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A Dual-Process Model of Economic Decision Making: The Symmetric Effect of Intuitive and Cognitive Judgments on Optimal Budget Allocation

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Abstract: Understanding the influence of dual-processing system on budget waste resulting from choice inconsistencies is critical in helping individuals maximize decision utility. In two studies we rely on the Generalized Axiom of Revealed Preferences (GARP) to explore the severity of choice inconsistencies resulting from intuitive and cognitive judgments separately, as well as overall severity across the two types of judgments. We focus on choice inconsistency that leads to the inefficient use of individuals' budget and not on the simple preferences divergence that may result from the two types of judgment. We find that budget waste resulting from intuitive and cognitive judgments is comparable, but that overall budget waste across the two types of judgments is significantly higher. These findings suggest that the inconsistency in choices resulting from intuitive versus cognitive judgments is responsible for significant loss of decision utility in individuals' economic decisions, rather than choice inconsistencies resulting from a specific type of evaluation in itself. We discuss theoretical and practical implications of our findings.

Keywords: Choice inconsistency, Intuitive judgments, Cognitive Judgments, Budget waste, GARP, Decision making

One of the basic goals of individuals when they go shopping is to choose products that maximize their utility given the available budget. However, very often people make inconsistent decisions, potentially resulting in inefficient budget use and a loss of utility (Kahneman, 2003; Kahneman & Thaler, 2006). Understanding this process is essential in order to help individuals improve the quality of their decisions, and as a result to enhance their welfare (Ratner et al., 2008).

A lot of research has linked inconsistent choices to behavior triggered by two different types of judgments, often referred to as *intuitive* and *cognitive* (Dhar & Gorlin, 2012). Intuitive judgments are relatively automatic, quick and effortless, whereas cognitive judgments are more deliberate, slow and effortful. Previous research has investigated the role of both types of judgments in choice inconsistencies. However, some important questions remain unanswered: Which type of judgment can lead to more severe inconsistencies? Can such inconsistencies lead to a significant waste of money? To the best of our knowledge, there is no study investigating whether inconsistent choices resulting from reliance on either intuitive or cognitive judgments lead to inefficient use of individuals' budget and thus waste of money.

Relying on the theory of revealed preferences and the Afriat Index[1], we develop a task that allows us to investigate severity of choice inconsistencies created by the two types of judgments. We do this by capturing budget loss resulting from choice behaviors relying on either type of judgments. Apart from quantifying severity of choice inconsistencies, our task adds to existing studies investigating decision quality in relation to intuitive versus cognitive judgments in several ways. First, our approach is non-parametric, which means that it does not rely on

[1] The Afriat Index is a goodness-of-fit measure that quantifies how close the observed behavior is to rational behavior (i.e. a consumer maximizing preferences subject to her budget constraint). See Choi et al. (2007) for a detailed discussion of the Afriat Index that we use in the current study.

spurious assumptions regarding the functional structure of preferences. Second, it allows to test choice consistency in a non-binary paradigm and thus to account for menu dependence effects (menu dependence effects arise when the choice can vary parametrically with which collection of alternatives is available for choice). Last but not least, our task allows us to account for the simple and rational change of preferences between the two types of judgments by focusing only on inconsistent choices that lead to inefficient use of individuals' budget.

We organize the article as follows. First, we review dual-process theories of decision making, and discuss key findings about how both intuitive and cognitive judgments can lead to inconsistent choices. Next, we introduce the theory of revealed preferences and the Afriat Index, and explain how those can assess choice inconsistency severity and quantify budget waste. We present two studies investigating budget waste triggered by the two types of judgments, and we conclude with a discussion of the results and their implications.

Dual-Process Theory

One of the important assumptions in behavioral science is that decision making is driven by two types of processes, intuition and cognition. Several studies have relied on this distinction between intuition and cognition, although different authors have been using different labels to refer to it, including (but not constrained to) nonverbal versus verbal processes (Paivio, 1986), associative versus rule-based system (Sloman, 1996), type I versus type II processes (Kahneman & Frederick, 2002), hot versus cold system (Metcalfe & Mischel, 1999), reflexive versus reflective system (Lieberman et al., 2002), and experiential versus rational system (Epstein, 1994, 2003). Intuitive judgments are quick and heuristic-based, whereas cognitive judgments are deliberate and rule-based. The main features of intuition are its automatic operation and minimal demands on working memory. Intuition operates mostly through

components of associative memory, meaning that different associations emerge spontaneously and influence behavior. It tends to be rapid, unconscious, and uncontrollable (Evans & Stanovich, 2013). In contrast, the main features of cognition are the active engagement of working memory and analytical thinking. Cognitive processing happens willfully, and is effortful most of the time. It tends to be slow, conscious, and controllable (Evans & Stanovich, 2013). It is important to note that this distinction between intuition and cognition is not definitive. That is, intuition and cognition do not act in isolation from each other: both are almost always active simultaneously. However, in some cases intuition puts more weight into the decisions, while in some other instances cognition is mainly responsible for the choices (Dhar & Gorlin, 2012).

Neuroscience has added evidence for the existence of this intuitive versus cognitive distinction. Several studies have shown a relationship between automatic responses and activity in the limbic system (anterior cingulate and amygdala) on the one hand, and a relationship between more analytic and controlled processes and activity in the frontal regions of the brain such as the prefrontal and orbital cortex (LeDoux, 1996; McClure et al., 2004; Panksepp, 2004) on the other. Awareness that such differences in processing exist has triggered a growing interest in the role of these different types of processing in decision making. Several studies have investigated the influence of intuitive and cognitive processing on the quality of individuals' decisions, which we discuss next.

Dual Processing and Loss of Utility

A stream of research has shown that cognitive judgments can have a negative impact on decision quality. This negative impact (in the form of suboptimal choices) can potentially lead to budget waste. According to this literature, cognition can hinder systematic processing in individuals' decisions (Toresdillas & Chaiken, 1999). Specifically, cognition has been regarded a

form of distraction which can pull attention away from the most relevant information, and as such lead to inconsistent behavior. For instance, Lee et al. (2009) showed in four studies that more cognitive processing can lead to more transitivity errors. In these studies, transitivity was defined as a well-defined preference structure, such that for any set of bundles a, b, and c, if a R b and b R c, it must also be the case that a R c. In another study, Nordgren & Dijksterhuis (2009) showed that more deliberation led to a less consistent attitude towards products.

Studies on (un)conscious thought and decision making also show that cognitive judgments can lead to less accurate decisions in some situations (Dijksterhuis, 2004; Dijksterhuis et al., 2006). For instance, in Dijksterhuis' (2004) study participants had to choose their favorite product (e.g. apartment or car) from a hypothetical set of options; some of the options had more positive attributes than other options. Participants who deliberated more chose significantly fewer options with positive attributes than participants who made a more intuitive choice. According to the authors, conscious thinking led to less polarized, clear, and integrated representations in memory and prevented meaningful clustering. Combined, although these studies do not provide measures on the severity of inconsistencies nor potential waste of budget, they provide a good indication that cognitive judgments can contribute to loss of utility.

On the other hand, several studies suggest that utility loss from suboptimal choices can stem from intuitive judgments. A lot of behaviors that can be viewed as suboptimal, such as lack of self-control and hyperbolic discounting, are attributed to intuition (Prelec & Loewenstein, 1998; Wertenbroch 2003). According to the traditional economic point of view (Thaler & Shefrin, 1981), a person consists of two inner selves, a planner (cognition) and a doer (intuition), at any point in time. The planner is responsible for utility maximization whereas the doer, who exists only in the current period, is selfish and myopic. The planner is responsible for the more virtuous decisions which maximize long-term utility, whereas the doer often succumbs to indulgence and

is responsible for impulsive behaviors and loss of long-term utility. In line with this view, O'Donoghue & Rabin (1999) showed that typical decisions based on intuition such as immediate gratification can cause welfare loss which may be severe on several occasions. In an experimental study, Van den Bergh, Dewitte & Warlop (2008) found that "hot" stimuli inducing intuitive processing led individuals to become more impulsive in the pursuit of monetary rewards. Furthermore, Shiv et al. (2005) showed that participants able to use their emotions made less advantageous investment decisions and thus gained less money than participants not able to use their emotions (due to brain damage) and thus relying on cognition only for making decisions. Studies on resource depletion showed that depleted consumers, who are considered to rely on intuition, were willing to pay significantly higher amounts of money for the same products than consumers who were not previously depleted (e.g. Bruyneel et al., 2006). Taken together, this set of studies suggests that intuitive judgments can contribute to loss of utility. None of these studies provides insights in the severity of this utility loss or the potential budget waste related to it, however.

Adopting yet another perspective, some studies suggest that loss of utility (and/or budget waste) does not necessarily result from a specific type of judgment (i.e., from either intuitive or cognitive processing), but rather from a potential discrepancy between types of processing and/or decision situations. For instance, Read & Loewenstein (1995) found that when people choose multiple goods simultaneously (for instance during grocery shopping), they choose more variety of products than when they choose these goods sequentially (i.e., known as the "diversification bias"). According to the authors, this discrepancy in desired variety can potentially lead to inconsistent choices and loss of utility over time. Investigating the diversification bias further, Read et al. (1999) concluded that what appears to be desirable locally might not be likeable when adopting a more global perspective.

Furthermore, some other studies suggest that loss of utility caused by choice discrepancy might result from discrepant forecasting between different types of judgments (Kahneman and Snell 2002; Kahneman and Thaler 2006; Fisher and Rangel 2014). For instance, Read and van Leeuwen (1996) showed that when people were hungry, they tended to choose more unhealthy food products compared to when they were satiated. In a similar vein, Fisher and Rangel (2014) found that when hungry, individuals tend to evaluate all food items higher than when satiated. In general, when individuals use one type of judgment (for example their cognition), they are not able to correctly predict their own preferences resulting from the other type of judgement (for example their intuition). Fisher & Rangel (2014) also observed these mispredictions to be symmetric (i.e., they occurred from intuitive to cognitive and from cognitive to intuitive). However, evaluating food differently or choosing different food items does not necessarily lead to waste of money (see method section and discussion for more detailed examples). To the best of our knowledge, none of these studies has investigated whether these mispredictions can lead to inconsistent choices severe enough to end up in a loss of budget.

To summarize, findings on the influence of cognitive and intuitive judgments on utility loss are equivocal. There are studies implying that utility loss is driven by cognitive judgments, but there are also studies hinting at the idea that intuitive judgments lead to loss of utility. Yet other studies adopt a more neutral position, and suggest that a discrepancy between decision situations (and decision processes) may trigger inconsistent decisions, and thus result in an overall loss of utility. However, none of the studies has used a direct measure of severity of inconsistent choices involving conditions with different price regimes and budget restrictions. We do precisely that by employing a measure capturing the severity of choice inconsistencies (and goes beyond just a mere preference change), and translate this into budget loss. We believe that an investigation that does this could be very helpful in shedding light on the drivers of loss of utility. We will conduct

such an investigation, and use the Generalized Axiom of Revealed Preferences (GARP) and the Afriat Index to examine choice behavior in terms of efficient budget use. We introduce GARP and the Afriat Index next.

Revealed Preferences and the Afriat Index Efficiency

According to the traditional view in economics, preference consistency is a prerequisite for utility maximizing behavior (Choi et al., 2007). However, not all inconsistent choices have an equally significant negative impact on how efficiently people use their budgets (Harbaugh et al., 2001; Echenique, Lee, & Shum, 2011). In order to estimate utility loss triggered by inconsistent choices one could calculate how severe observed choice inconsistencies are. Revealed preference theory and the Afriat Index allow us to do this, as they translate choice consistency violations into an estimation of waste of budget.

Revealed preference theory was initiated by Samuelson (1938), according to whom a chosen bundle of goods x_i is "directly revealed preferred" over some other bundle x_t, if x_i is chosen when x_t is also in the budget set (i.e. x_t is not more expensive than x_i at the prevailing prices p_i). If the individual (as a utility maximizer) always chooses the best bundle s/he can get, then, if x_i is revealed preferred to x_t, s/he must never choose x_t when x_i is available. This requirement is called the Weak Axiom of Revealed Preference (WARP).

Varian (1982) formulated the Generalized Axiom of Revealed Preferences (GARP)[2], which makes use of indirect revealed preferences. A chosen bundle of goods x_i is "indirectly revealed preferred" over some other bundle x_t, if and only if there exists a sequence of bundles x_j, x_k ,… , x_s such that x_i is directly preferred over x_j, x_j is directly preferred over x_k, … , and x_s is directly

[2] GARP is a restatement of cyclical consistency condition introduced by Afriat (1967).

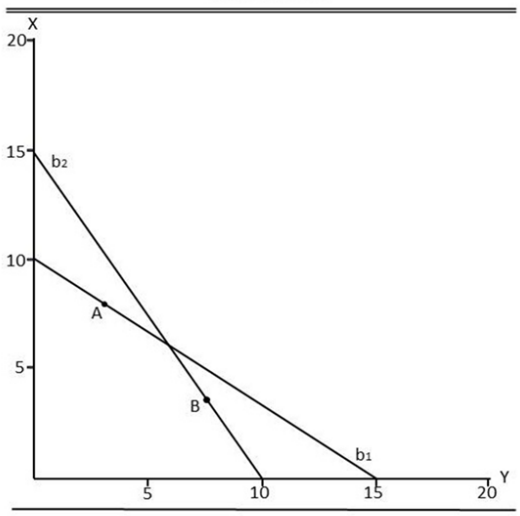
preferred over x_t.. According to GARP, if a bundle x_i is indirectly revealed preferred to x_t, then x_t is not strictly directly revealed preferred to x_i, that is, x_i is not strictly within the budget set when x_t is chosen. Varian proved that GARP provides a necessary and sufficient condition for decision-makers' choices to be consistent with the maximization of a concave, positive monotonic, locally non-satiated and continuous utility function.

Figure 1 exhibits a GARP violation, which consists of a choice inconsistency that ends up in waste of budget.[3] Suppose an individual wants to dedicate a budget of 120$ between 2 products X and Y. When the prices are p_1 (a price of 12 for X and a price of 8 for Y) the individual can buy all combinations below the budget line b_1. Suppose the individual chooses to buy the combination A (X=8, Y=3). When the prices change to p_2 (a price of 8 for X and a price of 12 for Y) all possible combinations that lie in the area below the budget line b_2 can be bought. Should the individual choose to buy the combination B(X=3, Y=8), this would violate GARP as bundle A is revealed preferred to bundle B, and bundle B is strictly revealed preferred to bundle A. By choosing combination B the individual actually wastes money as, for the given prices p_2, the revealed preferred bundle A was available at a lower cost (equal to 8*8+3*12=100$) than the chosen bundle B (in which case s/he pays 3*8+8*12=120$). In our example the individual thus failed to maximize the utility of the given budget as s/he chose bundle A over B at prices p_1 when B was cheaper (8*12+3*8=120$ for A and 8*8+3*12=100$ for B), while s/he also chose bundle B over A at prices p_2 when bundle A was cheaper (8*8+3*12=100$ for A and 8*12+3*8=120$

[3] The illustration in Figure 1 is actually a violation of WARP (Weak Axiom of Revealed Preference), which is generally weaker than GARP. WARP and GARP have the same empirical implications in the case of two commodities and linear budgets, as in this example. See Uzawa (1960), Gale (1960) and Heufer (2014) for detailed discussions on differences in empirical content of WARP and GARP. (Strictly speaking, these authors consider SARP (Strong Axiom of Revealed Preference) instead of GARP. See, for example, Varian (1982) for the subtle difference between SARP and GARP.) In this respect, we note that our experiments consider consumption bundles with up to four commodities. In such instances, GARP has generally stronger empirical implications than WARP.

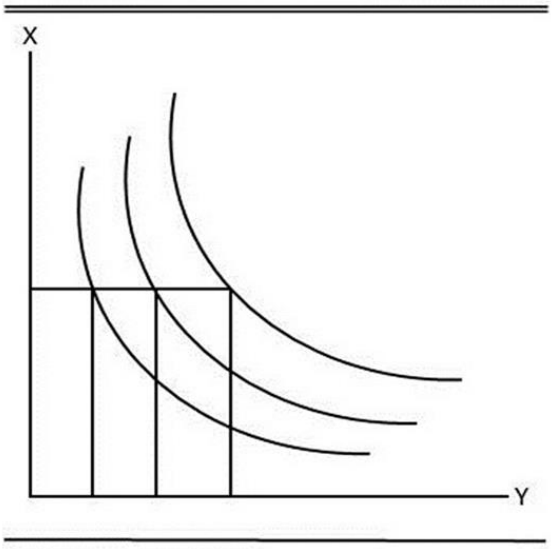
for B). In each situation s/he spent 120$ (240$ in total). If s/he had chosen B over A at prices p_1 and A over B at prices p_2 s/he would have spent 100$ in each situation (200$ in total) and ended up with the same quantities of products. This difference of 40$ constitutes waste of budget. Below we will introduce the Afriat Index as a measure for the efficiency of individuals' choices, which captures exactly this idea of budget waste associated with behavior that violates GARP.

Figure 1
GARP Violation



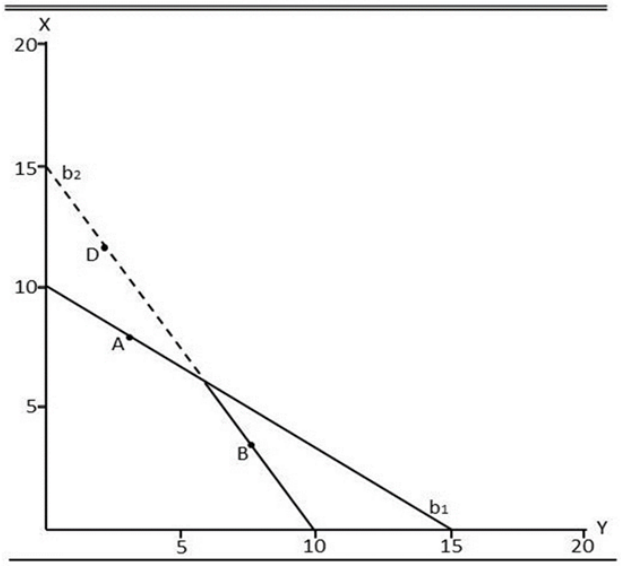
The essence of revealed preference theory and GARP lies in the concept of indifference curves. Indifference curves show the different bundles of goods between which a decision maker is indifferent. In other words, indifference curves show the quantity of product X an individual is willing to sacrifice to get a certain quantity of product Y. A utility maximizing individual always wants to move to higher indifference curves as s/he gets better bundles of products, meaning that s/he can combine the same quantity of X with larger quantities of Y (see figure 2) and vice versa.

Figure 2
Indifference Curves



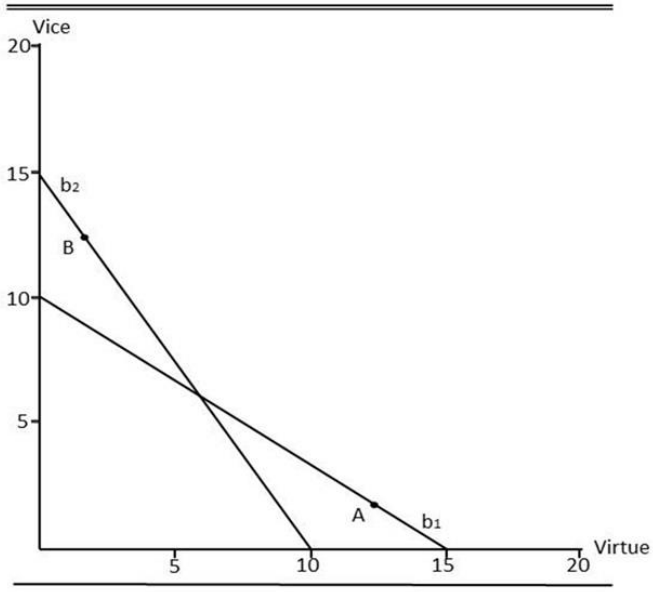
In the case of the above example, a choice that maximizes the utility of the available budget at prices p_2, given the fact that the individual chose the combination A (X=8, Y=3) at prices p_1, would be combinations placed on the dotted section of the budget line b_2, for example the combination D (X=12, Y=2) in figure 3. Choosing these combinations would allow the individual to move to higher indifferences curves and end up with bundles containing larger quantities of products. However, choosing combination B (X=3, Y = 8) would not.

Figure 3
Rational Choice



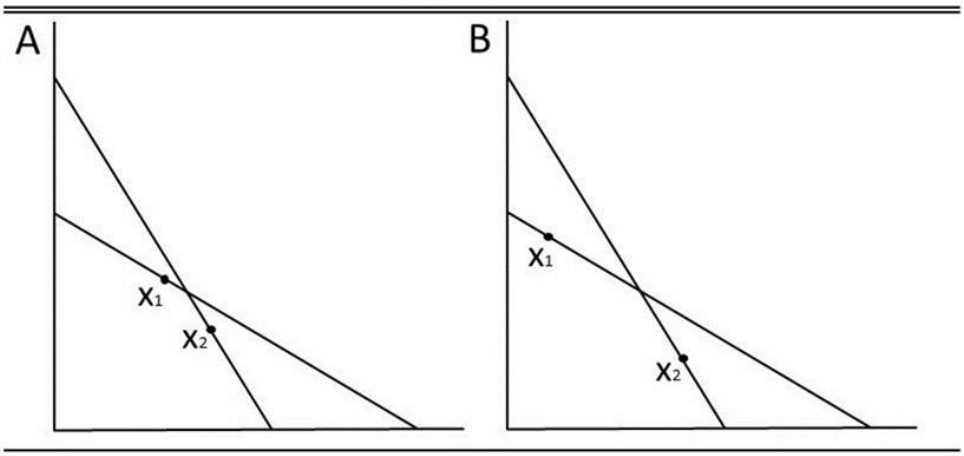
An important question pertains to the way GARP can reveal inconsistencies that go beyond a simple change in choice patterns. As one can observe, GARP does not necessarily punish every change in choices but merely those that are harmful for the efficient use of the available budget. Figure 4 exhibits how individuals can change their consumption patterns and in one instance for example choose a bundle with larger quantities of product X (choice B) and in another instance choose a bundle of goods containing larger quantities of product Y (choice A) without violating GARP (and thus without wasting budget).

Figure 4
Change of Preferences without violating GARP



Afriat (1972a; 1972b) has introduced an efficiency index which can be used to measure the severity of GARP violations. This measure has been developed in the context of budget waste. As explained above, a violation of GARP can be interpreted as a waste of money. Basically, the Afriat Index measures the overall efficiency of individuals' choices as the fraction of their budget that is wasted when GARP is violated (see Afriat (1973) and Varian (1990, 1991) for precise formal definitions). The index can take values between 0 and 1. A value of 1 means that there are no GARP violations (and no budget is wasted), whereas a value below 1 reveals that GARP is violated (with corresponding budget waste). Lower index values indicate that a larger fraction of the budget is wasted. In general, more severe inconsistencies in choices have a bigger impact on the Afriat Index. For example, the situation in the left panel of figure 5 implies a less severe GARP violation and, therefore, a higher value for the Afriat Index than the situation in the right panel of figure 5.

Figure 5: Severity of GARP violations. B a more severe violation



Several studies have used revealed preferences in experimental settings to investigate whether people behave consistently. Battalio et al. (1973) used data from choices made by female patients at a psychiatric hospital. Participants bought goods at a commissary, where the prices were arranged to change periodically. Between 5 and 50 percent of participants made choices that violated revealed preference axioms of choice consistency. In a sample of college students, Sippel (1997) studied choices for eight different consumption goods, using ten different budget sets. He found that more than 50% of participants violated GARP. However, both Sippel and Battalio et al. measured only the number of GARP violations and not the severity.

Mattei (2000) used the Afriat Index in three experiments to test whether individuals choose consistently. He found a number of violations in participants' choice behavior, which may be conceived as reflecting low levels of GARP inconsistencies. Harbaugh et al. (2001) used GARP and the Afriat Index to investigate the severity of choice (in)consistencies in children by asking them to decide between bundles of food products. They found that although the level of choice consistency appeared already high at the age of seven, the 7-year olds behaved less consistently than the 12 year-olds and the adults they studied. Andreoni & Miller (2002) investigated

consistency of altruistic behavior using a modified version of a dictator game. They found a high degree of heterogeneity between individuals: whereas some individuals behaved consistently altruistic or egoistic, others were quite inconsistent in their social preferences.

We will rely on GARP and the Afriat Index in an experimental setting to obtain more insight in choice consistency and budget waste when individuals make decisions relying on intuitive versus cognitive processing. To calculate the Afriat Index we construct a choice task in which decision-makers have to choose between 4 products on 12 different budget instances, and the prices of the products vary across the instances. Individuals have to go through this measurement twice, once using their intuition and once relying on cognition. This allows us to assess budget loss from choice behavior based on the two types of judgment separately. As the measurements are comparable, we can also calculate an overall Afriat Index as an indication of budget waste resulting from inconsistent choices made across both types of judgments. As such, these indices allow us to compare overall budget waste with budget waste caused by both types of judgments separately (cognitive versus intuitive). We use this rationale in two studies.

Study 1

The goal of the first study was to assess the extent of budget waste resulting from decisions relying more on cognitive versus intuitive judgment.

Method

Participants

Participants were 138 students from a large university (43.9% women, average age 20.43 years, SD=2.01). They were invited to come to the lab to complete a task designed to capture the

severity of inconsistent choices, in exchange for €12 or 4 course credits. Participants came to the lab in groups of 10, and completed the task individually on a pc in a semi-enclosed cubicle.

Design

Procedure

As a manipulation of cognitive and intuitive judgments we varied the visceral state hunger. A visceral state has a direct hedonic impact and influences the relative desirability of different goods and actions (Loewenstein, 1996). Its function is to grab the attention needed to ensure that certain actions are taken (e.g., obtaining food when hungry; Loewenstein, 2000). Visceral states function with minimal higher-level cognitive mediation, and thus can have a large influence on behavior without the interference of cognitive deliberation (LeDoux, 1996; Loewenstein, 2000). In general, people who are in a visceral state tend to rely more on intuitive judgments than people who are not in a visceral state (Nordgren, et al. 2007).Visceral influences have been associated with more intuitive and less deliberative behaviors such as over-eating (Loewenstein, 2000). In particular, hunger can lead to a variety of behaviors that can be characterized as more intuitive than cognitive. For instance, hungry people crave food more (Ditto et al., 2006), tend to forget about their weight goals (Nordgren, Van der Pligt & Van Harreveld, 2008) and spend more, even on non-food objects (Xu , Schwarz & Wyer, 2015).

We used a mixed design consisting of three between-subjects conditions: An experimental condition in which intuitive and cognitive judgments were activated sequentially during two choice-making episodes, and two control conditions in which only one of the two types of judgments was activated (intuitive or cognitive) during both choice-making episodes. In all conditions, the measurements were separated by one week (choice-making episodes were manipulated within-subjects). Similar to the design of Nordgren et al. (2007), in the hungry

(intuition) state participants were instructed to not eat for at least four hours prior to the study. In the satiated (cognition) state, participants were instructed to eat a full meal within the hour prior to the study. In the experimental condition, participants completed the choice task once hungry (intuition) and once satiated (cognition). The order of the tasks was counterbalanced, and did not influence the results. In the "cognition" control condition participants were asked to come to the lab satiated (eat a full meal within the hour prior to the study) both times, whereas in the "intuition" control condition participants were asked to come to the lab hungry both times. In the end of each session participants had to declared the time that has passed since their last meal in order to check if they followed the instructions. 12 participants that did not follow the instructions were not included in the analysis.

Varian (1988) has argued that, when part of the consumption space is not observed, GARP does not have any empirical content. However, recently, Heufer and van Bruggen (2017) showed that if the "the rest of the world" remains unchanged during all the decision making problems, GARP has empirical content. They showed that, for decisions made within a short time period, GARP has an empirical content, while this is not the case for decisions made with a relatively large time gap. We included the two control conditions in order to increase confidence that potential differences in the Afriat Index between sessions in the experimental condition could be attributed to differences between the two types of judgments, rather than to noise driven by the one week time lag in between the experimental sessions. We believe that if the differences in the consumption patterns between the two sessions in the control condition are similar (i.e. the difference is insignificant), this is a good indication that the preferences of the participants did not change in the time gap between the two sessions. Therefore, our comparisons in the experimental conditions are meaningful.

Revealed Preference Task: To be able to calculate the Afriat Index we created a choice task. Our task was similar to the one used in studies of Harbaugh et al. (2001) and Bruyneel et al. (2012). The task included 12 sequential choice problems, with each choice problem consisting of four products: two vice, relatively tasty but not so healthy (chocolate bar and Dorito chips) products and two virtue, relatively healthy but not so tasty (baby carrots and raisins) products. The prices of the products differed for every choice problem. Participants were asked to indicate the quantities they wanted from each product given the different price regimes and their budget (10 tokens). For every choice problem participants had to spend their entire budget and had the option to choose non-integer quantities. Table 1 presents a summary of our choice task.

The price-income regime in the task (variation in prices and a fixed budget) implies a high power for testing choice consistency, which means that the probability of detecting inconsistent behavior is high (Bronars 1987). High power arises from the fact that there is a lot of variation in prices and no income variation (Cherchye and Vermeulen 2008). In Appendix A we report some more in depth discussion of the notion of power and we present some descriptive statistics for our experiment.

Table 1: Revealed Preferences Task

Choice Problem	Prices per 10 gr				Budget
	Carrots	Raisins	Chocolate Bar	Dorito Chips	
1	5	3	4	4	10
2	5	4	3	4	10
3	5	4	4	3	10
4	3	5	4	4	10
5	4	5	3	4	10
6	4	5	4	3	10
7	3	4	5	4	10
8	4	3	5	4	10
9	4	4	5	3	10
10	3	4	4	5	10
11	4	3	4	5	10
12	4	4	3	5	10

Measures

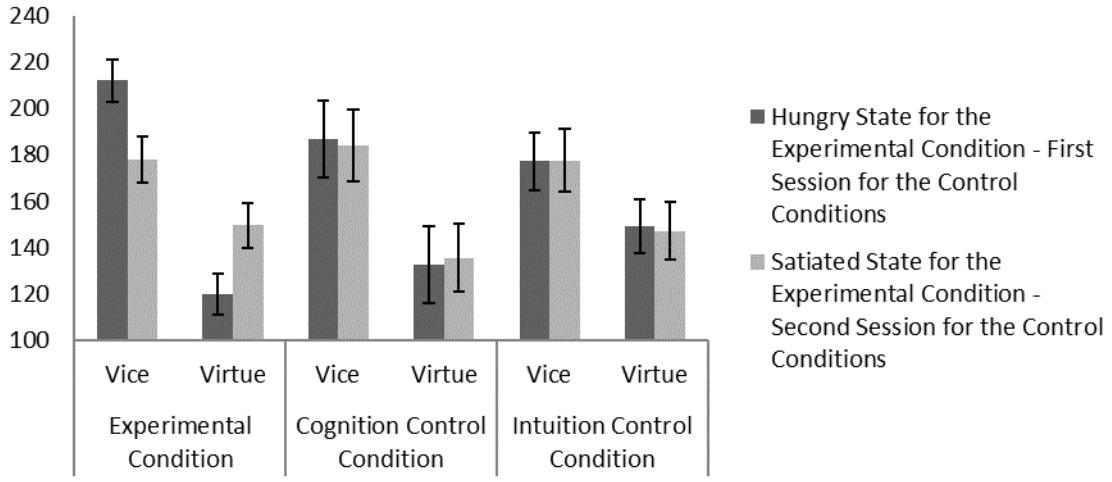
When completing the choice task, participants had to choose between virtue and vice products. To check whether the manipulation of cognitive versus intuitive processing was successful, we measured the relative occurrence of virtue and vice choices in both sessions. We expected choices in the hungry (intuition) state to be more vicious in nature than choices in the satiated (cognition) state. For every respondent we also calculated the Afriat Index for each session separately, as well as the aggregated Afriat Index across both sessions (the type of judgment varied across sessions in the experimental condition but remained constant in the control conditions). We compared these three different indices to investigate differences in severity of choice inconsistencies and budget waste resulting from the different types of judgments.

Results and Discussion

Product Choice

A paired samples test showed that in the experimental condition, respondents chose more grams of vice products when hungry than when satiated (see Table 2 and Figure 6), whereas they chose fewer grams of virtue products when hungry than when satiated. In the control conditions none of the differences were significant. Specifically, in the cognition control condition the quantities of vice and virtue products chosen in the first session were not significantly different from those chosen in the second session (See Table 3 and Figure 6). Similarly, in the intuition control condition the quantities of vice and virtue chosen in the first session did not differ significantly from those chosen in the second session (see Table 4 and Figure 6).

Figure 6: Product Choice



Additionally, we compared the differences between vice choices in the two sessions across conditions and did the same for virtues. The comparison showed that the difference in both vice and virtue choices for the two sessions was significantly larger in the experimental condition than in the two control conditions (combined) ($t_{vice}(136)=3.884$, $p<0.001$; $t_{virtue}(136)=2.115$, $p=0.036$).

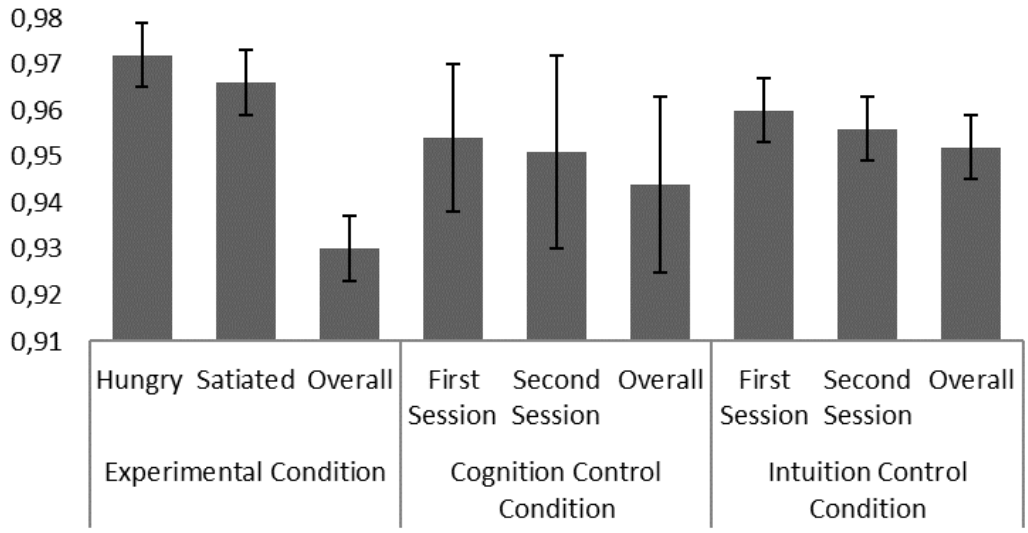
Budget Waste

Comparing the Afriat Indices resulting from choices in both sessions in the experimental condition, we found that the difference was insignificant (See Table 2 and figure 7). These results indicate that the proportion of the budget wasted was similar for both types of judgments (cognitive versus intuitive).

We also calculated the overall Afriat Index across the two sessions (different types of judgments) in a way that allowed us to directly compare it with both indices resulting from choices relying on either type of judgment separately. This is possible as the power and thus reliability of the choice test depends by construction on three components: the number of observations, the price variation, and the choice of budget sets (Cherchye and Vermeulen 2008). To meaningfully compare two Afriat Indices these components have to be the same. Therefore we constructed an overall Afriat Index with components that were identical to the ones of the separate indices. Specifically, we randomly picked six observations from each session dataset for each respondent to neutralize the fact that the Afriat Index is sensitive to the number of observations. We avoided picking the same price regime twice to secure that the price regime and the specific choice sets were identical with that of the within-sessions tests. This yielded a dataset consisting of 12 observations per individual that allowed us to calculate an overall, cross-states Afriat Index that was directly comparable to the separate, within session indices. We repeated the same procedure 200 times and calculated the average of the overall Afriat Index for every respondent. We observed that the overall index was significantly lower than both indices calculated based on choices relying on intuitive versus cognitive judgments, respectively (See Table 2). Percentage of budget wasted was approximately 3% for judgments relying on either intuition or cognition, whereas overall it was 7%.

The difference between the indices in the cognition control condition were all insignificant. The Afriat Index calculated from choices in the first session was not significantly different from the Afriat Index calculated from choices in the second session (see Table 3). In addition, these two indices were not significantly different from the overall index calculated from choices across sessions (see Table 3 and Figure 7). The overall Afriat Index was calculated in the same way as the overall Afriat Index in the experimental condition (cf. supra). Results were similar for the intuition control condition. The index calculated from choices in the first session was not significantly different from the index calculated from choices in the second session (see Table 4). Neither of these indices was different from the overall index calculated from choices across sessions (see Table 4 and Figure 7).

Figure 7: Afriat's Index



We calculated the absolute difference between the overall Afriat Index on the one hand and both separate Afriat Indices (which we averaged) on the other in all conditions, and compared these differences across conditions. We found that the difference ($d_{experimental}$ =0.031) in the

experimental condition was significantly larger than in the two (pooled) control conditions ($d_{control}$=0.006; t(136)=3.312, p=0.001).

Additionally, we calculated the Money Pump Index (MPI) as a robustness check for our results. The MPI is an alternative measure for the severity of GARP violations. The basic notion behind the MPI is similar to the Afriat Index. However, the two measures differ in their interpretation. The MPI "is the monetary magnitude that can be extracted from a consumer that violates GARP" (Echenique et al. 2011), while the Afriat Index can be interpreted more as the "margin of error" (Varian 1990) that can be allowed to the consumers when making consumption choices or as a tolerance for wasted expenditure. Following a suggestion of Smeulders et al. (2013), we computed the so-called "average" MPI (defined as the average of the "minimum" and "maximum" MPIs). Interestingly, the MPI results are very similar (almost identical) to the ones we got when we computed the Afriat Index (for the detailed results, see Appendix B). Again, all the comparisons for the control conditions were insignificant (apart from one comparison). Moreover, similar to the Afriat Index results, in the experimental condition the MPI of the session where participants used their intuition was not significantly different from the one where they used their cognition. However, when we compared these MPIs with the overall MPI, we observed a significant increase in the budget wasted in GARP violations.

The findings of our first experiment suggest that the degree of choice inconsistency and budget waste resulting from either intuitive or cognitive judgments is comparable. Although choice behavior relying on intuition (hungry state) was more vicious (the quantity of vice products chosen was larger) compared with choice behavior relying on cognition (satiated state), choice inconsistencies and budget wasted resulting from both types of behaviors as measured by the Afriat Index were not significantly different. Specifically, budget wasted when relying on

intuitive versus cognitive judgments was approximately 3% in both instances, indicating that respondents wasted only 3% of the budget on suboptimal choices regardless of whether they used their cognition or intuition to decide. However, the overall budget waste across types of judgments was significantly higher (7%). Thus, though loss of utility from choice behaviors relying on the different types of judgments was similar when assessed separately for each type of judgment, the preferences revealed by the two types of judgments had a negative impact on utility when pooled and assessed together.

Table 2: Experimental Condition

Product Choices

	Products	Difference		Products	Difference	
	Vice	t(66)	P	Virtue	t(66)	p
Hungry	211.99 (SD=72.81)			119.87 (SD=70.38)		
Satiated	177,87 (SD=82,20)	3.90	<0.001	149.52 (SD=79.20)	3.49	0.001

Budget Waste

Sessions	Afriat Index	Differences					
		Hungry-Satiated		Hungry-Overall		Satiated-Overall	
		Z	P	Z	p	Z	p
Hungry	0.972 (SD=0.081)						
Satiated	0.966 (SD=0.054)	-0.261	0.794				
Overall	0.93 (SD=0.077)			-3.836	<0.001	-3.169	0.002

Table 3: Cognition Control Condition

Product Choices						
Sessions	Products	Difference		Products	Difference	
	Vice	t(30)	p	Virtue	t(30)	p
Session 1	186.89 (SD=92.57)			132.55 (SD=92.88)		
Session2	184.14 (SD=85.38)	0.575	0.569	135.58 (SD=82.52)	-0.554	0.584

Budget Waste							
Sessions	Afriat Index	Differences					
		Session 1-Session 2		Session1-Overall		Session2-Overall	
		Z	p	Z	p	Z	p
Session 1	0.954 (SD=0.091)						
Session 2	0.951 (SD=0.119)	-0.568	0.570				
Overall	0.944 (SD=0.106)			-0.597	0.550	-1.232	0.218

Table 4: Intuition Control Condition

Product Choices						
Sessions	Products	Difference		Products	Difference	
	Vice	t(39)	p	Virtue	t(39)	p
Session 1	178.00 (SD=80.06)			148.77 (SD=72.97)		
Session 2	176.74 (SD=84.66)	0.230	0.819	149.65 (SD=79.22)	0.158	0.875

Budget Waste							
Sessions	Afriat Index	Differences					
	Mean	Session 1-Session 2		Session1-Overall		Session2-Overall	
		Z	p	Z	P	Z	p
Session1	0.962 (SD=0.077)						
Session2	0.954 (SD=0.087)	-0.579	0.794				
Overall	0.952 (SD=0.070)			-1.232	0.218	-1.003	0.316

Study 2

The aim of the second study was to replicate the results of the first study using another manipulation of intuitive versus cognitive judgment. To test the robustness of our results, in the second study we used another manipulation to trigger intuitive versus cognitive judgments that has been used in numerous studies in the past (e.g. Shiv and Fedorikhin 1999; Trope and Alfieri 1997): cognitive load. Cognitive load prevents individuals from deliberating and makes them use their intuition more (Shiv and Fedorikhin, 1999). Furthermore, we wanted to incentivize respondents to make utility maximizing choices by increasing the available budget in the choice

task (from 10 to 20 tokens) and offering participants one of their choices at the end of the session. Participants were told that the will (and actually did) receive the quantities of the products they would choose in one of the twelve exercises of the revealed preferences task in the end of each session[4]. This is in contrast to study 1 where choices were hypothetical.

Method

Participants

Participants were 118 students from a large university (60% women, average age 21.18 years, SD=3.62). They were invited to come to the lab in exchange for €12 or 4 course credits.

Design

Procedure

We again made use of a mixed design including three between-subjects conditions, completed in two sessions (48 hours difference; manipulated within-subjects). Specifically, in the experimental condition a different type of judgment (once intuitive and once cognitive) was activated in each session (the order was counterbalanced and did not affect the results), whereas in the two control conditions the same type of judgment was activated (either intuitive or cognitive) in each session. Specifically, a cognitive load task was used as a manipulation of the two types of judgment. That is, participants were asked to keep in mind a difficult sequence of 8 different consonants (e.g. GTPWLZKN, high cognitive load or intuitive judgment) or an easy sequence of 8 identical consonants (BBBBBBBB, low cognitive load or cognitive judgment) (e.g. Van Boven and Robinson, 2012; Beer, Chester and Hughes, 2013). We reasoned that in the

[4] In the study participants had to choose the commodities with precision of 0.01 gram. However, the quantities participants received in the end of the study were rounded to 1 gram.

high cognitive load condition, the intuitive system would become relatively stronger than the cognitive system compared to the low cognitive load condition.

Participants were given a piece of paper displaying the sequence for 90 seconds, and were asked to memorize it. In the experimental condition, participants executed the decision task (similar to the one used in study 1) while keeping in mind the difficult sequence (intuitive judgment) in one of the two sessions, and while keeping in mind the easy sequence (cognitive judgment) in the other session. In the cognition control condition participants were asked to keep in mind the easy sequence while making their decisions in both of the sessions, whereas in the intuition control condition participants had to keep in mind the difficult sequence while making decisions in both of the sessions. To ensure that participants put the appropriate effort in the task, we checked whether participants managed to reproduce the sequence. All the participants managed to reproduce at least 70% of the sequence. Consistent with prior literature, kept all of them in the analysis (e.g. Van Boven and Robinson, 2012; Beer, Chester and Hughes, 2013).

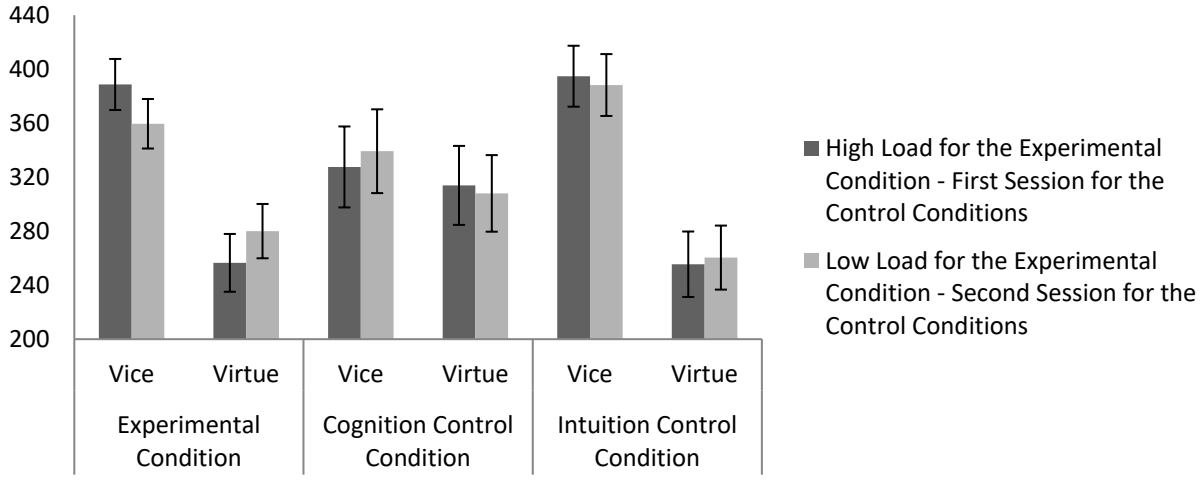
Measures: Similar to the first study, participants had to choose quantities of four products (the same 2 virtues and the same 2 vices that were also used in study 1) in each of twelve choice situations with different price regimes. As mentioned above, the only difference compared to study 1 was that the budget for every choice exercise was doubled. Furthermore, participants were (truthfully) told that they would be entitled to one of their chosen product bundles at the end of every session. As a manipulation check we again measured the relative virtue and vice choices resulting from cognitive versus intuitive judgment. Furthermore, for every respondent we calculated the Afriat Index for choices resulting from each type of judgment separately and both types of judgments combined.

Results and Discussion

Product Choice

A paired samples test showed again that in the experimental condition respondents chose more grams of vice products when they were under high cognitive load than when they were under low load, whereas they chose fewer grams of virtue products when under high load than when under low load (see Table 5). In the control conditions none of the differences was significant. Specifically, in the cognition control condition the quantities of vice and virtue products chosen in the first session were not significantly different from those chosen in the second session (see table 6). Similarly, in the intuition control condition the quantities of vice and virtue chosen in the first session did not differ significantly from those chosen in the second session (see Table 7).

Figure 7: Product Choice



Additionally, again we compared the difference in vice as well as virtue choices between sessions across conditions. The comparison showed once more that the difference in vice choices between sessions was significantly larger in the experimental condition than in the two control conditions. The difference in virtue choices between sessions was marginally significantly larger

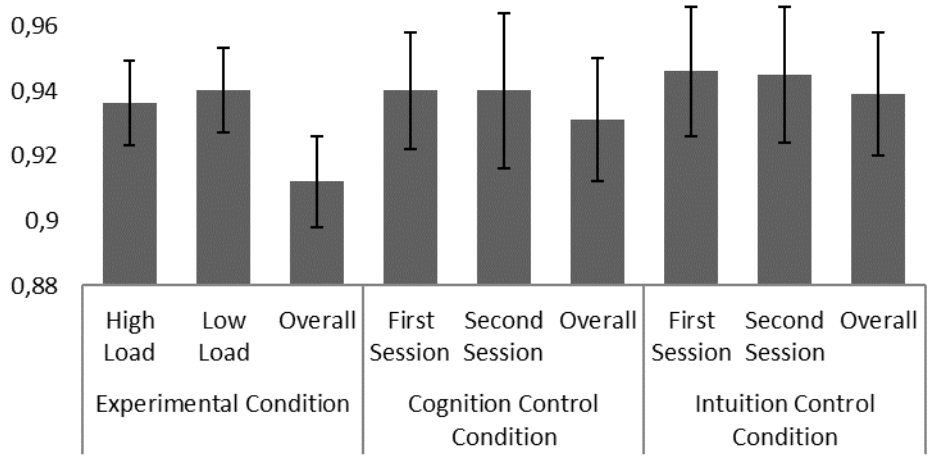
in the experimental condition than in the two control conditions ($t_{vice}(115)=1.992$, $p=0.049$; $t_{virtue}(115)=1.751$, $p=0.083$). This pattern of choice confirms our expectations and replicates the findings of study 1.

Budget Waste

As in study 1, the difference in the Afriat Indices resulting from choices in both sessions in the experimental condition was insignificant (Table 5). These results again indicate that the proportion of the budget wasted was similar for both types of judgments (cognitive versus intuitive). After a similar processing of the data as in Study 1, we calculated the overall Afriat Index and compared it with the separate indices. The overall index was significantly lower than the other two indices (Table 5). Percentage of budget wasted was approximately 6% for judgements relying on either intuition or cognition, whereas overall it was approximately 9%.

As in Study 1, none of the differences between any of the indices in the control conditions was significant. In the cognition control condition, the Afriat Index calculated from choices in the first session was not significantly different from the Afriat Index calculated from choices in the second session. In addition, these indices were not significantly different from the overall index calculated from choices across sessions (Table 6). The results were similar for the intuition control condition. The index calculated from choices in the first session was not significantly different from the index calculated from choices in the second session, and neither of these indices was different from the overall index (Table 7).

Figure 8: Afriat's Index



As in Study 1, we calculated the absolute difference between the overall Afriat Index on the one hand and both separate Afriat Indices (which we averaged) on the other in all conditions, and compared these differences across conditions. Again, we found that the difference in the experimental condition ($d_{experimental}$=0.025) was significantly larger than in the two (pooled) control conditions ($d_{control}$=0.009; t(115)=2.110, p=0.037).

We calculated again MPI as a robustness check. Once more, as in study 1 the results were similar the ones we got when we calculated Afriat Index (see Appendix B for more details).

The purpose of study 2 was to replicate the results of study 1, using a different manipulation of cognitive versus intuitive processing. The findings indicate, in line with study 1, that the degree of choice inconsistency and budget waste resulting from behaviors relying on either intuitive or cognitive judgments is not significantly different, although the behaviors themselves (the actual choices being made) differ. However, once more we noticed a significant increase in budget waste when calculating the overall budget waste from choices made across situations.

These results confirm that a significant waste of money results from conflicting behaviors triggered by the different types of judgments.

Table 5: Experimental Condition

Product Choices						
Sessions	Products	Difference		Products	Difference	
	Vice	t(63)	p	Virtue	t(63)	p
Cognitive load	390.72 (SD=151.07)			257.64 (SD=144.74)		
Non-load	363.34 (SD=168.36)	-2.645	0.010	278.57(SD=160.65)	2.097	0.040

Budget Waste							
Sessions	Afriat Index	Differences					
		Cognitive load-Non-load		Cognitive load-Overall		Non-load-Overall	
		Z	p	Z	p	Z	p
Cognitive load	0.937 (SD=0.108)						
Non-load	0.941 (SD=0.106)	-0.077	0.939				
Overall	0.913 (SD=0.112)			-2.144	0.032	-2.362	0.018

Table 6 : Cognition Control Condition

Product Choices						
Sessions	Products	Difference	Products	Difference		
	Vice	t(25)	p	Virtue	t(25)	p
Session 1	327.58 (SD=146.85)			313.91 (SD=143.32)		
Session 2	339.23 (SD=152.04)	-0.981	0.337	307.10 (SD=138.94)	0.487	0.631

Budget Waste							
Sessions	Afriat Index	Differences					
		Session 1-Session 2		Session1-Overall		Session2-Overall	
		Z	p	Z	p	Z	p
Session 1	0.943 (SD=0.093)						
Session 2	0.934 (SD=0.123)	-0.063	0.950				
Overall	0.931 (SD=0.100)			-0.511	0.609	-0.795	0.427

Table 7: Intuition Control Condition

Product Choices						
Sessions	Products	Difference		Products	Difference	
	Vice	t(27)	p	Virtue	t(27)	p
Session 1	394.28 (SD=119.50)			255.51 (SD=121.26)		
Session 2	388.26 (SD=128.29)	0.417	0.680	260.43 (SD=125.29)	-0.336	0.740

Budget Waste							
States	Afriat Index	Differences					
		Session 1-Session 2		Session1-Overall		Session2-Overall	
		Z	p	Z	p	Z	p
Session 1	0.946 (SD=0.110)						

Session 2	0.945 (SD=0.113)	-0.051	0.959				
Overall	0.939 (SD=0.105)			-0.621	0.535	-0.672	0.501

General Discussion

We conducted two studies to assess the degree of choice inconsistency from reliance on intuitive and cognitive judgment. Results of both studies indicate that the extent of budget wasted resulting from choices relying on either of both types of judgments is not significantly different, despite the fact that product choices differ. However, a further analysis revealed that the discrepancy between choices made under the influence of intuitive judgments on the one hand and cognitive judgments on the other had a negative impact on overall budget waste, as measured by the overall Afriat Index calculated from choices across situations in which intuitive and cognitive judgments were activated. This finding suggests that the discrepancy between choices resulting from the different types of judgment is responsible for a significant loss of decision utility.

Our findings provide an answer to the question as to which type of judgment leads to more severe choice inconsistencies. Our studies are the first to estimate how severe inconsistent choices resulting from intuitive versus cognitive judgment are. Our findings show that both types of judgments lead to an equal degree of choice inconsistency. Previous studies showing that cognitive judgment leads to more choice inconsistency have measured either the number of transitivity errors (Lee et al., 2009) or the extent of attitude inconsistency towards products (Nordgren & Dijksterhuis, 2009). However, transitivity errors differ in terms of their impact on budget waste (Harbaugh et al. 2001; Echenique, Lee, & Shum 2011), as does the degree of attitude inconsistency. The authors attributed the choice and attitude inconsistencies they observed to cognitive noise, but our data suggest that cognitive noise may have a minor impact

on overall budgeting efficiency. Furthermore, another research stream suggesting that intuitive judgment leads to less optimal choice making (Van den Bergh, Dewitte & Warlop, 2008; Shiv et al., 2005) has identified these suboptimal choices as biased by affective noise related to intuitive processes. Our data however suggest that affective noise only has a minor impact on overall budgeting efficiency. Although intuitive judgments have been found to lead to some types of suboptimal decisions such as temporal discounting and more risk seeking, there is a set of findings suggesting that intuition is not by definition harmful and that its impact depends on the context and the type of decisions (e.g. Pocheptsova et al., 2009).

Compared to previous research studying the influence of cognitive versus intuitive judgment on choice consistency, our study is the first to include some important components in the experimental setting that have been ignored by previous studies: 1) a non-binary setting (respondents had to choose between more than two products), 2) the use of budget constraints and 3) the price variation. Theses added components may also have contributed to the discrepancy between previous findings and ours. Binary choice settings and pairwise comparisons have been shown to be particularly vulnerable to changes in attribute importance (Rieskamp, Busemeyer & Mellers, 2006). Furthermore, available budgets and prices are important drivers of economic decisions, as they set the broader context under which these decisions take place and thus define the level of consistent behavior (Becker, 1962; 1993; Samuelson, 1938). We show both types of judgments to be equally appropriate for making consistent economic decisions. The symmetry in our findings suggests that the decision making rules followed by intuition and cognition in economic contexts involving price regimes and budget constraints might not be all that different. This is consistent with recent proposals suggesting that cognitive and intuitive judgments can be based on common principles in certain environments (Kruglanski & Gigerenzer, 2011). Specifically, Kruglanski & Gigerenzer (2011)

argue that in some environments in which relevant cues are set (for example in our case the budget constraints and price regimes) and the decisions are made sequentially, the two types of judgments will rely on the same rules to reach a decision. By rules the authors refer to the inferential devices used for categorization, estimation, paired comparisons, and other judgmental tasks that go beyond the given information.

Our findings can be related to literature on affective forecasting errors and hot-cold (and cold-hot) empathy gaps. Kahneman & Thaler, (2006) argued that when people make choices they tend to forecast utility of an outcome. When the forecast is wrong, decision-makers experience loss of utility in the future. For example, a very hungry shopper doing his/her weekly shopping at the beginning of the week may buy very large portions of food or a greater variety in food products, and end up having (too much) food at home that s/he does not like very much. On the other hand, satiated shoppers who underestimate the value of hedonic products will focus on a specific set of goods, and end up with a basket of products that they do not really want to consume when hungry. In both cases, wrong forecasting results in loss of experienced utility at time of consumption (Kahneman & Thaler, 2006). Although we did not directly test forecasting errors, we show how the gap between the two types of judgments prevents individuals from forming global preferences that will enable them to make more optimal decisions. A hungry shopper (relying on intuitive judgments) forms his/her preferences between various products as if the importance of the products and their prices will still be the same for him/her when satiated (when s/he will be relying on cognition to make his/her choices). Our findings show that the actual dissimilarity in the preferences can lead to severe inconsistencies which end up in a significant waste of budget from an overall perspective.

We contribute to the literature on economic decision making by showing that loss of utility due to inconsistent choices is not a result of the decisions driven by one specific type of

judgment directly, but of the conflicting choices driven by these two types of judgment separately instead. We speculate that in order to reach the indifference levels that allow them to choose products, individuals using either intuition or cognition give weights to the attributes of the products, which very often differ. For instance, "taste" is perceived and weighted as more important by intuition than by cognition (Fisher & Rangel, 2014). One result of such a dissimilarity in attribute weights is that the levels of indifference between various products reached by both types of judgment are different (Goldstein, 1990). Such dissimilar indifference levels should prevent decision-makers from moving to higher indifference curves and thus optimize the use of their budgets across decision situations in which they rely on different types of judgments.

Taking a broader perspective, our results suggest that self-control strategies characterized by anticipation of an upcoming event and the deployment of certain means to prevent one's future self from acting on desire, can have a negative impact on preference consistency. Employing strategies such as counteractive self-control, guilt, or other complex incentive schemes (e.g. Ariely & Wertenbroch, 2002; Fishbach, Dhar & Zhang, 2006) which bring more conflict between the two types of judgment might lead to more suboptimal choices from an overall perspective. For instance, a hungry shopper trying to suppress the weight of an attribute such as taste (counteractive self-control) might reach indifference levels between products that differ from the levels reached in a hungry as well as from those reached in a satiated state (as preferences across types of judgment seem hard to predict). Creating a third level of indifference may drive the overall waste of budget to even higher levels. Techniques aimed at increasing the connection between intuition and cognition might yield better results. Bartels & Urminsky (2011) found that increasing the connection between current and future self by using techniques such as manipulating perceived stability of one's identity decreased temporal discounting rates.

Similarly, Goukens et al (2009) showed that highlighting one's identity by promoting self-awareness led to more stable preferences and reduced decision biases. We speculate that such treatments may increase the cross-state alignment and reduce overall budget waste. Future research could test this hypothesis.

Furthermore, recent findings suggested that some product attributes have a larger impact on discrepancy in evaluations between intuitive and cognitive judgments. For example taste ratings (for the same products) are different when people are hungry compared with when they are satiated, whereas healthiness ratings do not differ (Fisher & Rangel, 2014). Future research could investigate which product attributes lead to more severe choice inconsistencies and hence to more severe budget inefficiency. These findings could potentially inform us on how different packaging and advertising strategies could contribute to making individuals' choices more optimal.

Future studies could investigate whether certain personality traits may moderate the effect of internal or external cues shifting the balance between intuition and cognition, and hence budget waste, because they chronically make one of the two systems relatively more dominant. Trait self-control may reduce the influence of intuitive judgment, which would lead to fewer discrepancies between the two types of judgment, to less choice inconsistencies, and to less budget waste.

Future research could also shed more light on forecasting errors and budget misuse by assessing the Afriat Index (both individual and overall) of choices made in an intuitive state when in fact making decisions for a cognitive state and vice versa. The findings of such a study could help us to further understand whether and how it is possible to better connect preferences of different types of judgments in order to have a positive influence on the overall rationality.

Understanding the ways intuition and cognition can be connected will provide opportunities to improve individuals' welfare.

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Appendix A

In the first table we present the results for the Bronars (1987) power measure. Basically, a power analysis evaluates the probability of detecting an alternative hypothesis to the model under study. Bronars defines the alternative hypothesis as "irrational behavior", which states that individuals randomly choose consumption bundles (drawn from the uniform distribution) that exhaust the available budget. Bronars' power measure then captures the probability of rejecting the rationality hypothesis for such randomly drawn consumption bundles.

In contrast to the bootstrap power measure that we discuss next, this Bronars power measure does not take into account the choices made by the individuals in our experiment and, thus, maximally focuses on the experimental design. That is, the Bronars measure basically quantifies whether the selected price-income regimes guarantee, in principle, enough discriminatory power to detect random behavior. With an average Bronars power of 0.78 (i.e. in 78% of the cases random behavior is detected), this is clearly the case.

Next, in the following tables we report descriptive statistics for the so-called bootstrap power measure (see, for example, Andreoni & Miller, 2002), in which the observed empirical choices are incorporated in the power measure. To be precise, for the Bronars power measure the uniform distribution is used to model random behavior, while for the bootstrap power the empirical distribution is used. Given that the price-income regimes are the same across experiments and treatments, Bronars power is the same . The same does not hold for the Bootstrap power because it depends on the empirical distribution in the treatment conditions. In short, the reported results show that on average the bootstrap power is slightly higher than the Bronars power, which confirms once more that we have a powerful experiment.

Bronar's Power	
	Afriat's Index
Mean	0.779
SD	0.055
Min	0.638
Median	0.789
Max	0.913

Experiment 1: Bootstrap

Bootstrap Power– Cognition Control Condition			
	Afriat's Index		
	Session 1	Session 2	Overall
Mean	0.875	0.876	0.761
SD	0.098	0.011	0.081
Min	0.600	0.600	0.599
Median	0.883	0.879	0.760
Max	1	1	1

Bootstrap Power– Intuition Control Condition			
	Afriat's Index		
	Session 1	Session 2	Overall
Mean	0.894	0.904	0.796
SD	0.098	0.089	0.086
Min	0,600	0,600	0.600
Median	0,900	0,920	0.788
Max	1	1	1

Bootstrap Power– Experimental Condition			
	Afriat's Index		
	Session 1	Session 2	Overall
Mean	0.900	0.917	0.805
SD	0.092	0.089	0.085
Min	0.640	0.600	0.600
Median	0.910	0.950	0,800
Max	1	1	1

Experiment 2: Bootstrap

Bootstrap Power– Cognition Control Condition			
	Afriat's Index		
	Session 1	Session 2	Overall
Mean	0.877	0.892	0.761
SD	0.110	0.114	0.088
Min	0.600	0.600	0.600
Median	0.897	0.920	0.750
Max	1	1	1

Bootstrap Power– Intuition Control Condition			
	Afriat's Index		
	Session 1	Session 2	Overall
Mean	0.897	0.894	0.776
SD	0.113	0.110	0.106
Min	0.600	0.600	0.600
Median	0.940	0.925	0,770
Max	1	1	1

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Bootstrap Power– Experimental Condition			
	Afriat's Index		
	Session 1	Session 2	Overall
Mean	0.875	0.884	0.755
SD	0.111	0.111	0.097
Min	0.600	0.600	0.600
Median	0.897	0.905	0.755
Max	1	1	0.987

Appendix B

Money Pump Index

Study 1

Cognition Control Condition							
Sessions	Money Pump Index	Differences					
		Session 1-Session 2		Session1-Overall		Session2-Overall	
		Z	p	Z	p	Z	p
Session 1	0.016 (SD=0.038)						
Session 2	0.018 (SD=0.043)	-0.646	0.518				
Overall	0.0208 (SD=0.037)			-1.737	0.082	-1.607	0.108

Intuition Control Condition							
Sessions	Money Pump Index	Differences					
		Session 1-Session 2		Session1-Overall		Session2-Overall	
	Mean	Z	p	Z	P	Z	p
Session1	0.015 (SD=0.029)						
Session2	0.009 (SD=0,019)	-1.095	0.563				
Overall	0.015 (SD=0.023)			-0.114	0.909	-2.48	0.013

Experimental Condition							
Sessions	Money Pump Index	Differences					
		Hungry-Satiated		Hungry-Overall		Satiated-Overall	
		Z	P	Z	p	Z	p
Hungry	0.0104 (SD=0.023)						
Satiated	0.009 (SD=0.019)	-0.120	0.904				
Overall	0.021 (SD=0.026)			-3.994	<0.001	-3.884	<0.001

Difference between overall MPI and the average MPI of the two individual MPI (Experimental Condition): $d_{experimental} = 0.021$

Difference between the overall MPI and the average MPI of the two individual MPI (Pooled Control Conditions: $d_{control} = 0.003$;

$t(136) = 5.535$, $p < 0.001$.

Study 2

Cognition Control Condition

Sessions	Money Pump Index			Differences			
		Z	p	Z	p	Z	p
Session 1	0.024 (SD=0.038)						
Session 2	0.017 (SD=0.040)	-0.795	0.427				
Overall	0.028 (SD=0.039)			-0.308	0.758	-1.538	0.124

Intuition Control Condition

States	Money Pump Index			Differences			
		Session 1-Session 2		Session1-Overall		Session2-Overall	
		Z	p	Z	p	Z	p
Session 1	0.035 (SD=0.081)						
Session 2	0.018 (SD=0.036)	-0.078	0.937				
Overall	0.022 (SD=0.037)			-1.681	0.093	-1.112	0.266

Experimental Condition

States	Money Pump Index			Differences			
		Session 1-Session 2		Load-Overall		Non-Load-Overall	
		Z	p	Z	p	Z	p
Load	0.023 (SD=0.042)						
Non-Load	0.024 (SD=0.046)	-0.007	0.995				
Overall	0.032 (SD=0.043)			-2.164	0.030	-2054	0.040

Difference between overall MPI and the average MPI of the two individual MPI (Experimental Condition): $d_{experimental} = 0.008$.

Difference between the overall MPI and the average MPI of the two individual MPI (Pooled Control Conditions: $d_{control} = 0.004$.

$t(115) = 1.25$, $p = 0.214$.

Appendix C

Instructions for the revealed preferences task

Dear Respondent

This task contains 12 different exercises in which you are asked to indicate your preferences on your favorite bundle of goods. In each task you have a certain budget (10 tokens) that you may freely devote to four different products: baby carrots, raisins, chocolate bars, or Dorito chips. In each exercise you will be asked to enter the quantity (in grams) of each product you want to consume in the indicated prices. The prices of the products (also expressed in tokens) are different in each exercise.

Please make your choices as truthful as possible. You will be given one of your choices in the end of the experiment.

How to carry out the experiment

In each exercise you will be asked to indicate the quantity of each product (in grams) you wish to consume in the gray colored cells. The gray cells take the default value of 0 if not filled. The green cells show the value (expressed in tokens) of the quantity of each products you have chosen to consume. The yellow cells display the maximum amount of each product you can consume with the available budget. The pink cell shows the total amount of the budget that has been spent. You should always spend the entire budget. If the amount spent is not exactly 10 tokens, the cell under "Budget Control" will display the message "Your total payout is not exactly 10". If the expenditures are equal to 10, the cell will display the message "OK".

Some useful information:

1)The exercises use tokens as a method of payment. For every task you have a budget of 10 tokens. The price of each product is also expressed in tokens. A budget of 10 tokens is not equal to 10 euros.

2) The given prices are for 10 gr of each products. For example if the prices of Dorito Chips is 5 you can buy 10 gr of Dorito Chips with 5 tokens. The photo below shows 10 grams of each product for your reference.

3) You are allowed to consume 0 grams of a product. Negative consumption or consumption that exceeds the given budget is not permitted. In both situations you will receive an error message.

4) You should always spend the entire budget. In case you have not spent the entire budget the cell under "Budget Control" will display the message "Your total payout is not exactly 10".

5) Every exercise must be carried out correctly. If a task is not properly completed or the information filled in is not in the correct order (example, exercise 1, exercise... 12), the first two cells in each exercise will display the message “Please return to the previous exercise to enter the right data. If everything is carried out correctly the same cell will display the message “You may proceed”.

6) You have the choice to modify the exercises indefinitely until you are convinced that the entered quantities correspond to your preferences.

7) In the end of every exercise there is a graph displaying the quantities you have chosen to consume.

Example of how participants could carry out the revealed preferences task

To get familiarized with the design, it is recommended to carry out the following exercise.

You can fill the quantity you would like to consume for each product in the grey cells. The green cells indicate the amount of budget spent in each product. In order to stay within your budget you should choose (for each product) a quantity ranges between 0 and the maximum amount displayed in the yellow cells. The value in the yellow cells (maximum quantity) will automatically adjust to the quantities you have entered in the grey cells. Please continue indicating your preferences until you have spent the entire budget.

For example, if you wish to consume 14 gr of baby carrots then enter 14 in the cell B11. The green cell (B12) will automatically show the value of 7 depicting the amount of budget spent to consume 14 of baby carrots. The green cell B13 will show the value of 20 indicating that you still can consume 7 gr of baby carrots to spent the entire budget, assuming that you will consume 0 gr of the other products. Cell C13 will show the value of 10 indicating that you can consume 10 gr raisins, given the fact the you will consume 14 gr of baby carrots and 0 gr of chocolate bars and Dorito chips.

	Baby Carrots	Raisins	Chocolate Bar	Dorito Chips	Total	Budget Control
Quantity in gr	14				14	
Budget use	7	0	0	0	7	Your total payout is not exactly 10
Maximum gr	20	10	8,57	8,57		

If you wish to consume 5 gr of raisins you have the budget to consume 4,29 gr of chocolate bars, assuming that you consume 14 gr of baby carrots and 0 of Dorito chips.

	Baby Carrots	Raisins	Chocolate Bar	Dorito Chips	Total	Budget Control
Quantity in gr	14,00	5,00			19,00	
Budget use	7,00	1,50	0,00	0,00	8,50	Your total payout is not exactly 10
Maximum gr	17,00	10,00	4,29	4,29		

If you consume less than 4,29 gr of chocolate bars you will still have the budget to consume in the rest of the products. By choosing to consume 3 gr of chocolate bar and 1,29 gr of Dorito chips you will have spent all the budget. The cell under "Budget Control" will display the message “OK” which means that you can proceed to the next exercise. If you are not satisfied with the selected quantities, you can still change them. Be aware of the fact that you are not obliged to consume all the products if you do not wish to.

	Baby Carrots	Raisins	Chocolate Bar	Dorito Chips	Total	Budget Control
Quantity in gr	14,00	5,00	3,00	1,29	23,29	
Budget use	7,00	1,50	1,05	0,45	10,00	OK
Maximum gr	14,00	5,00	3,00	1,29		