It's complicated: A Non–parametric Test of Preference Stability between Singles and Couples

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Abstract *In the context of household consumption models, authors frequently use data from single individuals to identify components of the collective model. This approach requires a controversal structural assumption that preferences are stable with respect to different household compositions. This paper develops a non–parametric test for this preference stability assumption based on observing only the marginal distributions of consumption choices for singles and couples, respectively. We allow for unobserved heterogeneity both with respect to preferences and intra-household bargaining by specifying a random utility model and making use of the Collective Axiom of Revealed Preference. To characterize our hypothesis we use an exhaustive finite-dimensional characterization of household types and construct a test–statistic using a stochastic choice argument. We strongly reject the preference–stability hypothesis based on data from the Russian Longitudinal Monitoring Survey (RLMS) and the Spanish Continuous Family Expenditure Survey (ECPF).*

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1 Introduction

It is widely accepted that the classical household consumption model, which assumes that a household consists of only one decision maker, is unable to answer many policy relevant questions concerning family economics such as pooling of taxable income or deciding which partner should receive the payments of childcare benefits. The collective household consumption model (Chiappori, 1988, 1992) provides an alternative to the unitary model by allowing household members to efficiently bargain over their consumption

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choices. However, even if individuals have homogeneous preferences, the proportion at which households split their resources is not identified from household–level data (Chiappori & Ekeland, 2006, 2009). Researchers often circumvent this issues by making use of data from single households and assume that the transition from being single to being in a couple and vice versa does not affect individual consumption preferences (most prominently Browning, Chiappori & Lewbel (2013), but also e.g. Barmby & Smith (2001), Vermeulen (2006), Bargain & Donni (2012), Gayle & Shephard (2016)).

In this paper we construct a test of the validity of this *stable preference* assumption. In order to avoid rejecting the hypothesis based on a restrictions imposed by the functional form of utilities or by preference homogeneity, our test is fully non–parametric and allows for a heterogeneous population. Preference homogeneity is particularly restrictive in the context of the collective model, since it not only requires every individual to have the same preferences, but also assumes that any two individuals matched as a couple would arrive at the exact same sharing of resources. Thus we specify a collective random utility model with continuous consumption and an arbitrary dimension of unobserved distribution factors and preference parameters. We then construct discrete heterogeneous household types for both couples and singles in a way that ensures that any two households which are not distinguishable in terms of their preferences without a functional form restriction are equivalent. There is only a finite number of possible types. The test is then constructed by considering couples satisfying the Collective Axiom of Revealed Preference (Cherchye, De Rock & Vermeulen, 2007) and singles satisfying the Strong Axiom of Revealed Preference (Afriat, 1967; Varian, 1982) as a baseline. Observing only their respective distributions of consumption choices, we then ask the question if these distributions could have been generated from an unobserved combination of hypothetical matches between different types of individuals into a common household. This requires us to utilise the stable preference assumption, so that failing to find a rationalisation leads to a rejection of the stable preference hypothesis.

A difficulty in the context of preference stability tests are consumption externalities which, without further assumptions, prohibit the possibility of disentangling an adjustment of consumption behavior due to a preference change from the gained possibility of consuming a good publicly as a couple, i.e. a Lindal price change. Thus we consider a generalization of a Beckerian caring model (Becker, 1981) which restricts us to only consider strictly private goods for the empirical test. In order to discretise choices for singles and couples, we make use of panel data and a time-stability of preferences assumption. We apply our test to two popular datasets: the *Russian Longitudinal Monitoring Survey (RLMS)* and the *Spanish Continuous Family Expenditure Survey (Encuesta Continua de*

Presupuestos Familiares, ECPF) which were used by Cherchye, De Rock & Vermeulen (2011) and Adams *et al.* (2014) in the context of the collective model. We consistently reject the hypothesis of preference stability for both datasets.

In contrast to our proposed discrete approach, testing preference restrictions in a continuous setting is often based on the Slutsky matrix which requires estimation of household demands and derivatives thereof. Browning & Chiappori (1998) construct a test of collective rationality based on a parametric almost ideal demand system with additive (measurement) errors. Similar to this, Brugler (2016) estimates a parametric quadratic ideal demand system (Banks, Blundell & Lewbel, 1997) and compares the parameter estimates for single men, single women and couples to draw conclusions about preference stability. While an almost ideal demand systems provides a flexible functional parametric form which can be easily tested based on parameter restrictions, the potential for misspecification and consequential type I errors caused by an inconsistent specification of the functional form restriction can be problematic. In addition to this, identification of continuous demand systems in the presence of general unobserved heterogeneity is difficult due to the structure of the collective model, which leads to demands that are non–separable with respect to unobserved preference and bargaining heterogeneity. Also in a continuous choice setting, Hubner (2018) thus develops a collective random utility model and derives restrictions for non–parametric identification of idiosyncratic utility functions and Pareto weights by showing global invertibility of demands, under the assumption of observed private demands. We do however not require such a strong form of identification in our context.

To our knowledge, the use of singles data in the context of the fully non–parametric global way to model collective households using revealed preference restrictions (Cherchye, De Rock & Vermeulen, 2007, 2009) is novel. The advantage of a revealed preference based approach is that it allows us to use a stochastic random utility and random distribution factor version of the collective model without requiring global invertibility. Revealed stochastic preference settings have recently been used in the context of the unitary consumption model. Hoderlein & Stoye (2014) consider the weak axiom of revealed preference in the unitary model. In particular they use the fact that demands of a heterogeneous population observed in a given price regime can be characterized as random variables supported on a normalized budget set. Observing the same population in different price regimes (repeated cross-sections), one can then use copula techniques to derive (Frechet–Hoeffding) bounds on the probability that the population behaves irrationally, i.e. is not in line with the weak axiom. Kitamura & Stoye (2013); Deb *et al.* (2017) integrate this approach into the stochastic choice framework (McFadden & Richter, 1991; McFadden, 2005) by fully discretizing budget sets using partitions which contain all the relevant information to test the strong axiom of revealed preference. We show that their large sample theory applies to our test statistic and use their results for our statistical inference.

2 Test Design

In this section we specify a collective random utility model with two-person households. Each spouse $r \in \{m, f\}$ consumes a bundle of goods from a finite set of alternatives which is a proper subset of $\mathbb{R}^L_+$. We denote continuous individual private consumption by $\tilde{x}^r$. Further let $\tilde{x}^c_{i,t} = \tilde{x}^f_{i,t} + \tilde{x}^m_{i,t} \in R^{LT}_+$ be continuous household consumption chosen by household $i \in I_N$ in period $t \in I_T$. We assume that a household characterized by $\varepsilon^c = (\varepsilon^m, \varepsilon^f, \varepsilon^\mu)$ arrives at this consumption bundle by having maximized its collective random utility

$$\max_{x^f, x^m} u^m(\tilde{x}^m, \tilde{x}^f, \varepsilon^m) + \mu(p, \varepsilon^\mu) u^f(\tilde{x}^f, \tilde{x}^m, \varepsilon^f) \text{ subject to } \tilde{x}^f + \tilde{x}^m \in B_t = \{\tilde{x} \mid p_t \tilde{x} \leqslant 1\}, \quad (1)$$

where μ is the relative bargaining power of spouse f (Chiappori, 1988, 1992). By introducing the possibly infinite–dimensional random variable ε we allow each household to optimize a different objective function according to idiosyncratic preferences and distribution factors[1]. We observe budget shares of household consumption, i.e. the fraction of the household budget spent on this good in a given period. In order to treat this as expenditure on a given good category $l \in I_L$ denoted by $p_{t,l}\tilde{x}^c_{i,t,l}$ (e.g. food, transportation or electronics), we normalize total household endowment to one. Observing prices p_t for each period $t \in I_T$ then allows us to calculate the vector of continuous household consumption $\tilde{x}^c_i$ for each household $i \in I_N$. Due to the random utility specification, these demands are scattered on the respective budget sets.

Now consider instead a single household $r \in \{f, m\}$ who maximizes $u^r(\tilde{x}^r, \tilde{x}^{r'}, \varepsilon^r)$ subject to the constraint $\tilde{x}^r \in B_t$ according to the standard unitary model. For them the spouse's consumption $\tilde{x}^{r'}$ is zero so that $\tilde{x}^c = \tilde{x}^r$ which we observe. In order to eventually model singles in a way that makes them informative for a couple's consumption behaviour we have to make a separability assumption.

Assumption 1. *Let the* $(L-1)$*-dimensional vector of marginal rates of substitutions for* $r \in \{m, f\}$ *be denoted as* $MRS^r(x^r, x^{r'})$ *with components* $MRS^r_l(x^r, x^{r'}) = \frac{\partial u^r/\partial x^r_l}{\partial u^r/\partial x^r_L}$ *for* $l = 1, \ldots, L-1$. *Then for* $r \neq r'$ *we have* $\partial MRS^r(x^r, x^{r'})/\partial x^{r'} = 0_{L-1,L-1}$.

This states that the marginal rates of substitution for own good consumption does not depend on the spouse's consumption. A sufficient condition for this would be for exam-

[1] See Hubner (2018) for a discussion.

ple separability of the form $u^r(x^r, x^{r'}, \varepsilon^r) = G(g(x^r, \varepsilon^r), x^{r'}, \varepsilon^{r'})$ for any two differentiable, increasing, real-valued functions G and g. While this assumption allows for positive consumption externalities, it restricts the way behaviour of a person is modified when entering or exiting a relationship.For example it rules out non-cooperative strategic behaviour of individuals within a couple. This assumption nests popular specifications such as the egoistic model $u^r = g^r$, but also the Beckerian caring model with altruistic preferences (Becker, 1981), in which utilities of one spouse are defined in terms of own-good consumption and the utility of the spouse, i.e. $u^r(x^r, x^{r'}, \varepsilon^r, \varepsilon^{r'}) = W(U^r(x^r, \varepsilon^r), U^{r'}(x^{r'}, \varepsilon^{r'}))$ where U^f and U^m are real-valued sub-utility functions with the usual properties and W is a strictly increasing, differentiable real-valued function.

Demands of each spouse are in general not observable and thus their individual preferences are not identified directly from couples data. Using the *stable preference assumption*, how can we exploit information of single households in order to identify u^f and u^m?

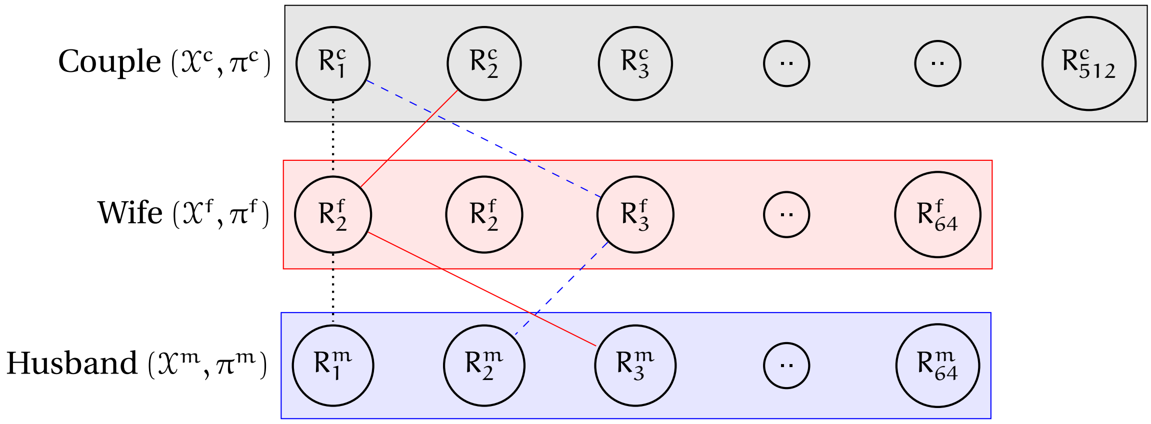
First, we characterize consumers in terms of their finite–dimensional preference relations. Both the collective and the unitary model as defined above impose restrictions on how both household and individual demands must change with respect to relative price changes. These set of restrictions are known as the Collective Axiom of Revealed Preference and the Strong Axiom of Revealed Preference, both defined in Appendix A.1. These axioms allow us to define a partition $\mathcal{E}^r = \bigcup_{k_r=1}^{K_r} \mathcal{E}_{k_r}$ such that for all $r \in \{f, m, c\}$ and for all $k_r \in I_{K_r}$ it holds that for any $\varepsilon^r_{k_r}, \xi^r_{k_r} \in \mathcal{E}_{k_r}$ we have $R^r(\varepsilon^r_{k_r}) = R^r(\xi^r_{k_r})$ where R^r are the preference relations resulting from our random utility model (1) with household utility evaluated at $u^m(x^m, \varepsilon^m_{k_m}) + \mu(p, \varepsilon^c_{k_c})u^f(x^f, \varepsilon^f_{k_f})$. To see this, note that revealed preference relations can be checked in terms of finite partitions of the budget sets. Consequently, without losing any important information, infinite–dimensional unobserved heterogeneity is mapped into a finite-dimensional space of discrete types represented by preference relations[2] R^f, R^m and R^c. We obtain the latter by making the following standard assumption (Cherchye, De Rock & Vermeulen, 2011):

Assumption 2. *(i) Preferences are constant over time* $u^r_t(x^r, x^{r'}) = u^r(x^r, x^{r'})$ *for all* $t \in I_T$.
(ii) We observe choices for each household (couples and singles) for at least three periods.

The time-homogeneity assumption of preferences is needed so that we can treat different periods as different price regimes. To be more precise we have to assume that preferences do not change over time, such that we can treat the heterogeneity of choices between periods $t \in I_T$ to be a consequence of facing different prices p_t rather than a change

[2]We use R^c_0 as notation and since it does not actually represent a preference relation, since household consumption is only a result of individual preferences.

Figure 1: Visualization: Stochastic Collective Revealed Preferences



Note: 3-partite graph where the nodes represent discrete consumption decisions (types) and the partitioning is such that there are three disjoint classes each representing the set of discrete decisions under a given household composition – single female f, single male m and couples and c. Connections between the type represent hypothetical fully characterized households. Every possible connection can be classified as rational or irrational according to a given set of restrictions.

in preferences over time[3]

Let the type spaces defining the preference relations be denoted by $\mathcal{X}^m = \mathcal{X}^f$ and $\mathcal{X}^c$, respectively[4]. Considering a finite number of choice types allows us to fully characterize households, by considering the product space $\mathfrak{X} = \mathcal{X}^c \times \mathcal{X}^m \times \mathcal{X}^f$ representing all possible combinations of household types. This should be interpreted as matching different consumption types R^f and R^m into different bargaining outcome types R^c. Under the preference stability assumption, which ensures that single male and single female households are informative for the respective spouse's behaviour within a couple, each element contains all relevant information to construct the three-tuple (R^c, R^m, R^f). Figure 1 presents a clustered graph representation of the fully characterized household type space. The links between the nodes are *not* observed from data.

Thus, in a second step we show that we can validate the axioms for a heterogeneous population while only observing marginal distributions of choices for households with different compositions. Let the probability that option $\xi_j \in \mathcal{X}^r$ is chosen within a household of a given household composition r be denoted as $\pi(\xi_j|\mathcal{X}^r)$. This can also be interpreted as the probability of household being of type R^r_j. We call this a stochastic choice in situation $\mathcal{X}^r$ and will often refer to it as the marginal distribution of choices under a given house-

[3]This assumption can likely be relaxed to continuous demands of the form $\tilde{x}_{it} = \tilde{x}(p_t, \varepsilon_i) + \varepsilon_{it}$, where ε_i is an element of a general probability space capturing unobserved heterogeneity and ε_{it} is a period specific idiosyncratic taste shock, when projecting observed demands onto budgets of periods t. Identification of such a specification is treated in Evdokimov (2010). Identification of the preference relation from multiple periods also has the advantage that we do not have to project observed demands onto budget sets to reduce the dimension of the choice space, such as Kitamura & Stoye (2013), which theoretically requires a homothetic preference assumption or a revealed price preference setting; c.f. Deb *et al.* (2017).

[4]We will discuss how these choice spaces are constructed and how we can encode observed choices under different household compositions in detail in the next section.

hold composition. Using principles from stochastic choice theory (McFadden & Richter, 1991; McFadden, 2005), we can ask the question whether there exists a probability measure ν over an appropriate subset of fully characterized household types $\mathfrak{X}^0$ that rationalizes the observed stochastic choices $\pi(\xi_j|\mathcal{X}^r)$ for $r \in \{c, m, f\}$. With this construction the choice function $\mathcal{X} \mapsto \Xi(\mathcal{X})$ determining a decision rule for a given state of the world is a function of household composition $\mathcal{X} \in \{\mathcal{X}^c, \mathcal{X}^m, \mathcal{X}^f\}$. We say that the stochastic choice π is stochastically rational if for all household compositions $\mathcal{X}^r$ for $r \in \{c, m, f\}$ it holds that $\pi(\xi_j|\mathcal{X}^r) = \nu(\{\Xi \in \mathfrak{X}^0 : \xi_j = \Xi(\mathcal{X}^r)\})$. Intuitively if the choices in different states of the world can be rationalized by a probability distribution over a set of rational households, we can say that the population is rational with respect to the decision rule Ξ.

Finally, we how can we test the preference stabilty assumption by choosing the appropriate decision rule? For this, we partition the universe of types $\mathfrak{X} = \mathfrak{X}^{\text{collective}} \cup \mathfrak{X}^{\text{alternative}}$, where the set $\mathfrak{X}^{\text{collective}}$ contains all household types for which there exists a feasible consumption allocation which is consistent with the collective axiom as in Cherchye, De Rock & Vermeulen (2007). In order to use the actual respective preference relations of both spouses we require the preference stability assumption. We denote the subset of houshholds who remain consistent with the collective axiom after including them as $\mathfrak{X}^0 = \mathfrak{X}^{\text{collective}} \setminus \mathfrak{X}^1$. Its complement $\mathfrak{X}^1$ then consists of the cases which satisfy the collective axiom based on couples data, but are not consistent with the collective axiom if preference relations from singles are added. Thus, for our test we drop all cases that are not collectively rational and consider $\mathfrak{X}^0$ and $\mathfrak{X}^1$ to answer the question whether the stable preference assumption holds.[5] If we find that among the collectively rational paths it is not possible to rationalize observed choice probabilities using the types belonging to the set $\mathfrak{X}^0$, then we can conclude that the hypothesis of stable preferences does not hold.

3 Test Statistic

Lemma 1. *The following statements are equivalent:*

(i) The population with observed choice distribution π is rational under the random utility model A, where columns of A represent an exhaustive list of rational types.

[5] Alternatively, one could test $\mathfrak{X}^{\text{collective}}$ against $\mathfrak{X}^{\text{alternative}}$. In fact, this is what Cherchye, De Rock & Vermeulen (2007) do which does not require single data since such a test can be based on aggregate consumption only and the whole joint distribution of such choices is directly identified from data. Equally, by adding single data and assuming separable and stable preferences one could test $\mathfrak{X}^0$ against $\mathfrak{X}^1 \cup \mathfrak{X}^{\text{alternative}}$ to obtain a stronger test of the collective model compared to the previous one. While this test has more power, it comes with the drawback of only applying to a separable caring-type model.

(ii) There exists $\nu \in \Delta^{|\mathfrak{X}^0|}$ *such that* $A\nu = \pi$ *where* Δ^M *is the* M*-dimensional probability simplex.*

(iii) Let $\underline{\nu} = 0$*. Then the vector* ν *solves* $\mathcal{J}_N(\pi, \underline{\nu}) := N \min_{\eta \in \{A\nu | \nu \geqslant \underline{\nu}\}} (\pi - \eta)^T \Omega (\pi - \eta) = 0$.

(iv) Similarly, for $\underline{\nu} = 0$ *the vector* ν *is a fixed point under the operation*

$$\Psi_{\pi,\underline{\nu}} : s \mapsto \mathit{max}(0, s - \mathit{diag}(H\iota)^{-1}(H^T s + f(\pi, \underline{\nu}))) \tag{2}$$

where $H = A^T \Omega A$ *and* $f(\pi, \underline{\nu}) = -A^T \Omega (\pi - A\underline{\nu})$.

Proof. See Appendix A.2 □

In order to construct a matrix representation A, we consider a matrix with $\sum_{r \in \{c,m,f\}} |\mathcal{X}^r|$ rows and $|\mathfrak{X}^0|$ columns, where $|\mathcal{X}^r|$ is the number of choices a household can make under a given composition. Now we split all columns $A_{\bullet,m}$ with $m \in I_{|\mathfrak{X}^0|}$ of the matrix A into 3 blocks of respective length $|\mathcal{X}^c|$, $|\mathcal{X}^m|$ and $|\mathcal{X}^f|$ and denote each block by $A_{r,\bullet,m}$. If household type $m \in I_{|\mathfrak{X}^0|}$ picks option j under composition $r \in \{c, m, f\}$ then $A_{r,j,m} = 1$ and zero otherwise. In the graph interpretation of the type space which was discussed in Section 2, a block represents a class or cluster in the graph. For a given class and a given path where the latter is represented by a column of the matrix A, a row value of 1 indicates the active node within that path.

The second ingredient is a vector of observed choice probabilities which we observe by mapping observed continuous consumption onto the defined type space for each household $i \in I_N$. Thus we can define the vector π with $\sum_{r \in \{c,m,f\}} |\mathcal{X}^r|$ rows in which we collect observed choice probabilities. Partitioning π the same way as a column A_m, we define $\pi_{r,j} = \frac{1}{N} \sum_{i=1}^{N} \sum_{\xi \in \mathcal{X}^r} \mathbb{1}\{\xi_i = \xi\}$ where $\mathcal{X}^r$ is the households' choice space under composition $r \in \{c, m, f\}$ as defined above and ξ_i is the encoded observed choice of household $i \in I_N$, which can be either single or couple.

The way the matrix A is constructed ν is not point-identified since A is far from full column rank since $|\mathfrak{X}^0| \gg \sum_{r \in \{c,m,f\}} |\mathcal{X}^r|$. Thus we make use of the equivalence between (ii) and (iii) in Lemma 1and estimate η by projecting observed choice probabilities $\hat{\pi}$ onto a τ_N-tightened linear cone $\mathcal{C} = \{A\nu : \nu \geqslant \tau_N \iota\}$ by minimising the projection residuals $\mathcal{J}_N(\hat{\pi}, \iota\tau_N)$ where we set $\tau_N = \frac{1}{H}\sqrt{\frac{\log \underline{N}}{\underline{N}}}$ and $\underline{N} = N_f \wedge N_m \wedge N_c$ is the minimum number of available observations per household composition N_r for $r \in \{c, m, f\}$ in the sample. To obtain the critical value, we then use a non–parametric bootstrap to obtain $\hat{\pi}^b$ and calculate $\mathcal{J}_N\left(\hat{\pi}^b, \iota\tau_N\right)$ for each $b \in I_B$, where B the number of bootstrap repetitions. Let $\hat{\eta}_{\tau_N}$ be the argument producing the projection residuals $\mathcal{J}_N(\hat{\pi}, \iota\tau_N)$. The centered choice probabilities $\hat{\pi}^b_{\tau_N} = \hat{\pi}^b - \hat{\pi} - \hat{\eta}_{\tau_N}$ are then used to approximate the empirical distribution $F_{\mathcal{J}_N}$ of $\mathcal{J}_N(\hat{\pi}, \iota\tau_N)$. Then, following Kitamura & Stoye (2013), the bootstrap is valid and we have for $\alpha \in (0, \frac{1}{2})$

and $\tau_N\sqrt{N} \to \infty$

$$\lim_{N\to\infty}\inf \inf_{\pi\in\mathcal{C}} \mathbf{P}\left(\mathcal{J}_N(\widehat{\pi}, \tau_N\iota) \leqslant \widehat{F^{-1}_{\mathcal{J}_N}}(1-\alpha)\right) = 1-\alpha. \tag{3}$$

The projection residuals are calculated for each bootstrap repetition and it will prove useful to rewrite Lemma 1.(iii) as the solution of a non-negative least squares problem and implement a fast algorithm for solving it. The most commonly used method to solve this is sequential quadratic programming, c.f. the widely-used Lawson & Hanson (1995) algorithm[6]. Due to the high dimensionality of our problem it is however preferrable to use coordinate-wise projection such as in (Franc, Hlavac & Navara, 2005) or Landwebers gradient descent method (Johansson *et al.*, 2006) approach as it requires only $\mathcal{O}(k)$ computations instead of $\mathcal{O}(k^3)$, where $k = |\mathfrak{X}^0|$ is the number of rational types in the NNLS problem. Equation (2) in Lemma 1.(iv) represents the Landweber method which we implement manually, in order to leverage the sparsity of the matrix A.

Appendix A.4 discusses the results of a simulation study in which we evaluate the power of our test by plotting empirical rejection frequencies against the proportion of households not optimising according to a given decision rule and its size by evaluating type 1 erros under worst case scenarios.

4 Results

In this section we use two widely used datasets for our tests: The Russian Longitudinal Monitoring Survey (RLMS) and the Spanish Continuous Family Expenditure Survey (ECPF). Neither of these datasets have information about allocation of consumption between the spouses. The results are consistent between the datasets. In both cases we strongly reject the hypothesis of stable preferences.

For the test we consider households consisting of singles or couples. We exclude households with children or other cohabiting groups of individuals who are not in a romantic relationship. We consider a minimal setting with three periods and three goods, where we have 64 types of singles and 512 types of aggregate household choices, resulting in 2,996 collectively rational household types who satisfy the stable preference assumption (Appendix A.3). Both panels are longer than required. Thus we evaluate different combinations of years and goods from a range of pre–defined private goods. After dropping incomplete and boundary cases, we select years and goods based on the resulting sample size. Due to attrition in panels, this procedure tends to pick out consecutive years. As such we face the trade–off between a small sample size and small price variation, where the latter

[6] `lsqnonneg` in Matlab and `optimize.nnls` in SciPy

decreases the power in any revealed preference setting (see e.g. Beatty & Crawford (2011)). Thus, in addition to the combination with the largest sample size, we report a range of such combinations for a fixed group of goods, in descending order of $N_{couples} + N_{singles}$.

We first consider phase two of the Russian Longitudinal Monitoring Survey (RLMS), collected in form of a personal interview by the Carolina Population Center (University of North Carolina) and available for the years 1994 – 2014. Due to a lot of missing or zero values of other types of private consumption expenditures, we focus on different categories of food.[7] The survey distinguishes between 57 different food consumption categories, which we we further aggregate to dairy, bread and meat. These three categories account for more than half of the food consumption. Price data is obtained from the Federal State Statistics Service (GKS) and available for the years: 2000, 2005, 2010, 2011 – 2015. Descriptive statistics can be found in Table 4 in Appendix A.5. Table 1 shows the result in form of p-values of our test for different combinations of periods.

Table 1: Results RLMS: Preference Stability Test

Years	$N^{total}_{couples}$	$N^{rational}_{couples}$	$N^{total}_{singles}$	$N^{rational}_{singles}$	p-value	
2012 2013 2014	327	315	305	295	0.027	**
2011 2013 2014	316	304	281	275	0.017	**
2011 2012 2014	314	307	283	276	0.020	**
2011 2012 2013	332	321	312	306	0.187	
2010 2013 2014	258	249	217	213	0.033	**
2010 2012 2014	256	248	221	217	0.060	*
2010 2012 2013	268	257	243	235	0.043	**
2010 2011 2013	268	260	239	235	0.057	*
2010 2011 2012	298	293	268	262	0.120	
2005 2011 2012	264	256	220	214	0.180	

Note: Number of total couples, rational couples according to aggregate CARP, total singles and rational singles according to SARP, for a given combination of years. P-values and significance levels 10%, 5%, and 1% indicated by *, **, and ***, respectively.

Second, to validate these results, we apply the test to data from the Spanish Continuous Family Expenditure Survey (ECPF), collected by the Spanish statistics office (INE) on a quarterly basis for the period 1985 – 2005, with a discontinuity in its design in 1997. The survey is designed in a way that participants are part of the sample for at most eight consecutive periods or two years. The ECPF was then replaced by the Encuesta de Presupuestos Familiare (EPF) in 2006, however with the caveat of an extension to an annual collection frequency while maintaining the participation lifespan of two years. Thus we will use data from the original ECPF from 1985 to 1996. We use the private goods clothing, food consumed outside of the household and consumption of non–durable articles for our

[7] The median household income is RUB 28,000, of which RUB 7,500 is spent on food.

test. Price data is also published by INE. Descriptive statistics can be found in Table 5 in Appendix A.5. Table 2 presents the results.

Table 2: Results ECPF: Preference Stability Test

Years	$N^{total}_{couples}$	$N^{rational}_{couples}$	$N^{total}_{singles}$	$N^{rational}_{singles}$	p-value	
19943 19941 19942	111	106	6	6	0.007	***
19934 19941 19942	111	106	8	8	0.000	***
19922 19923 19921	97	88	16	13	0.000	***
19904 19911 19912	98	94	14	13	0.020	**
19893 19891 19892	113	105	6	6	0.000	***
19882 19883 19884	106	103	7	5	0.000	***
19871 19872 19873	131	128	8	6	0.000	***
19864 19871 19872	164	157	9	6	0.003	***
19863 19864 19871	141	135	8	7	0.000	***
19863 19864 19862	135	130	9	8	0.007	***

Note: Number of total couples, rational couples according to aggregate CARP, total singles and rational singles according to SARP, for a given combination of years. P-values and significance levels 10%, 5%, and 1% indicated by *, **, and ***, respectively.

Two aspects of our results are worth noting. First, while there is overwhelming evidence to reject the stable–preference hypothesis for the RLMS (Table 1), there are some combination of periods for which there is not enough evidence to arrive at this conclusion. In any of these cases, we either have three consecutive years in which we are faced with little power of revealed preference axioms due to the lack of price variation or a particularly small sample size due to the wide span of considered years. This all points towards the trade–off discussed above. Second, Table 2 shows that our sample for the ECPF is very small, particularly for single households. Abstracting from the inferior statistical properties of the test in small samples (the numerical procedure still converges), the strong rejection of the hypothesis seems to indicate that it is harder to find a rationalisation of types when we observe zero probability mass for some types $\xi_j \in \mathcal{X}^r$ for some $r \in \{f, m, c\}$. As a standalone result, we would have to take the result with some caution. Due to the consistency with the first dataset, we however believe that the evidence uniformly points towards a rejection of the stable–preference hypothesis.

5 Conclusion

In this paper we use tools from both the discrete non-parametric collective consumption literature and the one from stochastic random utility modeling to construct a test of the stable preference assumption which is often used in collective model, stating that consumption preferences do not change as individuals transition between relationship states.

For this we constructed hypothetical household types that satisfy revealed preferences restrictions the collective model imposes on observed household demands and showed how we can exploit information from single households in order to non-parametrically test the stable preference hypothesis. We provided simulation evidence that our test has power against the alternative hypothesis of non-stable preferences. In addition to this, we discussed worst cases and showed that the size of the test is correct under such scenarios. Using data from the Russian Longitudinal Monitoring Survey (RLMS) and the Spanish Continuous Family Expenditure Survey (ECPF), we strongly rejected the preference–stability hypothesis

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A.1 Collective Axiom of Revealed Preference

Definition 1 (Collective Axiom of Revealed Preference, Cherchye, De Rock & Vermeulen (2007)). *Suppose that there exists a pair of utility functions* u^f *and* u^m *that provide a collective rationalization of the set of observations* $\left\{(p_t; \tilde{x}_t^c, \tilde{x}_t^f, \tilde{x}_t^m) : \tilde{x}_t^c = \tilde{x}_t^f + \tilde{x}_t^m, t \in I_T\right\}$. *Then there exist preference relations*[8] R_0^r *and* R^r *for each* $r \in \{c, m, f\}$ *such that:*

(i) *if* $\tilde{x}_s R_0^c \tilde{x}_t$, *then* $\tilde{x}_s R_0^f \tilde{x}_t$ *or* $\tilde{x}_s R_0^m \tilde{x}_t$

(ii) *if* $\tilde{x}_s R_0^r \tilde{x}_{s_1}, \tilde{x}_{s_1} R_0^r \tilde{x}_{s_2}, \ldots, \tilde{x}_{s_S} R_0^r \tilde{x}_t$ *then* $\tilde{x}_s R^r \tilde{x}_t$ *for* $r \in \{m, f\}$

(iii) *if* $\tilde{x}_s R_0^c \tilde{x}_t$ *and* $\tilde{x}_t R^r \tilde{x}_s$, *then* $\tilde{x}_s R_0^{r'} \tilde{x}_t$ *for* $r \neq r'$ *where* $r, r' \in \{m, f\}$

(iv) *if* $\tilde{x}_s R_0^c (\tilde{x}_{t_1} + \tilde{x}_{t_2})$ *and* $\tilde{x}_{t_1} R^r \tilde{x}_s$ *then* $\tilde{x}_s R_0^{r'} \tilde{x}_{t_2}$ *for* $r \neq r'$ *where* $r, r' \in \{m, f\}$.

(v) *if* $\tilde{x}_{s_1} R^f \tilde{x}_t$ *and* $\tilde{x}_{s_2} R^m \tilde{x}_t$ *then* $\neg\left(\tilde{x}_t R_0^c (\tilde{x}_{s_1} + \tilde{x}_{s_2})\right)$

(vi) *if* $\tilde{x}_s R^f \tilde{x}_t$ *and* $\tilde{x}_s R^m \tilde{x}_t$, *then* $\neg\left(\tilde{x}_t R_0^c \tilde{x}_s\right)$

where R^r *is defined as* $\tilde{x}_s R_0^r \tilde{x}_t$ *whenever* $p_s \tilde{x}_s^r \geqslant p_s \tilde{x}_t^r$ *and* R^r *is the transitive closure of* R_0^r *(Afriat, 1967; Varian, 1982).*

A.2 Proofs

Proof of Lemma 1. The equivalences between (i), (ii) and (iii)' are shown in McFadden & Richter (1991); McFadden (2005). Statement (iii)' referenced therein, differs from (iii) in that it additionally requires $\iota^T \nu = 1$. We now show that this is implied. It is easy to see that by construction of A for any solution of the quadratic problem we have $\eta = \pi$ and since $3 = \iota^T \pi = \iota^T A \nu = 3\iota^T \nu$ by construction, we get $\iota^T \nu = 1$. Thus constraint $\nu \geqslant 0$ in is sufficient for η to be on the probability simplex.

It will be useful to write this problem with a *tightened* cone constraint indexed by $\underline{\nu}$. Let L be a lower diagonal matrix from the Cholesky decomposition $\Omega = LL^T$. Then we can rewrite the quadratic form (iii) as

$$\min_{\eta \in \{A\nu | \nu \geqslant \underline{\nu}\}} (\pi - \eta)^T LL^T (\pi - \eta).$$

Using $\eta = A\nu$ and introducing a slack variable $s \geqslant 0$ such that we can write $\nu = \underline{\nu} + s$ we obtain

$$\min_{\nu = \underline{\nu} + s, s \geqslant 0} (\pi - A(\underline{\nu} + s))^T LL^T (\pi - A(\underline{\nu} + s)).$$

This does not depend on ν but only on s and we can write it in the quadratic form

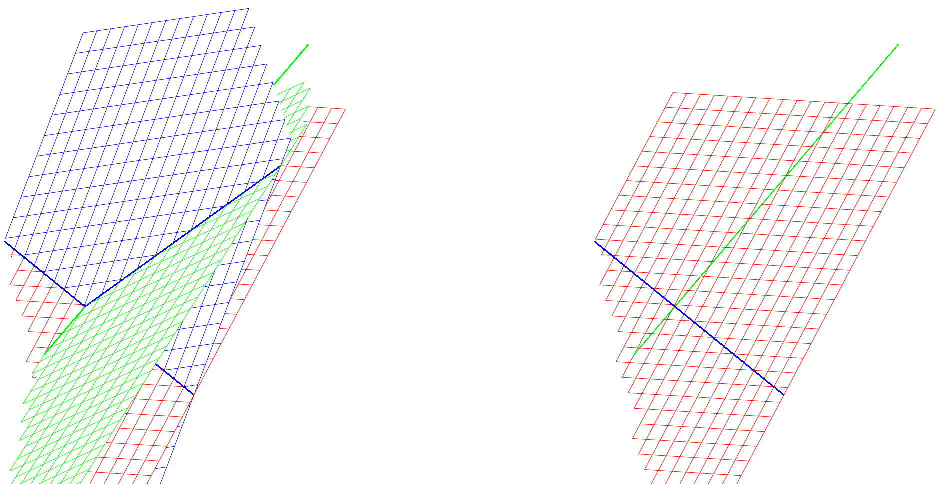
$$\min_{s \geqslant 0} \left\{ \frac{1}{2} s^T A^T \Omega A s - s^T A^T \Omega (\pi - A\underline{\nu}) \right\}.$$

[8] Note that R_0^c is just notation and not actually a preference relation, since household consumption is only a result of individual preferences.

Letting $H = A^T\Omega A$ and $f(\pi, \underline{\nu}) = -A^T\Omega(\pi - A\underline{\nu})$ we get a cannonical form of a non-negative least squares problem, with gradient for iteration $\tau \geqslant 0$ defined as $\mu_\tau = H^T s_\tau + f(\pi, \underline{\nu})$. Johansson *et al.* (2006) show that component–wise projection $s_{\tau+1,j} = \max(0, s_{\tau,j} - \mu\tau, j d_j$ where $d = \text{diag}(H\iota)^{-1}$ and $j \in I^{|\mathfrak{X}^0|}$ referring to the j^{th} component of s will find the solution of the problem. □

A.3 A Minimal Example

Figure 2: Three intersecting budget sets $B_{\text{red}}, B_{\text{blue}}, B_{\text{green}}$ with three goods



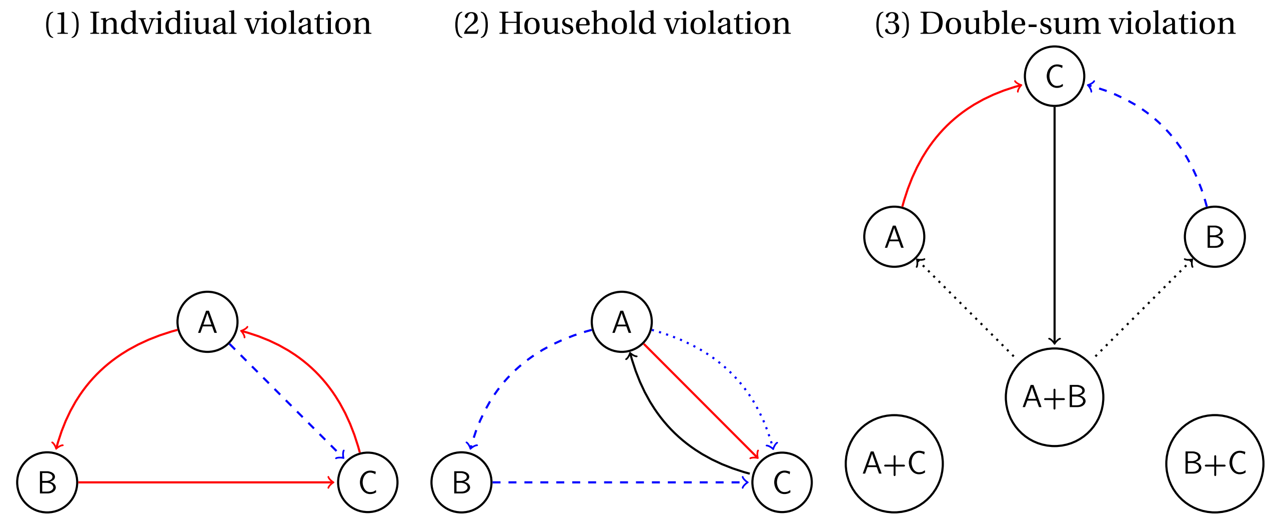
Note: Example of a three-good economy with three price-regimes characterizing budgets B_t where $t \in \{\text{blue, red, green}\} = I_T$. In the figure on the right hand side the green and blue budgets are removed and only the lines in which they intersect with the remaining red budget are plotted.

In this setting, the cardinality of $\mathfrak{X}^r$ is $|\mathfrak{X}^r| = \prod_{t \in I_T} J_t = 4 * 4 * 4 = 64$ for $r \in \{m, f\}$ representing single males and single females, respectively. For couples we have to store double-sums for which we have $J_{T+\kappa} = 2^3$ different possibilities with $\kappa = \frac{1}{2}(T-1)(T-2) = 1$ which results in $\prod_{t \in I_{T+\kappa}} J_t = 4 * 4 * 4 * 8 = 512$ choices. In total we have thus $|\mathfrak{X}| = 512 * 64 * 64 = 2{,}097{,}152$ fully characterised household types.

Assume we observe a couple consuming x_r^c, x_b^c and x_g^c, a single female consuming x_r^f, x_b^f and x_g^f and a single male consuming x_r^m, x_b^m and x_g^m, when faced with the respective budgets. Their consumption satisfies the following inequalities which contain all the necessary information to check whether or not this choice their respective choices are consistent with the Collective Axiom of Revealed Preference.

$$\begin{array}{ccc|cc|cc}
p_b x_r^c \geqslant 1, & p_g x_r^c \geqslant 1, & p_r(x_b^c + x_g^c) \geqslant 1 & p_b x_r^m \leqslant 1, & p_g x_r^m \geqslant 1, & p_b x_r^f \geqslant 1, & p_g x_r^f \leqslant 1 \\
p_r x_b^c \geqslant 1, & p_g x_b^c \geqslant 1, & p_b(x_r^c + x_g^c) \geqslant 1 & p_r x_b^m \geqslant 1, & p_g x_b^m \leqslant 1, & p_r x_b^f \geqslant 1, & p_g x_b^f \geqslant 1 \\
p_r x_g^c \leqslant 1, & p_b x_g^c \geqslant 1, & p_g(x_r^c + x_b^c) \leqslant 1 & p_r x_g^m \geqslant 1, & p_b x_g^m \geqslant 1, & p_r x_g^f \geqslant 1, & p_b x_g^f \geqslant 1
\end{array}.$$

Table 3: Violations of the Collective Axiom



Note: Nodes refer to different consumption bundles. the red solid line to the wife's preference relation R_0^f, the r ed dotted line to the implied transitive closure R^f, the blue dashed line to the husband's preference relation R_0^m, and the black solid line to the household "preference" relation.

If f and m were to be matched together, the inequalities restricting x^c represent one potential joint consumption type, in which case the graphs of the respective preference relations are

$$R_0 = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \qquad R_0^m = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix} \qquad R_0^f = \begin{bmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

with transitive closures for both individuals:

$$R^m = \begin{bmatrix} 0 & 1 & 1 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix} \qquad R^f = \begin{bmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}.$$

Table 3 shows different vioations of the collective axiom. Situation (1) is a trivial violation of individual SARP by f. In the example above we have situation (2), in which the preference relation R_0^m is one of a person who prefers good A over good B and good B over good C. Thus he must also prefer good A over good C by transitivity, for which there is no contradicting revelation of preferences. Hence, this person is rational. The preference relation of R_0^f also represents a rational person, who prefers good A over good C. Note that this implies that both individuals prefer good A over good C, but aggregate household consumption represented by R_0^c revealed that the household chose good C over good A; a violation of the Collective Axiom of Revealed Preference. This households is also irrational due to a violation of type (3), in which the household could have consumed both A and B, but chose to consume only C instead, making both individuals worse off.

Ruling out all violations the collective axiom, we end up with $|\mathfrak{X}^0| = 2{,}996$ fully characterized household types who are collectively rational under the stable preference assumption. $|\mathfrak{X}^{\text{collective}}| = 475{,}136$ are consistent with the collective axiom based on the necessary conditions using only aggregate household consumption data. This leaves us with about 22.7% collectively rational types. From this we should not necessarily conclude a restrictive nature of the collective model, since for a given range of budget planes only a subset of the total choice set would actually be feasible (e.g. have positive demands). Hence we obtain a matrix A with $512+64+64 = 640$ rows and 2,996 columns representing rational types under the stable preference assumption. The vector π is a vector of choice probabilities of the population of the same dimension: 640. While this might seem high-dimensional we note that this matrix is very sparse. In fact A only has $3|\mathfrak{X}^0| = 3 * 2{,}996$ non-zero items.

A.4 Simulations

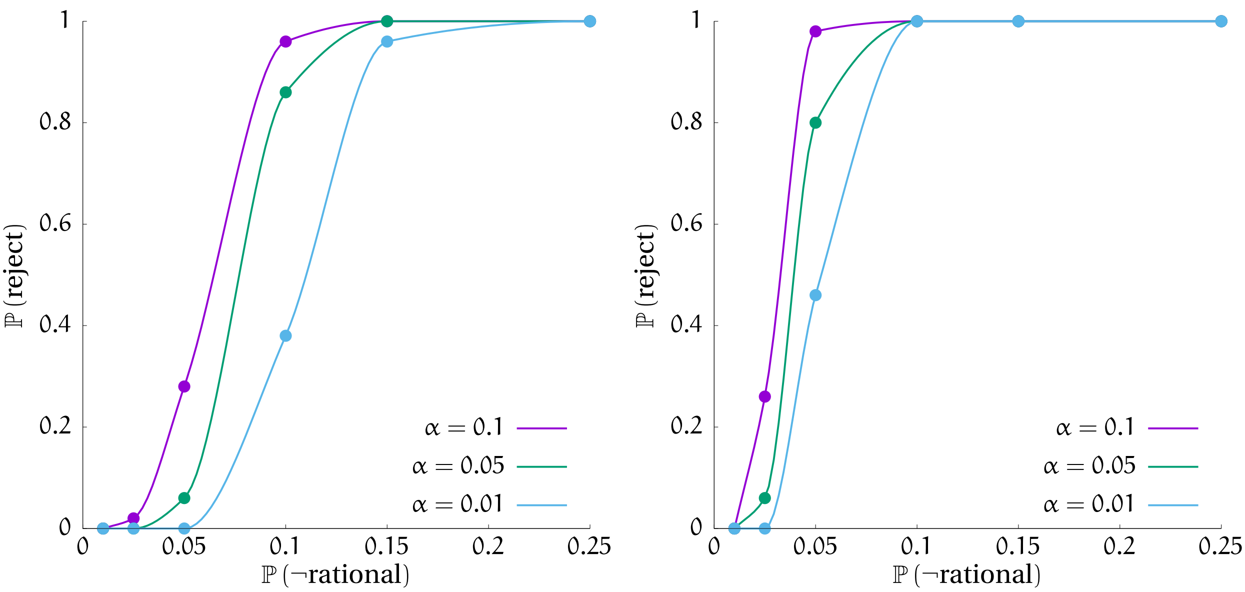
In this section we investigate the properties of our proposed test in a simulation setting. In particular we are interested in how much power it has to detect a violation of the stable preference assumption and whether or not it has a reasonable frequency of false positives.

Since specifying a parametric continuous demand system requires at least five goods to impose the SNR(S-1) condition on the Slutsky matrix and distinguish the collective model from the unitary model, we will not sample continuous demands as functions of prices and individual budget constraints, but rather draw our sample directly from the discrete choice space[9]. This should be interpreted as a continuous uniform distribution of choices on different budget planes, where the relative prices are such that the partitions of the budget planes are of equal size. Recall that we test this against the set of households which are consistent with the necessary conditions of the collective axioms based on aggregate consumption but not consistent when single data and the stable preference assumption is added. This set is denoted by $\mathfrak{X}^1$ and we have $\mathfrak{X}^{\text{collective}} = \mathfrak{X}^0 \cup \mathfrak{X}^1$. If we reject the null hypothesis that both the collective axiom and the stable preference assumption holds, by excluding all irrational paths $\mathfrak{X} \setminus \mathfrak{X}^{\text{collective}}$, we must conclude that the stable preference assumption does not hold. To control the proportion of households for whom this is the case (our data generating process) we introduce the parameter p which specifies the probability[10] that a particular choice is both collectively rational and satisfies the stable preference assumption $p := \mathbf{P}(x \in \mathfrak{X}^0)$. By only considering collectively rational choices in our simulations we thus have $1 - p = \mathbf{P}(x \notin \mathfrak{X}^0) = \mathbf{P}(x \in \mathfrak{X}^1)$ by construction.

[9] A revealed preference based setting allows us to test the restrictions of the model with only three goods (Cherchye, De Rock & Vermeulen, 2007), whereas Browning & Chiappori (1998) need five goods.

[10] This rationality parameter is similar as for example λ in Dette, Hoderlein & Neumeyer (2016) which specifies the population's deviation from Slutsky symmetry.

Figure 3: Power function for $N = 1{,}500$ (l.h.s) and $N = 3{,}000$ (r.h.s.)



Our simulation setting is as follows. We consider $S = 100$ samples of size $\underline{N} \in \{500, 1000, 2000\}$ where $\underline{N} = N_f = N_m = N_c$ such that $N = 3\underline{N}$ in a minimal setting of $T = 3$ periods which we construct by drawing $\lfloor \underline{N}p \rfloor$ indices from the space of collectively rational choice paths $\mathfrak{X}^0$ for which the stable preference assumption holds and $\lceil \underline{N}(1-p) \rceil$ indices from the space of collectively rational types $\mathfrak{X}^1$ which does not satisfy the assumption. Based on a sample of choice paths, we then calculate the choice probabilities $\widehat{\pi}$ accordingly. For estimation we only use the marginal distribution of choices of each sample of household compositions and draw $B = 100$ samples from the respective empirical distributions (i.e. with replacement) to calculate $\pi^b_{\tau_N}$ and estimate the empirical distribution of the test statistic $\mathcal{J}^{\tau_N}_{N,b}$. These simulations are repeated for $p \in \{0.75, 0.85, 0.9, 0.95, 0.975, 0.99, 1.00\}$.

Figure 3 shows the power of our test against the the non-stable preference alternative as a function of p, with sample-size $\underline{N} = 500$ for the left hand side graph, and $\underline{N} = 1000$ for the right hand side graph, respectively. We use monotone cubic splines to interpolate between the actual simulation results, which are marked as solid dots. To be more precise, the respective functions refer to sample rejection frequencies using the rejection rule $J \mapsto \mathbb{1}\left\{J > \widehat{F^{-1}_{\mathcal{J}_N}}(1-\alpha)\right\}$ for $\alpha \in \{0.01, 0.05, 0.10\}$. In addition to this, we also observe that as $\underline{N}$ increases the power of our test improves and is able to correctly reject the hypothesis of a collectively rational population already at small proportions p.

The intercepts of these functions should be interpreted as the proportion of false positives (type I errors), since they correspond to the case where everyone is rational. One might expect that for a correctly sized test the empirical rejection frequencies should tend to α. However, given our partial identification procedure we have a composite null hypothesis, *i.e.* the probability of a type I error should be at most α as defined in equation

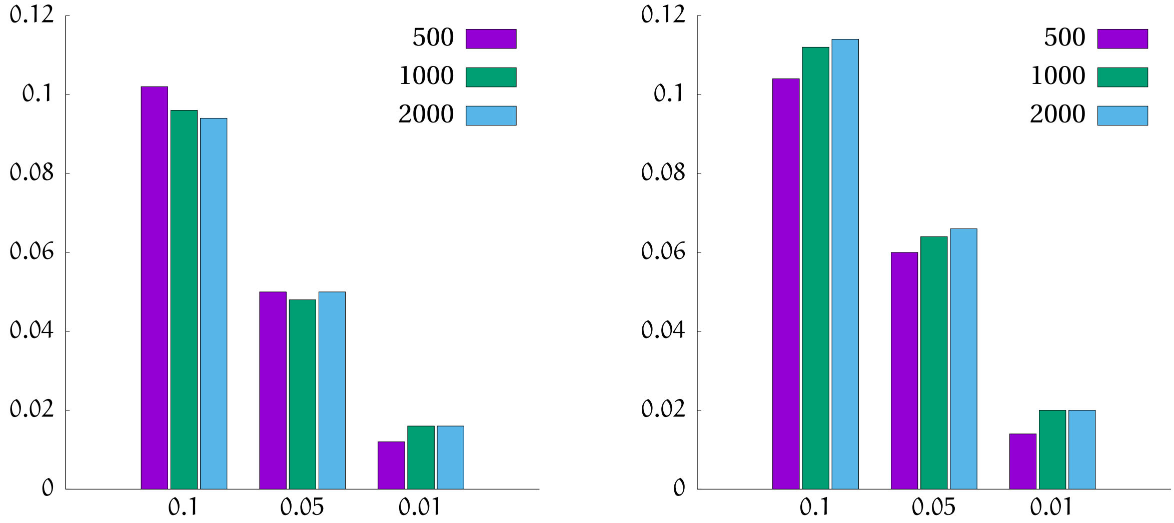
(3). To see this note that every vector of "true" choice frequencies denoted by π_0 that is in the interior of the cone will have projection residuals of length zero. Bootstrapping out of $\widehat{\pi}$ which tends to π_0 using the usual regularity properties could then lead to a confidence interval which is always entirely in the interior of the cone and we would never wrongly reject the null hypothesis. This also implies that in such a case our bootstrap distribution is degenerate and has mass one at point zero.

In our Monte Carlo setting in the case where $p = 1.0$ we randomly select types from the type-space $\mathfrak{X}^0$, satisfying collective rationality. Thus the "true" parameter vector ν_0 is assumed to have a uniform distribution over the probability simplex and the worst case – namely to get a ν such that $\pi_0 = A\nu$ is on the boundary of the cone with respect to any of its dimensions – occurs with measure zero.

Thus, in order to evaluate whether the size of our test is correct under the test's minimax strategy, we have to construct a worst case. For this, note that the test is constructed in a way that considers hypothetical types by taking combinations of possible household choice behaviour per price regime over a range of price regimes. To fix notation, we will call two collectively rational choice paths *similar* if there is at least one element in the product space spanned by these two paths which is an element of the space of collectively rational paths that do not satisfy the stable preference hypothesis. We will then construct worst cases by specifying a distribution over n_0 such similar paths. To make sure that our π_0 is on the boundary of the cone in all dimensions, *i.e.* on the cusp, we shift the cone by manually controlling the tightening parameter τ_N according to this distribution. Figure 4 shows simulation results for two such worst case scenarios with 5 similar paths and 2 similar paths, respectively.

While both are asymptotically valid from a theoretical point of view, it is not surprising that for finite samples the size for the case with a larger number of worst case paths behaves worse than the case in which there are fewer worst case paths. Since the properties of the test are based on an asymptotic argument, we should see the empirical frequency of false positives tending to the respective α which define the rejection rules and are plotted on the x-axis. The results are what one would expect, with all sample sizes being reasonably accurate. Since in a well-behaved test false-positives are by definition rather rare events, in order to minimize simulation uncertainty, we increased the number of Monte Carlo repetitions to $S = 500$ and the number of bootstrap repetitions to $B = 200$, which greatly increased computational complexity due to the high dimensionality of the testing problem.

Figure 4: Type I error for $n_0 = 5$ (l.h.s) and $n_0 = 2$ (r.h.s.) worst-case paths



A.5 Descriptive Statistics

Table 4: RLMS: Monthly Consumption

		Dairy			Bread			Meat		
Year	N	Mean	IQR	P	Mean	IQR	P	Mean	IQR	P
2000	1506	81.7	120.4	121.1	113.2	102.8	116.5	322.0	439.7	128.3
2005	1601	222.3	277.8	110.5	199.3	171.8	103.0	1003.5	1175.8	118.6
2010	2839	475.7	492.7	116.7	303.3	270.8	107.6	1862.1	1926.0	105.3
2011	2983	520.3	544.8	106.3	317.3	270.9	108.9	2165.8	2154.7	109.2
2012	3154	551.0	550.5	104.4	330.2	291.7	112.0	2284.8	2315.0	108.3
2013	3076	617.7	622.9	113.1	352.9	287.1	108.0	2366.2	2399.8	97.0
2014	2516	695.3	675.8	114.4	372.9	323.0	107.5	2805.6	2847.5	102.1

Note: Descriptive statistics of the Russian Longitudinal Monitoring Survey (RLMS) reporting mean, interquantile range (IQR) and price index P for monthly consumption of composite goods in a given year. All quantities are inflated to 2014 prices and denoted in local currency (Russian Ruble). Goods are aggregated to composite good categories as follows. Dairy: Canned/powdered milk, fresh milk, sour milk products and sour cream; Bread: White (wheat) bread and black (rye) bread; Meat: Canned meat, beef/veal, lamb/goat, pork, giblets, poultry, lard, sausage and semi-prepared meat products

Table 5: ECPF: Weekly Consumption

Year	N	Clothing			Food out			Nondurables		
		Mean	IQR	P	Mean	IQR	P	Mean	IQR	P
1985	65	1284.4	1406.4	165.7	940.9	899.7	174.3	35.1	43.8	150.6
1986	95	1334.8	1545.3	191.6	927.3	1128.1	224.7	28.8	47.6	164.5
1987	288	1743.3	1897.1	174.2	1054.7	1244.8	191.5	37.0	53.8	157.2
1988	195	1537.6	1831.0	158.1	1036.2	1400.9	160.0	42.6	53.3	145.8
1989	225	2253.9	2344.4	134.3	1446.3	1685.6	139.6	57.2	70.5	140.7
1990	205	2289.9	2565.5	106.6	1636.4	2152.1	112.2	41.0	53.2	101.9
1991	210	2255.2	2398.5	183.5	1852.4	2229.4	208.7	52.5	66.7	160.8
1992	202	2652.5	2795.1	154.5	1852.6	1957.9	154.5	69.1	85.4	144.0
1993	185	2823.0	2471.3	112.4	2386.2	3022.2	121.0	75.7	80.8	114.5
1994	210	2102.8	2471.0	106.4	2322.7	2730.5	111.2	79.8	97.4	102.9
1995	194	2186.9	2287.9	113.6	2068.9	2187.8	122.2	117.8	118.3	114.4
1996	199	2397.4	2595.2	126.5	2761.4	3230.4	126.6	107.5	129.6	129.5

Note: Descriptive statistics of the Spanish Continuous Family Expenditure Survey (Encuesta Continua de Presupuestos Familiares) reporting mean, interquantile range (IQR) and price index P for weekly consumption of goods in a given quarter. We only report descirptive statistics of the first quarter of a given year. All quantities are normalized to arbitrary units using the price indices P.