Review article

Empirical evidence for intransitivity in consumer preferences

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ABSTRACT

The present paper addresses one of the most important assumptions in consumer preference patterns: transitivity. This assumption states that, logically, selections between goods are rational because of the transitivity statement, which posits that people always prefer goods in the following order: A is preferred to B, and B is preferred to C, so A is preferred to C. With the aim of proving this principle's validity, we conducted an experiment with 70 subjects and probed their preferences in relation to edible and nonedible goods. We used a survey methodology, which allowed us to analyze three distinct situations: 1) individuals faced with goods choices without restrictions; 2) individuals facing budget restrictions and price changes; and 3) individuals faced with decreased disposable income. The results mostly showed that there was no evidence of transitivity in consumer preferences. On average, transitivity appeared in only 8% of the sample, and in cases where transitivity was proved, it was revealed to be strong. The preferences were transitive primarily in relation to edible rather than nonedible goods.

1. Introduction

Economic theory is characterized by the persistent pursuit of generalized results. This means that its history has been defined by the hypothetical-deductive method (Bresser-Pereira, 2009); however, such findings are being put to the test due to the importance, in recent years, of including experimentation in the social sciences, particularly in economic science. Roth (1993) pointed out that "[s]tarting from a low level of activity, the literature of experimental economics has experienced exponential growth in every decade since, which has yet to level off" (p. 185). This interest increased markedly after the publication of Kahneman and Tversky's (1979) work on prospect theory, in which they showed that individual choices—how humans make decisions—do not necessarily depend on those choices' expected utility; they depend on the value assigned to the gains and losses in which probabilities are replaced by decision weights. Experiments concerning choices based on experience are yet to be designed to test utility theory. For example, the experiments conducted in Erev and Roth's (2014) research, which concerns lotteries, did not attempt to determine the subjects' beliefs about the lotteries they experienced. Instead, the authors allowed the discovery of behavioral regularities that could not have been determined in experiments introducing lotteries with numerical probabilities (Erev and Roth, 2014).

Despite the late inclusion of experimentation in economic theory, the eighteenth and nineteenth centuries exhibited traces of experimental economics, such as accounts of Bernoulli's 1738 hypothetical choice experiment on the St. Petersburg paradox (Bernoulli, 1954) and Thurstone's experiment with indifference curves (Roth, 2015). However, these experiments were only aimed at validating the existence of a phenomenon rather than including experimentation as a methodology in economics.

The most widespread use of experimentation in economics could be divided into three well-defined stages. The first stage concerns experiments designed to test theories of individual choice. The second stage concerns testing game-theoretic hypotheses. The third stage concerns early investigations in industrial organization (Roth, 1993). It is important to note that it is in the field of game theory that experimentation has been most widely applied.

Nevertheless, the non-inclusion—late inclusion—of experimentation as a method in economic science has drawn attention because this science raises questions about selection in a world of limited resources and infinite needs whose answers could easily be illustrated in a laboratory under specific conditions. In this regard, Guala (2012) pointed out that "laboratory technology can be used to create simple (but real) economies. These simple economies can then be used to test and evaluate the

predictive capability of the general theories when they are applied to the special cases" (p. 601). Schotter (2015) later described two reasons that could explain the limited interest in empirical validation in economic theory:

> [H]istorically, economic theorist[s] were philosophers whose theories were no more than speculations about human nature; when these speculations were eventually mathematized, the ethos of the field was already set in cement. Another possibility is that when economic theory was first created and later formalized in [the twentieth] century, it was strongly believed that economics was not an experimental science, so seeking validation through experiments was pointless. (p. 59)

Nevertheless, experimentation in economic theory serves two purposes: (a) testing theoretical models and (b) estimating model parameters. The first purpose is related to empirical tests based on the assumption that a theory is valid in all cases or for determining whether special cases exist in which the theory does not predict the expected behavior. The theory-testing view assumes that theories come to be fully interpreted and presented in a form that makes them amenable to direct empirical testing (Guala, 2012). In this case, there are two facets to experiments. On one hand, there are experiments concerning individual choices, which aim to estimate individual indifference curves. This is the case for Thurstone's (1930) experiment:

> [I]n which each subject was asked to make a large number of hypothetical choices between commodity bundles consisting of hats and coats, hats and shoes, or shoes and coats…. [C]hoice[s] … could be adequately represented by indifferences curves, and … it was practical to estimate them this way. (Roth, 1993, p. 186)

On the other hand, there are experiments concerning interactive behavior, which "focus on a specific aspect of the theory other than those which naturally come to the fore in the theoretical literature" (Roth, 1993, p. 193).

The second purpose is related to econometric analysis, in which "empirical and traditional economists use regression techniques to convince them [selves and others] their results are valid" (Croson, 2005, p. 144). Econometricians apply statistical techniques to establish the strength of various correlations between economic variables. However, except in some special, happy conditions, the spontaneous variation found in the data does not warrant the drawing of specific causal inferences (Guala, 2012).

Currently—and especially after the Nobel Prize in Economics was awarded to Daniel Kahneman and Vernon Smith in 2002 for having incorporated into economic science insights from psychological research specifically concerning human judgment and decision-making under uncertainty—experimentation in economics has been met with a new future. In 2005, Robert Aumann and Thomas Schelling, whose investigation was, in great part, carried out in laboratories, were awarded the Nobel Memorial Prize in Economic Sciences for having enhanced the understanding of conflict and cooperation through game-theory analysis. In addition, in 2017, Richard Thaler received the same award for his contributions to behavioral economics.

All these awards have reoriented economic analysis toward models and experiments, casting doubt on the generalization of individual preferences and, thus, making researchers wonder about the theorems assuring these preferences. Against this backdrop, the present study was designed to query subjects about their preferences and, in so doing, analyze the existence, or nonexistence, of transitivity. "Starting with May (1954) and Tversky (1969), many studies have observed systematic and substantial violations of transitivity, suggesting that transitivity does not describe people's preferences well" (Brandstatter et al., 2006, p. 9; Baillon et al., 2015, p. 198). As stated by Diecidue and Somasundaram (2017), "[A]llowing for intransitivity entails a fundamental breakaway from any classical theory, requires new insights into concepts of

maximization, indifference and utility (p. 89)." A number of studies, most of which employed multiple experiments and conditions designed to test the robustness of the preference models, have appeared since the 1980s. These studies have shown frequent violations of the expected utility hypothesis and have been grouped under the regret theory umbrella, where intransitivity could be considered a specific case.

In this context, the purpose of the present investigation was to test a theoretical model related to individual choices. More specifically, we sought to prove whether the transitivity axiom that states that an ordinal and logical chain of preferences—where A is preferred to B, B is preferred to C, and so A is preferred to C—occurred in all the analyzed cases. Additionally, we sought to prove whether transitivity was strongly or weakly preferred in the cases in which it appeared. The motivations to conduct this study were in response to this axiom's relative importance in assuring the existence of a utility function on one hand and the necessity of addressing the lack of research on this basic and essential axiom on the other.

2. Theoretical literature

As stated in the previous section, the inclusion of experimentation in economics is a recent phenomenon and, above all, it has been linked to the newly-realized importance of game theory. Other areas of economic analysis related to rational decision theory have also acquired importance in recent years. According to Roth (2015), "A major focus on mainstream behavioral economic research involved experiments designed to find and study counterexamples to rational decision theory, and specifically examples in which the expected utility theory can be shown to make a false prediction" (p. 17). In this regard, we consider it imperative to investigate whether the axioms related to consumer preferences are appropriate for interpreting how individuals make decisions and whether these decisions are transitive, since transitivity is necessary for utility.

Before doing this, it is essential to consider some important aspects of rationality. In economic theory, individuals can be classified into three categories: producers, suppliers, and consumers. Consumers are supposed to be rational, in the sense that they look for goods and/or baskets of goods that maximize benefits. To be considered rational, this maximization must comply with three axioms that establish the functioning logic of preferences for consumer choices. However, it should be noted that consumer choices will be crossed by budgetary restrictions—what the individual alone can consume within a maximum income curve.[1] The axioms related to consumer preferences are as follows:

1 The *completeness axiom* indicates that the individual can always compare two baskets of consumption and, following the comparison, can clearly define the relationship between these baskets, always preferring one to the other. In this axiom, it is not possible to avoid making a choice.

   The algebraic representation of the completeness axiom is:
   A $\succsim$ B o B $\succsim$ A, meaning,

1) A is preferred to B.
2) B is preferred to A.
3) A is indifferent to B.

   Without this property, preferences are undefined.

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[1] In microeconomics, a basket of goods generally refers to two or three goods that are comparatively eligible for a given consumer. However, once extracted from the findings in such comparisons, it is assumed that the same comparisons are valid for a basket of goods with an infinite number of combinations—for example, a basket of goods in the form of X = (Xi Yj,..,Xn, Yn).

2. The second axiom concerns the *transitivity of preferences.* This assumption implies that if at first an individual chooses good A over good B, and if a second time chooses good B over good C, with B being the same in both cases, then it is logical that the consumer will select good A over good C.

   Algebraically, this may be expressed as:
   A $\gtrsim$ B y B $\gtrsim$ C denotes A $\gtrsim$ C.

3. The third axiom implies that preferences are *continuous* (continuity)— meaning that a good's usefulness increases its consumption. It is important to insist that the saturation point, where the marginal benefit of consuming an extra unit of the good no longer generates greater utility, is reachable.

   The algebraic representation of this axiom is:
   x $\geq$ x', y $\geq$ y' implies A $\gtrsim$ B.
   x > x', y > y' involves A $\succ$ B.

The three axioms at once define a utility function and avoid having indifference curves that cross. Nevertheless, the second axiom—the transitivity axiom—implies that consumers are consistent in their preferences. If this is not the case, then it is possible that utility maximization will not be reached, and therefore, a consumer's choice is neither optimal nor rational. According to May (1954), "[I]t is a familiar fact that some preference patterns are transitive. For example, the preference pattern of an individual confronted with different amounts of cash will usually be an ordering according to the amounts" (p. 5). However, in relation to nonmonetary goods (food, property, etc.), preference patterns—-transitivity—might not be so clear cut. Moreover, "if we aggregate subjects to an experiment that [seeks] to discover the preferences of a group about a kind of phenomenon … it is [clear] that the outcome could be related to [the] intransitivity of individual preferences" (May, 1954, p. 6).

This behavior, which violates the transitivity axiom, was first discovered by Lichtenstein and Slovic (1971) and Lindman (1971), who coined the term *preference reversal.* This phenomenon, subsequently investigated by Grether and Plott (1979), appears when there is a systematic tendency for the ranking revealed by the valuation tasks to differ from that revealed by the choice task (Loomes et al., 1991). This phenomenon takes the following general form: "asked to make a direct choice between gamble A and gamble B, an individual states a preference for A; but asked to consider the two gambles separately, he places a higher certainty equivalent value, or reservation price, on B" (Loomes and Sugden, 1983. p 428).

Reversal preference could be regarded as a case of a larger set of behavioral patterns that contradict the standard expected utility predicted by *regret theory.* This theory states that

> [P]eople tend to compare their actual situations with the ones they would have been in, had they made different choices in the past. If they realize that a different choice would have led to a better outcome, people may experience the painful sensation of regret … they then take these expectations into account when making their decisions. (Loomes and Sugden, 1983)

According Diecidue and Somasundaram (2017), "regret theory is concerned not only about the outcome a decision maker receives but also about the outcome he would have received had he chosen differently (p. 58)." Both regret theory and the preference reversal phenomenon give an account of the intransitivity of individual preferences. Moreover, Slovic and Lichtenstein (1983) highlight that "preferences are neither absolute, stable, consistent, precise or exogenous (unaffected by the choices they control) (p. 599)." Some researchers have tried to explain the preference reversal phenomenon, arguing that it is "a weaker form of independence axiom [but that] the value of this effort … is considerably diminished, however, if more basic axioms such as transitivity are violated" (Holt,

1986. p 508). Further, "even when the subjects are exposed to strong incentives for making motivated, rational decisions, the phenomenon of preference reversal does not vanish" (Pommerehne et al., 1982. p 573).

In the last two-decades, intransitivity behavior has been tested through experiments in economics and psychology. For example, "Muermann et al. (2006) and Michenaud and Solnik (2008) applied [a] regret theory frame to study financial decisions and asset allocation decisions, respectively. Other regret models includ[ing] Sarver (2008) and Hayashi (2008) have been tested in order to study preferences over menus, i.e. sets of prospects, in which decisions-makers experience regret if their choice turns out to be inferior ex-post" (Bleichrodt and Wakker, 2015).

As such, this danger of intransitivity and the consequential impossibility of reaching utility maximization necessitate analyzing, via experimentation, subjects' consumer preferences. In this sense, we hypothesize that the intransitivity comportment is what effectively characterizes the consumer patterns of individuals faced with choices of goods. This tendency toward intransitivity does not depend on characteristics linked to gender, age range, economic situation, or employment. Moreover, "the transitivity assumption is needed for the existence of a utility functional that represents preferences" (Holt, 1986. p 508).

3. Methodology

3.1. Experimental design

The experiment comprised a survey containing 36 questions divided into three sections (see annex 1). Each section contained two categories of questions. The first category involved questions about the choice itself (do you prefer A or B, and so on), and the second was about that choice's level of preference (highly preferred or slightly preferred). For the stated preference level, we used a simple scale comprising two categories.

With the objective of ensuring initial equivalence, the participants were randomly assigned to groups. Random assignment probabilistically ensures that two or more groups are equivalent (Kirk, 2012). With this in mind, the target population was chosen and differentiated by gender (male and female), employment situation (employed or unemployed), age (by range), and socioeconomic situation (low, medium, or high). Finally, we explained the research aims to all the participants, who then had 12 min to answer the survey questions in a single sitting.

In the first section, the participants were faced with an initial situation in which they chose between two edible goods.[2] They were then confronted with two additional goods, having to choose between them. Finally, they were confronted with two edible goods and asked to select one. The chain of selection was: A p B - B p C - A p C[3], where p means "preferred to," and each other letter refers to a specific edible good. During this phase, we studied only the preferences and their levels. In the second section, we also asked the individuals to select between goods, but we added two elements: disposable income and the goods' prices. Again, we studied the preferences and their levels. In the third section, we decreased the disposable income but left the goods' prices unaltered and again studied the preferences and their levels.

3.1.1. Procedures: pilot study

In their paper, Grether and Plott (1979) pointed to four possible sources of experimental bias, among which confusion and misunderstanding were deemed essential for ensuring an experiment's reliability. Thus, prior to the experiment, we conducted a pilot study to calibrate our survey. By *calibrate* we mean prove the consistency of the instrument (survey), not to measure transitivity itself. As stated by Parker and Berman (2003), [our] objective in that pilot was not to achieve statistical

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[2] All goods were presented to the participants as high-definition images of real goods.
[3] In all phases, this was the logical chain to selection.

Table 1. Pilot Study: Characterization of participants.

Phase/Gender	Men	Women
1 Choice between goods	Age 18–23	Age 18–23
2 Choice between goods, with disposable income and the goods' prices	Unemployed 1 participant Business students	Unemployed 8 participants Business students
3 Choice between goods decreased the disposable income but left the goods' prices unaltered		

significance, but rather to gather enough information to decide [how] to pursue the experiment. In fact, "pilot studies are often the first step to investigate whether a concept is reasonable" (Parker and Berman, 2003. p 167). In that sense, the pilot serves to probe the instrument's reliability rather than to measure the results related to transitivity.

The procedures for recruiting students for our pilot study was as follows: First, we announced a call at the Indoamérica Technological University for participation in an experiment, explaining the specific objectives to be achieved. The level of response to this call was not significant, with nine students agreeing to participate. As the call for participation was open to anyone who wanted to participate—with the only condition being that respondents had to be students—randomness was guaranteed, and the possibility of a gender or income effect bias was substantially reduced. Second, the participants were told that it was a pilot study about an economic experiment, and that they would receive $10 USD at the end of the survey. Third, once the overall experiment conditions were explained, we convoked the participants on a specific day to carry out the pilot (see Tables 1 and 2).

The results of the pilot study in regard to the survey's structure were as follows: The average duration of the survey was 15 min. The questions related to budget restrictions and price changes were not very clear to the participants. Thus, we had to better explain the purpose of such questions. Moreover, the results of the pilot regarding transitivity itself showed that preferences were transitive only in relation to women. Additionally, when budget restrictions and altered prices for goods were included, three cases of transitivity were found. Likewise, when we decreased disposable income, three cases validated the existence of transitivity. Based on these results, we reviewed the survey—adding two topics: socioeconomic situation and employment situation—and extending the sample.

3.1.2. Procedures: experiment

Once we carried out the pilot study and adjusted the survey, we implemented the experiment itself. The time elapsed between the pilot and the experiment was approximately one year, which was due to the operativity and the search for subjects. For the experiment, we recruited 70 subjects. Recruitment was announced by e-mail to students attending the Central University and Catholic University of Ecuador and workers from the Central Bank of Ecuador. As the participants included both a group of students (from two different universities, one public and one private) and formal workers, the possibility of bias was reduced due to the participation of unsophisticated subjects (Grether and Plott, 1979; Levitt and List, 2007).

In terms of randomness, there was no selection bias, since everyone had the same probability of participating due to nature of the recruitment announcements. The subjects were required to have some form of

experience in experimental fields. The sample comprised 35 women and 35 men, ensuring a balanced sample based on gender. Additionally, the whole sample was divided into four categories: gender (male and female), employment situation (employed or unemployed), age (by range), and socioeconomic situation (low, medium, or high).

As presented in Table 3, male and female participants were equally represented. Moreover, 56% of the participants were employed. In terms of age, most participants were concentrated in the 18–25 range (60%), while 40% were 25 years or older. Additionally, based on how the economic situation category was divided, we observed that most participants (67%) were classified as having an income exceeding $2,459 USD per month—that is, people with high-level incomes. Furthermore, 27% had medium-level incomes ($678 USD per month), and only six percent had low-level incomes ($305 USD per month).

The Indoamerica Technological University's ethics committee approved this research. It was also conducted according to established ethical guidelines, and informed consent was obtained from the participants.

The conditions under which the experiment was developed were as follows. The assignment was random, and the order of arrival was considered. The experiment required the implementation of two scenarios. In the first scenario, we decided to show each participant a high-definition image of goods or services and asked them to choose between the goods and services. As this was a blind experiment, the subjects' anonymity and privacy were respected, and they had no information about what the other subjects saw, chose, or experienced. In the second scenario, called the "hypothetical scenario," we asked the subjects to imagine having an income equal to the minimum wage ($394 USD per month) to spend on goods or services, whose prices were included in a list that was previously provided to them. In this scenario, we decided not to incorporate the alternative of working with real incentives due to the budget constraints regarding the experiment. Furthermore, according to Rubinstein (2001) and Camerer and Hogarth (1999), "Using financial incentives, or increasing their size, often has little benefit (though it can serve to decrease the variance of choices), and when it does have an effect, its size is comparable to that of other treatment variables (and indeed can interact with these other variables)" (Feltovich, 2011, p. 365). In fact, quoting Camerer and Hogarth (1999),

> The complaint that subjects were insufficiently motivated often arises when a principle of rational choice—transitivity, dominance, game-theoretic equilibrium, or perhaps self-interest—appears to be violated in favor of an alternative, more psychologically plausible, hypothesis. Critics and referees very commonly assert that if the stakes were just high enough, the rationality rejection would disappear. While several studies have tried to make rationality violations disappear—in utility theory paradoxes, ultimatum bargaining, and voting experiments—none have succeeded in clearly overturning anomalies. (p. 33)

In our case, when incentives were announced *a-priori*, the number of subjects (specifically students) registering for the survey increased considerably, while the time of each interview tended to be reduced. Thus, the decision was taken to interview only those who had registered prior to having knowledge about the incentives, thereby eliminating any possibility of bias.

Table 2. Experiment: General characterization of participants.

Phase/Gender	Men	Women
1 Choice between goods	Age 18–53	Age 18–43
2 Choice between goods, with disposable income and the goods' prices	Students and workers 35 participants Business students and Workers from the Central Bank of Ecuador	Students and workers 35 participants Business students and Workers from the Central Bank of Ecuador
3 Choice between goods decreased the disposable income but left the goods' prices unaltered		

Table 3. Experiment: Quantitative characterization of participants.

Gender			Employment		
	Frequency	Percentage		Frequency	Percentage
Women	35	50	No	31	44
Men	35	50	Yes	39	56
Total	70	100	Total	70	100
Age			Socioeconomic Situation		
Range	Frequency	Percentage		Frequency	Percentage
18–25	42	60	Low	4	6
25+	28	40	Medium	19	27
Total	70	100	High	47	67
			Total	70	100

Other instructions were clearly established for the participants. Concerning incentives, we stated that all participants would be paid on an equal basis at the end of the experiment. In the framing aspect, neutral labels were used. Likewise, all expectations affecting the participants' behaviors were eliminated.

4. Results

To evaluate the results of the experiment, we analyzed each section of the survey, bearing in mind that each individual responded to the entire survey in a single round. In the first section, as presented in Table 4a, when the individuals were faced with having to choose between two edible goods, there was evidence of transitivity in 5 out of 70 cases (7%). For nonedible goods, transitivity appeared in 9 out of 70 cases (12%). When employment was considered, the results in favor of transitivity were less promising. For edible goods, 3 out of 70 cases showed transitivity (4%), and for nonedible goods, 8 out of 70 cases were transitive (11%). In addition, in both the edible and nonedible categories, men appeared to be more transitive than women. In fact, for edible goods, 3 men out of 35 showed transitivity preferences, while in women, 2 out of 35 showed transitivity preferences. For nonedible goods, 5 men out of 35

and 4 women out of 35 showed transitivity. Likewise, when the economic situation filter was used, those whose preferences were transitive were mostly in the high-income category (3 out of 5) for both edible and nonedible goods. Furthermore, filtering by age, we found that in most cases, 4 out of 42 people in the 18 to 25 age category showed transitivity in their preferences for edible goods. In the 25 + age category, only one case showed transitivity. In this category, the situation was highly similar for nonedible goods (Loomes et al., 1983; Pommerehne et al., 1982).

Additionally, evidence of choice indifference was shown in only one case of edible goods, and incompleteness was shown in one case of nonedible goods. This last finding showed that, marginally, we can always find someone who is incapable of establishing a preference ordering.

Conversely, as presented in Table 4b, in analyzing the level of preference (highly preferred or slightly preferred) in the cases in which transitivity was present for edible goods, we found strong transitivity—that is, highly preferred (5 out of 6 cases). Upon applying the gender filter, three out of three men's (100%) and two out of two women's choices were highly preferred. Moreover, upon filtering by age, the choices were highly preferred in the 18 to 25 age range. Similar results were found when we applied the employment and socioeconomic

Table 4a. Section 1. Transitivity in preference with alterations in combinations of goods.

Categories	Gender		Age		Employment		Socioeconomic Situation		
Edible Goods*	Men	Women	18–25	25+	Employed	Unemployed	High	Mean	Low
Transitivity	3	2	4	1	3	2	1	1	3
Intransitivity	32	32	38	26	27	37	45	18	1
Indifference	0	1	0	1	1	0	1	0	0
*Cereals and derivatives, fresh fruits, food and beverages									
Nonedible Goods*	Men	Women	18–25	25+	Employed	Unemployed	High	Mean	Low
Transitivity	5	4	3	6	8	1	1	2	6
Intransitivity	30	30	38	22	22	38	45	15	0
Both	0	1	1	0	1	0	1	0	0
*Playground and reading material, care and personal items, men's/women's clothing									

Table 4b. Section 1. Preference levels with alterations in combinations of goods.

Categories	Gender		Age		Employment		Socioeconomic Situation		
Edible Goods*	Men	Women	18–25	25+	Employed	Unemployed	High	Mean	Low
Highly Preferred	3	2	3	1	2	1	3	1	0
Slightly Preferred	0	0	1	0	1	1	0	0	1
*Cereals and derivatives, fresh fruits, food and beverages									
Nonedible Goods*	Men	Women	18–25	25+	Employed	Unemployed	High	Mean	Low
Highly Preferred	3	4	2	5	7	1	5	2	0
Slightly Preferred	2	0	1	1	1	0	1	0	1
*Playground and reading material, care and personal items, men's/women's clothing									

Table 5a. Section 2. Transitivity in preferences with alterations in goods' prices and budget restrictions.

Categories	Gender		Age		Employment		Socioeconomic Situation		
Edible Goods*	Men	Women	18–25	25+	Employed	Unemployed	High	Mean	Low
Transitivity	3	6	3	6	7	2	5	4	0
Intransitivity	30	27	38	19	20	37	39	15	3
Both	1	2	1	2	3	0	2	0	1
Indifference	1	0	0	1	1	0	1	0	0
*Fresh vegetables, tubers and derivatives, meat and preparation									
Nonedible Goods*	Men	Women	18–25	25+	Employed	Unemployed	High	Mean	Low
Transitivity	2	4	5	1	2	4	2	3	1
Intransitivity	33	31	42	27	29	35	45	16	3
*Tobacco, housing, healthcare									

situation filters, in which three out of five cases and four out of five cases were highly preferred, respectively. Furthermore, for nonedible goods, transitivity was strong in seven out of nine cases, and in the employment category, employment was found to yield very strong transitivity in seven out of eight cases.

In the second section of the survey, as presented in Table 5a, we asked the subjects to consider their wants and needs when budgetary restrictions and goods' prices were known. This time, the goods—both edible and nonedible—did not yield the same results as in the first section of the experiment. In addition, we requested that subjects imagine a situation in which their salaries were equal to twice the minimum wage—approximately $784 USD per month—and asked them to consider the goods' prices. (We provided them with a complete list of goods and their prices.)

The results regarding edible goods were as follows: 9 out of 70 subjects (12%) revealed transitivity in their preferences. Once we filtered by employment, we found that transitivity was present in 7 out of 31 employees (22%). Conversely, 2 out of 39 (5%) unemployed participants showed transitivity in their choices. Concerning gender, women's preferences were more transitive than men's. In fact, 6 out of 35 women were concerned about transitivity, and only 3 out of 35 men showed transitivity. Likewise, in the socioeconomic situation category, both high and medium socioeconomic situations revealed transitivity in preferences. For example, 5 out of 49 (10%) of those belonging to the highest income category demonstrated transitive preferences. By contrast, 4 out of 19 (21%) men showed transitivity. In all cases, those belonging to the lowest income category showed transitivity.

Finally, upon filtering by age, preferences appeared to be mostly transitive for the 25 + category (6 out of 28). For nonedible goods, 6 out of 70 subjects (8%) revealed transitivity. In the gender category, we found that 2 out of 35 men (5%) and 4 out of 35 women (11%) showed transitivity preferences. In relation to employment, the percentages were exactly the same for employees and the unemployed, respectively. Dividing by age, young people (18–25 years) were less transitive than adults (25+). In fact, 3 out of 42 (7 %) young people exhibited transitivity preferences compared to 6 out of 28 (21 %) adults. In terms of socioeconomic situation, both the high and mean socioeconomic situations revealed transitivity in preferences. For example, 2 out of 49 (4%)

of those belonging to the highest income category demonstrated transitive preferences, while 3 out of 19 (15%) in the low-income category revealed transitivity. For those belonging to the lowest income category, transitivity was revealed in a single case.

Interpreting these results in light of degrees of transitivity, we found the following outcomes: In the case of edible goods, six out of nine subjects revealed strong transitivity (very preferred). Most women (5 out of 6) showed strong transitive preferences. In terms of age, two out of three of those belonging the 18–25 range displayed strong transitivity, and four out of six in the 25 + range exhibited strong preferences. In terms of socioeconomic situation, three out of five persons of the highest income revealed strong transitivity, and three out of four persons of mean income exhibited strong transitivity.

In the case of nonedible goods, five out of six participants revealed strong transitivity. Three out of four were women; five out of six were in the 18–25 range; three out of six were unemployed; two belonged to the highest economic situation; and two belonged to the mean economic situation (see Table 5b).

In the third section (see Tables 6a and 6b), the subjects dealt with a decrease in available income, but the goods' prices remained unchanged. The postulation behind this was linked to testing whether preferences—transitivity—would change with changes in income. The results indicated that for edible goods, only 3 out of 70 subjects (4%) revealed transitive preferences. Comparing this outcome with those in the previous section, we found that when disposable income changed—in this case, decreased—transitivity, in most cases, disappeared (Diecidue and Somasundaram, 2017). Filtering by gender, men (2 out of 35; 5 %) were more persuaded by transitivity than women (1 out of 35; 3 %), and as seen in the previous section, an advantageous socioeconomic situation defined a favorable terrain for transitivity. In fact, 2 out of 47 (4%) and 1 out of 19 (5%) of those in the highest and mean economic situations individuals, respectively, displayed transitivity.

In relation to employment situation, only the employees (2 out of 31, 6 %) exhibited transitivity in their preferences. Moreover, the adult participants revealed more transitive preferences (2 out of 28; 7 %) than the youngest participants (1 out of 42; 2 %). Furthermore, evidence of choice indifference was shown in two cases, specifically in women, employees, and high-income subjects.

Table 5b. Section 2. Preference levels with alterations in goods' prices and budget restrictions.

Categories	Gender		Age		Employment		Socioeconomic Situation		
Edible Goods*	Men	Women	18–25	25+	Employed	Unemployed	High	Mean	Low
Highly Preferred	1	5	2	4	4	2	3	3	0
Slightly Preferred	2	1	1	2	3	0	2	1	0
*Fresh vegetables, tubers and derivatives, meat and preparation									
Nonedible Goods*	Men	Women	18–25	25+	Employed	Unemployed	High	Mean	Low
Highly Preferred	2	3	5	0	2	3	2	2	1
Slightly Preferred	0	1	0	1	0	1	0	1	0
*Tobacco, housing, healthcare									

Table 6a. Section 3. Transitivity in preferences with changes in available income (i.e., a 50% decrease in disposable income).

Categories	Gender		Age		Employment		Socioeconomic Situation		
Edible Goods*	Men	Women	18–25	25+	Employed	Unemployed	High	Mean	Low
Transitivity	2	1	1	2	2	1	2	1	0
Intransitivity	33	32	40	25	27	39	43	18	4
Indifference	0	2	1	1	2	0	2	0	0
*Fish and seafood; milk and milk products and eggs; coffee, tea, and soft drinks									
Nonedible Goods*	Men	Women	18–25	25+	Employed	Unemployed	High	Mean	Low
Transitivity	2	0	1	1	2	0	2	0	0
Intransitivity	32	33	39	26	26	39	45	17	3
Both	1	2	2	1	3	0	0	2	1
*Transportation, luxury housing, education									

Table 6b. Section 3. Preference levels with changes in available income (i.e., a 50% decrease in disposable income).

Categories	Gender		Age		Employment		Socioeconomic Situation		
Edible Goods*	Men	Women	18–25	25+	Employed	Unemployed	High	Mena	Low
Highly Preferred	1	2	1	2	2	1	2	1	0
Slightly Preferred	0	0	0	0	0	0	0	0	0
*Fish and sea food; milk and milk products and eggs; coffee, tea, and soft drinks									
Nonedible Goods*	Men	Women	18–25	25+	Employed	Unemployed	High	Mean	Low
Highly Preferred	0	0	0	0	0	0	0	0	0
Slightly Preferred	2	0	1	1	2	0	2	0	0
*Transportation, luxury housing, education									

In relation to nonedible goods, the outcomes showed transitivity in 2 out of 70 cases (3%). Analyzing by gender, some of the men exhibited transitive preferences (2 out of 35; 6 %), whereas none of the women exhibited transitive preferences. Similar to what happened with edible goods, employees (2 out of 31; 6 %) and individuals earning the highest incomes (2 out of 47; 4 %) showed transitivity in their preferences. Finally, one individual (2%) in the 18–25 age range and one individual (3%) in the 25 + category exhibited transitivity.

Moreover, low-income subjects revealed no transitivity preferences in relation to edible and nonedible goods. This finding is important because it reveals that when those whose salary perceptions oscillated between $0 USD and $305 USD per month dealt with a decrease in available income, they did not think about transitivity when choosing between edible and nonedible goods. Additionally, we found evidence of incompleteness in three cases relating to nonedible goods. This demonstrates that, marginally (3 out of 70; 4 %), we can always find someone who is incapable of establishing a preference ordering.

Transitivity regarding edible goods was strong in all the cases in which it was verified. In fact, 2 out of 35 (6 %) women and 1 out of 35 (3 %) men exhibited strong transitivity. In particular, adult participants (7%), employees (6%), and mean-income subjects (5%) showed highly preferred choices.

The results for nonedible goods did not differ substantially from those for edible goods. Nevertheless, besides edible goods, the degree of transitivity was weak in all cases. In fact, only men (2 out of 35, 6 %) exhibited strong transitivity, and mostly employees (2 out of 31, 6 %) and high-income subjects (2 out of 47, 4 %) showed highly preferred choices.

5. Conclusions

Our experiment reveals violations of the transitivity axiom. This preference intransitivity occurred when a subject chose a pair of goods that did not form part of an initial preference. Such violations of the transitivity axiom render difficult the existence of a utility function that represents rational preferences. In our experiment, we showed a sustainable tendency for individuals to choose, in a pairwise set of goods—edibles and nonedibles—that which was not preferred in an initial

situation. Nevertheless, according to utility theory, when transitivity appears, it is revealed to be strong.

To deconstruct the nature of this intransitivity, we divided the whole sample into well-defined categories. This decomposition highlighted the importance of gender in understanding the violation of the transitivity axiom. Women appeared to reveal more transitive preferences than men. The economic situation was a very important factor in defining the tendency toward intransitivity. Likewise, the employment situation symbolized the tendency to elect between goods. It is important to underline that, marginally, there were two relevant findings relating to two other main assumptions of the utility function. On one hand, some subjects revealed incompleteness in their choices, and on the other hand, some revealed indifference.

The findings in our experiment end the long lethargy on investigations in economics on the nature of the intransitivity phenomenon. However, we believe that it is necessary to extend the sample of people exposed to an experiment of this nature, although we maintain that the results will not vary significantly.

Declarations

Author contribution statement

Additional information

Data associated with this study has been deposited at DSpace Universidad Indoamerica under the accession number http://repositorio.uti.edu.ec//handle/123456789/1053.

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