mathbf{x})_n \\ \text{for} \quad \mathbf{x} = \mathbf{x}_O, \mathbf{x}_j \quad (j \in M, j \neq k) \end{gathered} \tag{25}$$

or

$$\begin{gathered} \sum_{\substack{n \in N_{P_j} \\ j \neq k}} \big(\mathbf{p}_j\big)_n (\mathbf{x}_j)_n \geq \mathbf{p}_j' \mathbf{x}_O - \sum_{\substack{n \in N_{P_k} \\ k \neq j}} \big(\mathbf{p}_j\big)_n (\mathbf{x}_O)_n \\ \text{for} \quad j, k \in M \quad (j \neq k) \end{gathered} \tag{26}$$

hold, then $\mathbf{x}_j \succ^{l_j} \mathbf{x}_O$ for all admissible individual demand functions $\big(\mathbf{d}^1, \cdots, \mathbf{d}^m\big) \in X(\mathbf{d})$ that satisfy WARP such that for all $i, j, l_i, l_j \in M$, if $\mathbf{x}_j \succ^{l_j} \mathbf{x}_O$ and $\mathbf{x}_i \succ^{l_i} \mathbf{x}_O$ with $i \neq j$, then $l_i \neq l_j$.

Proof of Proposition 3.

The proof for the first condition in (25) is the same as in the proof for Proposition 2 above. The second part of condition (25)

$$\sum_{\substack{n \in N_{P_k} \\ k \neq j}} (\mathbf{p}_k)_n (\mathbf{x}_k)_n \geq \mathbf{p}_k' \mathbf{x} - \sum_{\substack{n \in N_{P_j} \\ j \neq k}} (\mathbf{p}_k)_n (\mathbf{x})_n \tag{27}$$

for all $\big(\mathbf{d}^1, \cdots, \mathbf{d}^m\big) \in X(\mathbf{d})$ and $\mathbf{x} = \mathbf{x}_j, \mathbf{x}_O$ $(j \in M, j \neq k)$, implies

$$\mathbf{x}_k \succ^{l_k} \mathbf{x}_j \quad \text{and} \quad \mathbf{x}_k \succ^{l_k} \mathbf{x}_O.$$

To prove this, note that

$$\sum_{c\in C}\left(\mathbf{p}_k^{k,c}\right)'\mathbf{x}_k^c \geq \sum_{\substack{n\in N_{P_k}\\ k\neq j}} (\mathbf{p}_k)_n(\mathbf{x}_k)_n \tag{28}$$

for all possible $\mathbf{p}_k^{k,c}$ and $\mathbf{x}_k^c$ $(k \in M, c \in C)$. Specifically,

$$\left(\mathbf{x}_k^k\right)_n = (\mathbf{x}_k)_n \quad \text{and} \quad \left(\mathbf{p}_k^{k,k}\right) = (\mathbf{p}_k)_n$$

for the private goods $n \in N_{P_k}$. Thus

$$\left(\mathbf{p}_k^{k,k}\right)'\mathbf{x}_k^c \geq \sum_{\substack{n\in N_{P_k}\\ k\neq j}} (\mathbf{p}_k)_n(\mathbf{x}_k)_n$$

with $\sum_{\substack{c\in C\\ c\neq k}}\left(\mathbf{p}_k^{k,c}\right)'\mathbf{x}_k^c \geq 0$ by construction.
For $\mathbf{x} = \mathbf{x}_j, \mathbf{x}_O$ $(j \in M, j \neq k)$,

$$\mathbf{p}_k'\mathbf{x} - \sum_{\substack{n\in N_{P_j}\\ j\neq k}} (\mathbf{p}_k)_n(\mathbf{x})_n \geq \sum_{c\in C}\left(\mathbf{p}_k^{k,c}\right)'\mathbf{x}^c \tag{29}$$

which, using similar logic to (28), results in

$$\sum_{c\in C}(\mathbf{p}_k^{j,c})'\mathbf{x}^c \geq \sum_{\substack{n\in N_{P_j}\\ j\neq k}} (\mathbf{p}_k)_n(\mathbf{x}_j)_n$$

such that

$$\begin{aligned}\mathbf{p}_k'\mathbf{x} - \sum_{\substack{n\in N_{P_j}\\ j\neq k}} (\mathbf{p}_k)_n(\mathbf{x})_n &\geq \mathbf{p}_k'\mathbf{x} - \sum_{c\in C}(\mathbf{p}_k^{j,c})'\mathbf{x}^c \\ &= \sum_{c\in C}\left(\mathbf{p}_k^{k,c}\right)'\mathbf{x}^c.\end{aligned}$$

Using (28) and (29),

$$\sum_{c\in C}\left(\mathbf{p}_k^{k,c}\right)'\mathbf{x}_k^c \geq \sum_{c\in C}\left(\mathbf{p}_k^{k,c}\right)'\mathbf{x}^c$$

for $\mathbf{x} = \mathbf{x}_j, \mathbf{x}_O$ $(j \in M, j \neq k)$, which results in

$$\mathbf{x}_k \succ^{l_k} \mathbf{x}_j \quad \text{and} \mathbf{x}_k \succ^{l_k} \mathbf{x}_O$$

for all $\left(\mathbf{d}^1, \cdots, \mathbf{d}^m\right) \in X(\mathbf{d})$ proves (27).

Now, assume $\mathbf{x}_k \succ^{l_k} \mathbf{x}_j$. Using similar logic as in part 2 of the proof of Proposition 2 for (24), if, for all $\left(\mathbf{d}^1, \cdots, \mathbf{d}^m\right) \in X(\mathbf{d})$, $\mathbf{x}_k \succ^{l_k} \mathbf{x}_j$ and $w_j \geq \mathbf{p}_j\left(\mathbf{x}_O + \sum_{\substack{k\in M \\ k\neq j}} \mathbf{x}_k\right)$, then $\mathbf{x}_j \succ^{l_j} \mathbf{x}_O$.

Thus, if condition (25) holds, then $\mathbf{x}_j \succ^{l_j} \mathbf{x}_O$ $(j \in M)$ for all admissible individual demand functions $\left(\mathbf{d}^1, \cdots, \mathbf{d}^m\right) \in X(\mathbf{d})$ that satisfy WARP.

□

B Additional tables and figures

Table B.1: Summary statistics (other household members)

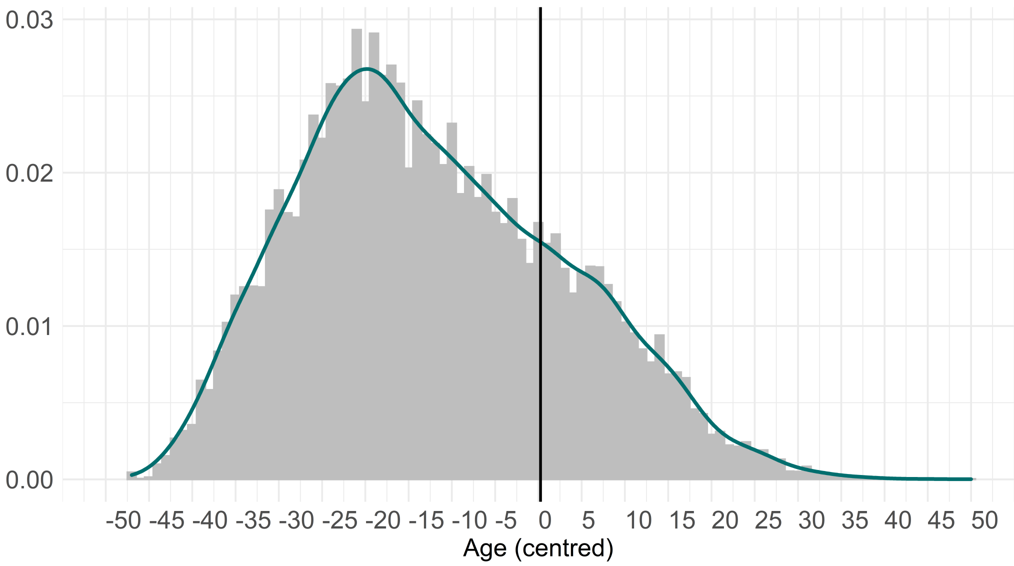
Variable	Sample	Mean	Median	SD	Min	Max	N
Age (years)	Full	28.50	25.00	12.32	15	91	51,599
	Sharing rule	32.63	29.00	13.24	15	91	17,303
	Estimation	30.22	26.00	13.45	15	91	7,224
Black African	Full	0.88	1.00	0.33	0	1	51,599
	Sharing rule	0.86	1.00	0.35	0	1	17,303
	Estimation	1.00	1.00	0.00	1	1	7,224
Coloured	Full	0.09	0.00	0.29	0	1	51,599
	Sharing rule	0.11	0.00	0.31	0	1	17,303
	Estimation	0.00	0.00	0.00	0	0	7,224
Indian/Asian	Full	0.01	0.00	0.12	0	1	51,599
	Sharing rule	0.01	0.00	0.11	0	1	17,303
	Estimation	0.00	0.00	0.00	0	0	7,224
White	Full	0.02	0.00	0.14	0	1	51,599
	Sharing rule	0.02	0.00	0.15	0	1	17,303
	Estimation	0.00	0.00	0.00	0	0	7,224
Female	Full	0.56	1.00	0.50	0	1	51,584
	Sharing rule	0.66	1.00	0.47	0	1	17,300
	Estimation	0.59	1.00	0.49	0	1	7,223
Pension recipient	Full	0.02	0.00	0.16	0	1	51,201
	Sharing rule	0.06	0.00	0.23	0	1	17,025
	Estimation	0.05	0.00	0.22	0	1	7,224
Less than primary school	Full	0.14	0.00	0.34	0	1	51,434
	Sharing rule	0.16	0.00	0.37	0	1	17,275
	Estimation	0.15	0.00	0.36	0	1	7,205
Primary school	Full	0.77	1.00	0.42	0	1	51,434
	Sharing rule	0.71	1.00	0.45	0	1	17,275
	Estimation	0.73	1.00	0.44	0	1	7,205
High school and above	Full	0.10	0.00	0.29	0	1	51,434
	Sharing rule	0.13	0.00	0.33	0	1	17,275
	Estimation	0.11	0.00	0.32	0	1	7,205
Married/Civil union	Full	0.24	0.00	0.43	0	1	23,986
	Sharing rule	0.36	0.00	0.48	0	1	8,736
	Estimation	0.31	0.00	0.46	0	1	3,499
Urban area	Full	0.05	0.00	0.21	0	1	51,599
	Sharing rule	0.06	0.00	0.23	0	1	17,303
	Estimation	0.04	0.00	0.20	0	1	7,224
Homeowner	Full	0.80	1.00	0.40	0	1	51,518
	Sharing rule	0.77	1.00	0.42	0	1	17,276
	Estimation	0.82	1.00	0.39	0	1	7,215
HH size	Full	5.97	5.00	3.17	2	39	51,599
	Sharing rule	5.20	5.00	2.44	2	23	17,303
	Estimation	4.42	4.00	1.57	2	8	7,224
Adults	Full	3.99	4.00	1.85	1	22	51,599

Table B.1: Summary Statistics (other household members) *(continued)*

Variable	Sample	Mean	Median	SD	Min	Max	N
	Sharing rule	3.40	3.00	1.37	2	17	17,303
	Estimation	2.91	3.00	0.78	2	4	7,224
Children	Full	1.98	2.00	1.87	0	17	51,599
	Sharing rule	1.80	1.00	1.63	0	14	17,303
	Estimation	1.50	1.00	1.21	0	4	7,224
HH income (R)	Full	3,745.68	3,317.79	2,226.77	0	14,274	51,599
	Sharing rule	4,192.88	3,660.07	2,350.43	112	14,274	17,303
	Estimation	3,507.77	3,112.30	1,877.64	309	13,446	7,224
HH food expenses (R)	Full	987.71	835.26	703.04	9	17,882	51,237
	Sharing rule	967.62	848.91	629.05	9	17,882	17,181
	Estimation	858.44	780.64	472.34	9	5,482	7,171
HH non-food expenses (R)	Full	1,480.76	801.03	3,054.94	0	139,842	51,237
	Sharing rule	1,492.54	858.81	2,912.03	0	139,842	17,181
	Estimation	1,319.11	718.73	3,665.64	0	139,842	7,171
HH housing expenses (R)	Full	642.98	391.85	802.26	1	12,860	51,336
	Sharing rule	651.24	393.18	800.31	1	11,299	17,217
	Estimation	544.82	356.66	638.41	2	11,299	7,193
Individual income (R)	Full	1,380.93	1,116.07	1,366.92	1	28,904	26,025
	Sharing rule	1,385.25	1,128.67	1,263.54	4	11,733	17,303
	Estimation	1,360.99	1,171.17	1,058.59	15	8,240	4,629
Pension income (R)	Full	1,156.19	1,213.35	181.67	18	1,286	1,960
	Sharing rule	1,168.26	1,213.35	150.68	270	1,286	1,471
	Estimation	1,195.11	1,210.76	44.83	932	1,254	488
Hours worked p/w	Full	39.25	40.00	18.16	1	112	14,121
	Sharing rule	40.53	40.00	17.78	1	112	9,185
	Estimation	40.78	40.00	17.33	2	112	2,559
Wage (R/h)	Full	14.09	8.13	21.73	0	649	13,792
	Sharing rule	12.57	8.17	16.13	0	292	9,185
	Estimation	11.23	8.12	11.98	0	179	2,517
Labour force participation	Full	0.47	0.00	0.50	0	1	47,900
	Sharing rule	0.63	1.00	0.48	0	1	16,737
	Estimation	0.54	1.00	0.50	0	1	6,873
Employed	Full	0.25	0.00	0.44	0	1	47,900
	Sharing rule	0.47	0.00	0.50	0	1	16,737
	Estimation	0.33	0.00	0.47	0	1	6,873
Unemployed	Full	0.46	0.00	0.50	0	1	21,251
	Sharing rule	0.24	0.00	0.43	0	1	9,819
	Estimation	0.38	0.00	0.48	0	1	3,340

Notes: Summary statistics shown for the full data set, the subset for the sharing rule calculation, and the sample for the estimation of the effect of an income shock on the sharing rule. Statistics shown for household members other than the decision maker in the household with the highest centred age (age in years minus pension eligibility age). All income and expenditure variables are in South African Rand (R) per month, and have been corrected for inflation. On the 24th of April 2021, one Euro was equal to R17, one Swiss Franc was equal to R16, and one US dollar was equal to R14. All statistics weighted to account for survey design.

Figure B.1: Age density



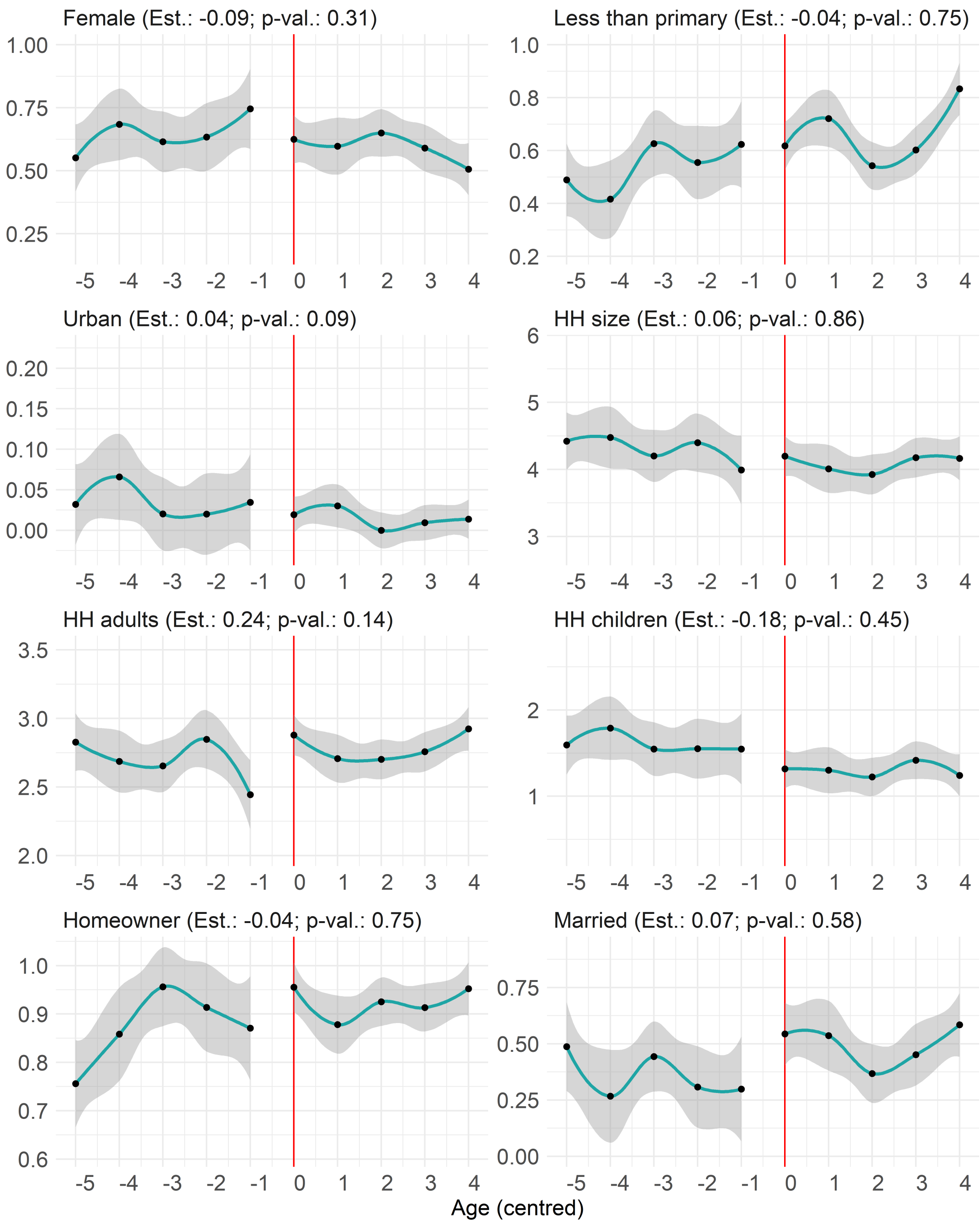
Notes: This figure shows the age density with age centred at the age-eligibility cut-off. The sample for this figure is the full sample restricted to individuals with the highest centred age in the household, Black Africans, households satisfying the means test, a minimum of two and maximum of four adults in the household, and at most four children in the household. A test for a discontinuity at the cut-off in the spirit of McCrary (2008), adapted for a discrete running variable and implemented with the *rddensity* package (Cattaneo et al., 2019, 2018, 2021, 2020), fails to reject the null of no discontinuity at the cut-off.

Table B.2: Covariate balance

	Female	No primary	Urban	HH size	HH Adults	HH children	Married	Homeowner
Eligibility	−0.094	−0.039	0.036’	0.060	0.241	−0.181	0.074	−0.058
	(0.092)	(0.124)	(0.021)	(0.343)	(0.162)	(0.240)	(0.134)	(0.066)
Bandwidth	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)
Clustered SE	District	District	District	District	District	District	District	District
Year & District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	718	718	718	718	718	718	376	718

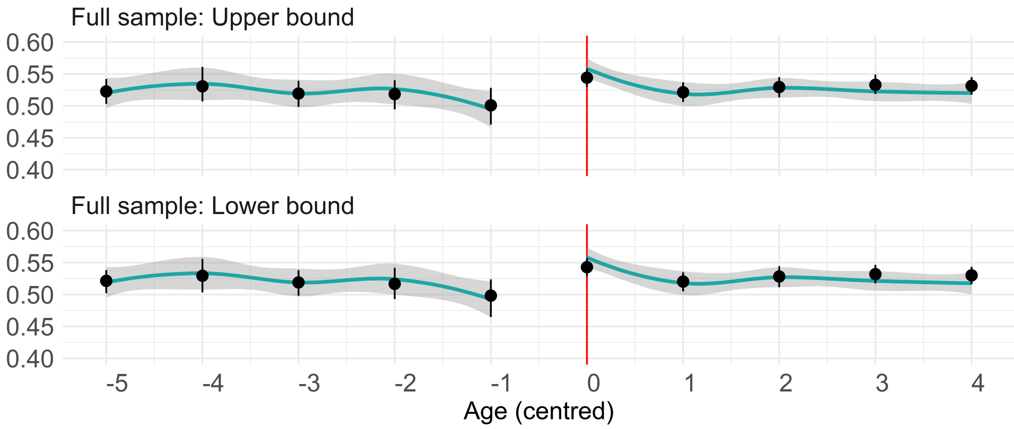
Notes: ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$, ’: $p < 0.1$. Standard errors in parentheses. This table presents FRD models using the respective covariate as the outcome variable. “Female” is a dummy for being female, “No primary” is a dummy for less than primary school education, “urban” is a dummy for residing in an urban area, “married” is equal to one if married or living with a partner, and “homeowner” is dummy for homeownership. All models include weights to account for survey design.

Figure B.2: Covariate balance



Notes: Each panel shows binned averages of the outcome overlaid with a loess smooth. The estimates and p-values in parentheses are the reduced form effect on a dummy for crossing the age-eligibility threshold in a 5 year window either side of the age-eligibility threshold (see Table B.2).

Figure B.3: Reduced form effect of pension receipt on the sharing rule



Notes: This figure shows the binned averages (at years before and after age-eligibility) for the upper and lower sharing rule bounds overlaid with loess smooths below and above the age-eligibility cut-off.

Table B.3: Heterogeneity: Children in household

	Children		No children	
	Upper	Lower	Upper	Lower
Pension receipt	0.048'	0.051'	0.079	0.078
	(0.030)	(0.031)	(0.065)	(0.066)
Bandwidth	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)
Clustered SE	District	District	District	District
Year & District FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
N	548	548	170	170
First stage F-stat	136.7	136.7	64.12	64.12

Notes: ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$, ': $p < 0.1$. Standard errors and p-values calculated with 1000 bootstrap replications. The estimated coefficient is the effect of pension receipt on the pension recipient's sharing rule bounds. The sample is split into recipients living in households with and without children. The first stage F-statistic is the Kleibergen Paap Wald F-stat for joint instrument relevance. All models include weights to account for survey design.

Table B.4: Heterogeneity: Adults in household

	2 adults		3 or more adults	
	Upper	Lower	Upper	Lower
Pension receipt	0.042	0.043	0.026	0.029
	(0.039)	(0.040)	(0.037)	(0.040)
Bandwidth	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)
Clustered SE	District	District	District	District
Year & District FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
N	315	315	403	403
First stage F-stat	310.59	310.59	65.59	65.59

Notes: ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$, ’: $p < 0.1$. Standard errors and p-values calculated with 1000 bootstrap replications. The estimated coefficient is the effect of pension receipt on the pension recipient’s sharing rule bounds. The sample is split into recipients living in households with two adults and households with three or more adults. The first stage F-statistic is the Kleibergen Paap Wald F-stat for joint instrument relevance. All models include weights to account for survey design.

Table B.5: Heterogeneity: Education

	Primary and higher		Less than primary	
	Upper	Lower	Upper	Lower
Pension receipt	0.053	0.055	0.054	0.054
	(0.044)	(0.045)	(0.039)	(0.041)
Bandwidth	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)
Clustered SE	District	District	District	District
Year & District FE	Yes	Yes	Yes	Yes
Controls	No	No	No	No
N	232	232	486	486
First stage F-stat	36.6	36.6	90.31	90.31

Notes: ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$, ': $p < 0.1$. Standard errors and p-values calculated with 1000 bootstrap replications. The estimated coefficient is the effect of pension receipt on the pension recipient's sharing rule bounds. The sample is split into recipients with less than a primary school education and those with at least primary school. The first stage F-statistic is the Kleibergen Paap Wald F-stat for joint instrument relevance. All models include weights to account for survey design.

Table B.6: Effect of pension recipient gender on income

	Female recipient		Male recipient	
	Indiv. income	HH income	Indiv. income	HH income
Pension receipt	0.653**	0.083	0.481	0.140
	(0.239)	(0.180)	(0.469)	(0.293)
Bandwidth	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)
Clustered SE	District	District	District	District
Year & District FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
N	480	480	238	238
First stage F-stat	160.09	160.09	47.1	47.1

Notes: ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$, ': $p < 0.1$. Standard errors in parentheses. The estimated coefficient is the effect of pension receipt within the household on the natural logarithm of the other decision makers' income(s), partitioned by the gender of the pension recipient. An additional control is a dummy for less than primary school. The first stage F-statistic is the Kleibergen Paap Wald F-stat for joint instrument relevance. All models include weights to account for survey design.

Table B.7: Effect of pension receipt on income (other decision makers)

	Indiv. income	Indiv. income	Indiv. income
Pension receipt (in household)	−0.057	−0.018	0.003
	(0.272)	(0.278)	(0.267)
Bandwidth	(-5, 5)	(-5, 5)	(-5, 5)
Clustered SE	District	District	District
Year & District FE	No	Yes	Yes
Controls	No	No	Yes
N	712	712	711
First stage F-stat	159.47	164.19	152.32

Notes: ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$, ': $p < 0.1$. Standard errors in parentheses. The estimated coefficient is the effect of pension receipt within the household on the natural logarithm of the other decision makers' income(s). Additional controls are gender and a dummy for less than primary school education. The first stage F-statistic is the Kleibergen Paap Wald F-stat for joint instrument relevance. All models include weights to account for survey design.

Table B.8: Effect of pension recipient gender on income (other decision makers)

	Female recipient			Male recipient		
	Indiv. income	Indiv. income	Indiv. income	Indiv. income	Indiv. income	Indiv. income
Pension receipt (in household)	−0.185 (0.299)	−0.419 (0.280)	−0.319 (0.250)	0.160 (0.423)	0.625 (0.396)	0.594 (0.393)
Bandwidth	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)
Clustered SE	District	District	District	District	District	District
Year & District FE	No	Yes	Yes	No	Yes	Yes
Controls	No	No	Yes	No	No	Yes
N	466	466	466	246	246	245
First stage F-stat	190.63	156.37	132.38	47.09	45.72	44.53

Notes: ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$, ': $p < 0.1$. Standard errors in parentheses. The estimated coefficient is the effect of pension receipt within the household on the natural logarithm of the other decision makers' income(s), partitioned by the gender of the pension recipient. Additional controls are gender and a dummy for less than primary school education. The first stage F-statistic is the Kleibergen Paap Wald F-stat for joint instrument relevance. All models include weights to account for survey design.

Table B.9: Effect of pension recipient gender on labour market outcomes

	Female recipient				Male recipient			
	LFP	Emp. Rate	Unemp. Rate	Hours	LFP	Emp. Rate	Unemp. Rate	Hours
Pension receipt	−0.375* (0.161)	−0.361* (0.166)	0.156 (0.369)	8.976 (12.367)	−0.665*** (0.137)	−0.683*** (0.138)	0.149 (0.130)	19.351* (8.806)
Bandwidth	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)
Clustered SE	District	District	District	District	District	District	District	District
Year & District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	473	473	134	153	231	231	113	107
First stage F-stat	160	160	26.08	30.66	39.16	39.16	14.55	12.23

Notes: ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$, ': $p < 0.1$. Standard errors in parentheses. The estimated coefficient is the effect of pension receipt on the pension recipient's following labour market outcomes: labour force participation rate, employment rate, unemployment rate, and hours worked, partitioned by gender. Additional controls are gender and a dummy for less than primary school education. The first stage F-statistic is the Kleibergen Paap Wald F-stat for joint instrument relevance. All models include weights to account for survey design.

Table B.10: Effect of pension receipt on labour market outcomes (other decision makers)

	LFP	Emp. rate	Unemp. rate	Hours
Pension receipt (in household)	−0.203’	−0.185’	0.087	10.089
	(0.107)	(0.104)	(0.157)	(7.551)
Bandwidth	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)
Clustered SE	District	District	District	District
Year & District FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
N	1.148	1.148	562	389
First stage F-stat	110.47	110.47	38	82.84

Notes: ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$, ’: $p < 0.1$. Standard errors in parentheses. The estimated coefficient is the effect of pension receipt on the other decision makers’ following labour market outcomes: labour force participation rate, employment rate, unemployment rate, and hours worked. Additional controls are gender and a dummy for less than primary school education. The first stage F-statistic is the Kleibergen Paap Wald F-stat for joint instrument relevance. All models include weights to account for survey design.

Table B.11: Effect of pension recipient gender on labour market outcomes (other decision makers)

	Female recipient				Male recipient			
	LFP	Emp. Rate	Unemp. Rate	Hours	LFP	Emp. Rate	Unemp. Rate	Hours
Pension receipt (in household)	−0.265’	−0.348*	0.398’	−1.285	−0.125	0.101	−0.371	13.326’
	(0.156)	(0.156)	(0.216)	(8.393)	(0.187)	(0.200)	(0.322)	(7.317)
Bandwidth	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)	(-5, 5)
Clustered SE	District	District	District	District	District	District	District	District
Year & District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	743	743	375	258	405	405	187	131
First stage F-stat	122.86	122.86	87.34	98.9	28.35	28.35	35.31	31.76

Notes: ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$, ’: $p < 0.1$. Standard errors in parentheses. The estimated coefficient is the effect of pension receipt on the other decision makers’ following labour market outcomes: labour force participation rate, employment rate, unemployment rate, and hours worked, partitioned by gender. Additional controls are gender and a dummy for less than primary school education. The first stage F-statistic is the Kleibergen Paap Wald F-stat for joint instrument relevance. All models include weights to account for survey design.