

# A Statistical analysis of Consumer Behavior Using Laboratory Experimental Data

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## ABSTRACT

Experimental economics is used here to solve some discussions provided by many studies about habit formation problems for infinitely-lived agents whose preferences certainty exhibit in the presence of labor income. The standard approach to modeling consumption behavior is to assume that consumers are solving dynamic optimization problems. However, under realistic descriptions of utility and certainty income and habit formation--these problems are very difficult to solve. We demonstrated that experimental economic method found here yields a better assessment of the habit formation at the behaviors of consumers. The present paper reports on the results of an experiment based on consumer behavior. This experiment is carried out with 66 agents organized in two experimental sessions. Using an experimental approach and applying nonparametric tests, results show that into the presence of labor income certainty consumption framework, participants' actual spending behavior converged effectively towards optimal consumption. Consumers persistently spend too much in early periods, they learn rapidly from their own experience to consume the same choice of meals and drinks. Nonparametric tests indicate that behavioral influences sharply affect decisions of consumers (p-value >5%) in the second and the third period. Their spending is closely linked to optimal consumption (non conditional on earlier spending) and they choose the same basket of goods in the future horizon, which shows that there's a habit formation in the behaviors of consumers.

**Keywords:** *Consumption, Habit formation, Behavior, Experimental Economic Method, Nonparametric test, Tunisia.*

## 1. INTRODUCTION

Experimental economic is a method developed in the sixties by Veronon Smith (1952) [15] and adopted since then by a number of researchers in economics and psychology. It can be defined as a method which consists in making "plays" of the economic situation simplified with participants remunerated according to their decisions of the others plays.

Understanding the habit formation of consumer's choices is essential to direct the decisions of the authorities. So the analysis of habit formation for consumer's behaviors drew the attention of the economists since the Fifties. Few works studied the behavior of consumption using economic models [4], [5], [6]. Yet results provided by these studies were no conclusive and the existence of the habit formation of consumers hasn't been clear.

Recent econometric studies manage to estimate the parameter of habit formation. Constantinides and Ferson (1991) [9] come to estimate this parameter using generalized moments method. They found that there is a phenomenon of persistence of the spending patterns in the data in the United States over the period of 1970 to 1989 by using quarterly aggregate data. In the same order of idea, when the estimates are undertaken by using monthly data, Dun and Singleton (1986), Eichernbaum et al., (1988), Eichernbaum and Hansen (1988) and Heaton (1993) show that there is either a phenomenon of durability or that of habit formation. Dynan (2000) tests the assumption of habit formation on

data of food consumption in annual frequency. The results obtained do not show any phenomenon of habit formation.

Unlike these previous works, this study is somewhat different and is based on experimental economic method to answer some discussions provided by the previous econometrics approaches, which incorporate habit formation into a multiperiod von Neuman-Morgenstern expected utility model. The consumer is assumed to acquire a "taste for the good life", as past consumption negatively affects his or her current level of satisfaction. In particular, the more one has consumed in the past, the more current consumption is needed to bring the consumer up to any specified utility level. In other words, the consumer develops consumption habits over time that affects current levels of satisfaction. Abel (1990), Constantinides (1990), and Detemple and Zapatero (1991) discuss many of the merits of habit-formation models in a detailed way.

Considering the empirical to put forward the inaptitude of econometric approaches to test assumption of habit formation in the behavior of consumers, we profited from the experimental contribution to mitigate these insufficiencies. Indeed, the experiment that we conceived and realized gives us the possibility to circumvent the problem involved in the assumption of the habit formation in the behavior of consumption. Although previous studies have not specifically identified the habit formation at consumer behavior, this paper was designed to use experimental economic method and identify habit formation at consumer behavior.

This paper is structured as follows. Section 2 gives the materials and method used in our analysis. This section described the study population, the game and the experimental set-up. Statistical analysis and results are presented in section 3. Three types of results are proposed in this section to confirm our reports on the existence of habit formation in the consumers' behaviors. Conclusion and discussion are presented in the last section.

## 2. MATERIALS AND METHODS

### 2.1 Study Population

The two experiments sessions took place in two different laboratories for Experimental Economics at the Higher Institute of Management of Tunisia (ISGT) and at the University of Jendouba (FSEGJ). The laboratories are equipped with computers linked to a central network on which we have planned the game. Following an announcement inside the department of Management, in both universities, 66 students participated in the game: 35 students took part in the first experiment session at ISGT on April 10<sup>th</sup>, 2010, and 31 students participated in the second experiment session at University of FSEGJ on December 4<sup>th</sup>, 2010.

### 2.2 The Game

Since we are interested to identify the habit formation at the behavior of consumers', the game was spans on three periods. Each student has a periodical budget used to satisfy consumer needs within the framework of certainty and reparability of income. To find oneself in a situation close to reality, and since we cannot afford to spend more than 594 TND, the periodical budget is set to 3 TND, the two experiments sessions took place at lunch time, and the students were asked to make their choice from menu. At the end of the game, they are assumed to consume the menu of the first period. Those relative to the second and third one are served respectively the same day of the successive two weeks.

### 2.3 The Experimental Set-Up

Each of the two experiments sessions that lasted 45 minutes took place at mid time of the day. The choice of the time is not arbitrary as explained above; it is related to the nature of game. Every experiment session relied on 8 simulations during which the subjects participating in the game are asked to allocate their periodical budget for consumption. To capture the habit formation form, each simulation was supposed to last 3 periods after which the game is reinitiated.

**Table 1:** Meals and drinks which prices (TND) vary across the 8 simulations in the first experiment session

	Sim1	Sim2	Sim3	Sim4	Sim5	Sim6	Sim7	Sim8
<b>MEALS</b>								
Tuna & French Fries	1.6	2.1	1.6	1.1	1.8	2.0	1.9	1.4
Escallop	2.2	2.2	1.7	2.7	2.4	2.2	2.2	2.1
Greek Sandwich	2.2	1.7	2.2	2.4	1.4	2.7	2.6	1.2
Salami & French Fries	1.6	1.1	1.6	1.8	1.9	1.7	1.6	1.8
Merges	1.7	2.2	1.7	2.0	1.7	1.4	1.8	2.0
Cheese & French Fries	1.6	1.1	2.1	1.8	1.5	2.2	1.6	1.6
<b>DRINKS</b>								
Mineral Water	0.5	0.5	0.3	0.5	0.7	0.9	0.8	0.9
Boga	0.8	1.2	0.8	0.7	1.1	0.9	1.2	1.3
Coca	0.8	1.0	1.2	0.7	0.5	1.1	1.2	0.9
Fanta	0.8	1.0	0.8	0.7	1.1	0.9	0.5	1.3

Then to achieve conditions close to real allocation budget, at the beginning of each simulation we grant every subjects with 3 TND per period and proposed to **them a basket of consumption goods made of meals and drinks**. According to their relative prices

allowed to vary across the simulations in the first experiment session and across the simulations and periods

in the second experiment session (see table 1 and 2), and the constrain of no savings and loans, subjects are asked to make their choice for the 3 periods.

In order to help the subject not to waste anything of his budget, additional information appeared on the screen, showing the meals and the drinks. This information clearly helped the subject avoid an annoying trial-and error mechanism. Subjects could spend as much

time as they like on their decisions and were free to compare, reconsider and correct choices already made.

**Table 2:** Prices vary across the first two simulations and the 3 periods in the second experiment session

Simulation 1					Simulation 2		
	Period 1	Period 2	Period 3		Period 1	Period 2	Period 3
				MEALS			
Tuna & French Fries	2.1	1.1	2.0		1.6	1.8	2.0
Escallop	2.2	2.7	2.2		2.4	2.4	2.2
Greek Sandwich	1.7	2.4	2.7		2.7	1.4	2.7
Salami & French Fries	1.1	1.8	2.4		1.8	1.9	1.7
Merges	2.2	2.0	1.8		1.4	1.7	1.7
Cheese & French Fries	1.1	1.8	2.0		2.2	1.5	1.4
				DRINKS			
Mineral Water	0.5	0.5	0.9		0.3	0.7	0.9
Boga	1.2	0.7	0.9		0.8	1.1	0.9
Coca	1.0	0.7	1.1		1.2	0.5	1.1
Fanta	1.0	0.7	0.9		0.9	0.9	0.9

They are not allowed however, to communicate with the other participants; they might run the risk of being excluded, and therefore not being paid. But, the menus that they will be effectively served during the 3 consecutive weeks will correspond to the ones chosen during the different simulations. The selection was randomly made by the computer.

### 3. STATISTICAL ANALYSIS

A data base was conceived with Visual Basic (VB version 6.0) using the individual and the subject responses as statistical unit. Data were entered and checked. The distribution of data response was performed in order to study the presence of habit formation in the behavior of consumer.

#### 3.1 Experimental Results

To exhibit habit formation in the behavior consumption, having a fixed income, even if the prices vary across the simulations (Experiment session 1) or periods and simulations (Experiment session 2), we should observe almost the same choice of basket of goods. Among 6 varieties of meals and 4 varieties drinks, if within 3 weeks, someone chooses for the principal, the

same meal, it is obvious that the choice is not due to religions conviction or to foods allergic. The number of renewal of the same choice is then an indicator of the habit formation. If it is equal to zero, that is no persistence in the preferences; if not, at least the subject chooses to eat 2 over 3 times the same meal, we conclude that this is due to a habit formation.

#### 3.1.1 Experiment Session 1

Results of the first experiment session where the prices were constant over the 3 periods but varying across the simulations are reported in table 3. We can see along the different simulations that 34 to 48% of subjects chose the same meal during the 3 periods. Table 3 describes the 0, 1 and 2 repetitions in percentage for meals and drinks per simulation. This table indicates that from simulation 1 to simulation 8, the percentage of two repetitions of meals is superior to 0 and one repetition. This means that most of students choose the same basket of meals for the three periods. In this respect, it can be said that the subjects (consumers) have a prior persistence of habit formation in their behaviors. For the drinks, the percentage of two repetitions of drinks is in general superior to 0 and one repetition for the eight simulations. This can confirm the preceding notice about the existence of habit formation in the behaviors of subjects.

**Table 3:** Percentage of meals and drinks choices repetitions for 35 subjects studied in the first experiment session

	Percentage of meals repetitions			Percentage of drinks repetitions		
	0-Repetition	1-Repetition	2-Repetitions	0-Repetition	1-Repetition	2-Repetitions
sim1	11.4	40.0	48.5	25.7	31.4	42.8
sim2	25.7	28.5	48.5	28.5	37.1	34.2
sim3	20.0	37.1	42.8	17.1	48.5	34.2
sim4	20.0	40.0	40.0	31.4	31.4	37.1
sim5	25.7	28.5	45.7	22.8	34.2	42.8
sim6	22.8	34.2	42.8	17.1	25.7	57.1
sim7	31.4	34.2	34.2	28.5	31.4	40.0
sim8	31.4	31.4	37.1	20.0	34.2	45.7

Table 3 shows as well that there exists a persistent behavioral phenomenon of consumption through time. Indeed, the average of percentage (8 simulations) of zero repetition, one repetition and two repetitions is equal to 0.235, 0.342 and 0.424 respectively.

This means that there are eight subjects who do not present a behavior of habit formation. On the other hand, 27 subjects choose at least the same meal twice for the three periods.

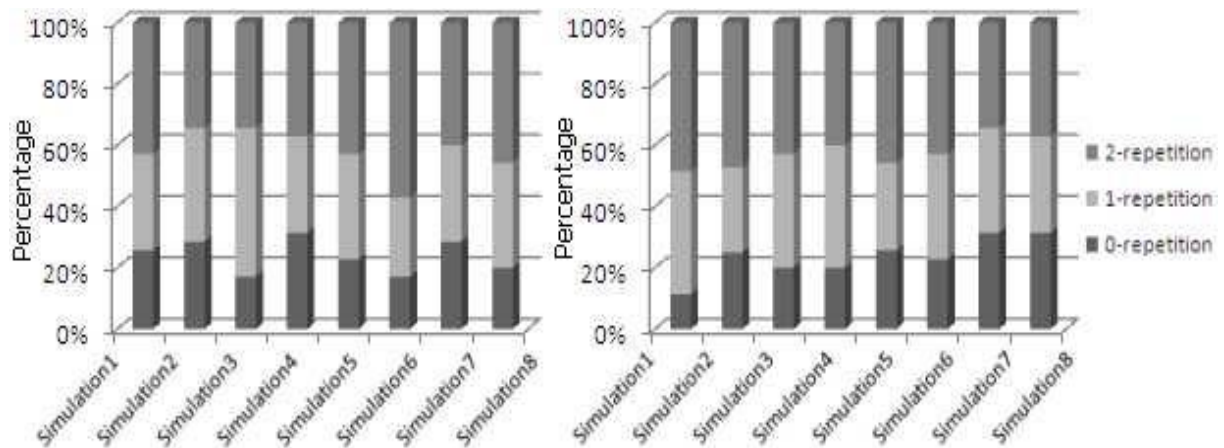
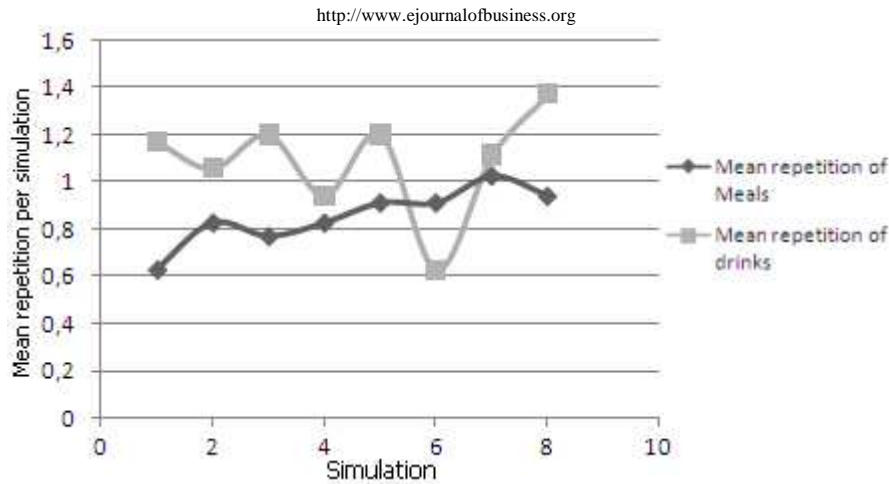
**Fig 1:** Percentage of meals (left) and drinks (right) choices repetitions per simulation for 35 subjects studied in the first experiment session

Figure 1 describes the percentage of the subjects who have chosen in each simulation a meal (left) and a drink (right) different for each period (zero repetition), two meals (left) and two drinks (right) identical (one repetition) for the three periods and the same meal (left) respectively drink (right) identical (two repetitions) for the three periods. This figure shows that all the subjects choose the same meal and the same drink for the three

periods all along the simulations. One can conclude that there is a priori presence of habit formation in the behavior of consumers.

Figure 1 shows as well, that the choice of the same meal at least 2 times is on average 77%. We have almost the same result with the drink; 34 to 57% choose the same drink during the 3 periods and an average of 76% choose the same drink over at least 2 periods. All these figures indicate the presence of the habit formation in the subjects' behavior.



**Fig 2:** Mean repetitions of meals (black) and drinks (grey) per simulation for 35 subjects studied in the first experiment

Figure 2 describes the average of repetitions of the meals (black) and the drinks (grey) by simulation for the 35 subjects. From this figure, we notice that the assumption of the habit formation in the behavior of consumption of the subjects is quite visible. Indeed, the average of the repetitions of meal in the case of simulation 2 and 5 is equal to that of simulation 4 and 6 respectively. This is due to the fact that the subjects are laid out to sacrifice drinks to obtain the same choice of meal.

### 3.1.2 Experiment Session 2

To confirm the results found in the first experiment session, a second experiment was carried out with 31 subjects at the University of Jendouba (FSEGJ). As it is already previously mentioned, the prices of meals vary across simulations in the first experiment session but in the second experiment session prices vary across simulations and periods. The goal of this second experiment session is on the one hand to widen the sample size and on the other to identify the phenomenon of habit formation in the behavior of consumption of the subjects with respect to the variation of prices of meals across the simulations and periods.

**Table 4:** Percentage of meals and drinks choices repetitions for 31 subjects studied in the second experiment session

	Percentage of meals repetitions			Percentage of drinks repetitions		
	0-Repetition	1-Repetition	2-Repetitions	0-Repetition	1-Repetition	2-Repetitions
sim1	9.67	25.8	64.51	22.58	32.25	45.16
sim2	6.45	32.22	61.29	12.90	38.70	48.38
sim3	3.22	25.80	70.96	19.35	48.38	32.25
sim4	6.45	48.38	45.16	16.12	35.83	48.38
sim5	12.9	29.03	58.06	9.67	41.93	48.38
sim6	9.67	32.25	58.06	6.45	61.29	32.25
sim7	19.35	35.48	45.16	6.45	41.93	51.61
sim8	6.45	29.03	64.51	9.67	51.61	38.70

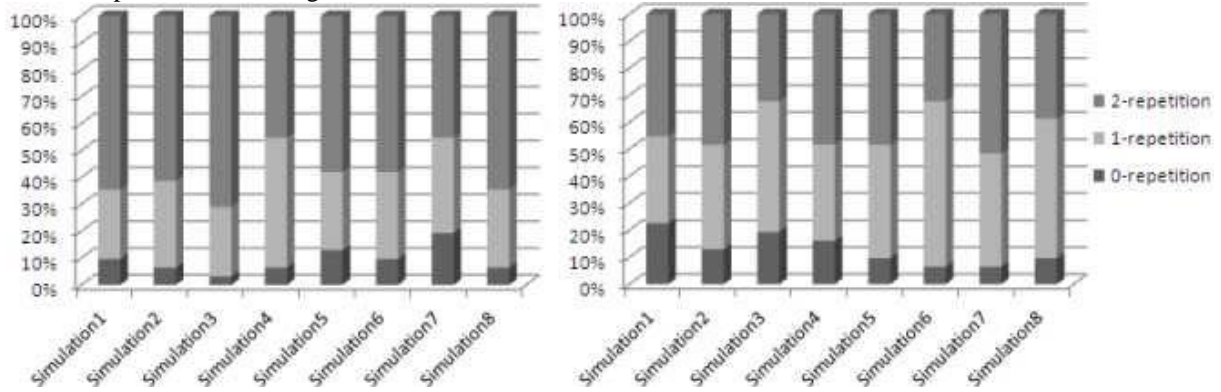
Results of the second experiment session where the price varies across the simulations and periods are reported in table 4. This table describes the 0, 1 and 2 repetitions in percentage for meals and drinks per

simulation. We can see along the different simulations that, except simulation 4, 45 to 70% of subjects choose the same meal during the 3 periods. Thus, we remark from this table that from simulation 1 to simulation 8 (except simulation 4); the percentage of 2 repetitions of meals is superior to 0 and 1 repetition. This means that

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most of subjects (consumers) choose the same basket of meals for the three periods. This leads to the assumption that subjects (consumers) have a priori presence of habit formation in their behaviors. For the drinks, the percentage of 2 repetitions of drinks is in general superior to 0 and one repetition for the high simulations. This can

confirm the preceding notice about the existence of habit formation in the behaviors of subjects.

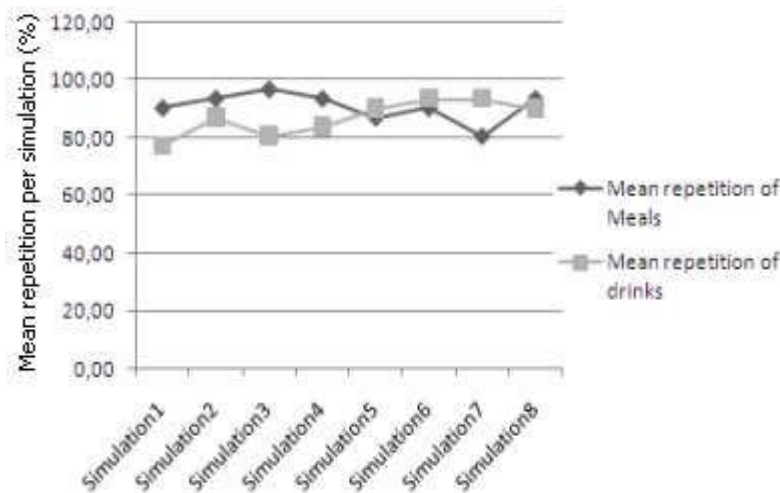


**Fig 3:** Percentage of meals (left) and drinks (right) choices repetitions per simulation for 31 subjects studied in the second experiment session

Figure 3 describes the percentage of the subjects who have chosen in each simulation a meal (left) and a drink (right) different for each period (zero repetition), two meals (left) and two drinks (right) identical (one repetition) for the three periods and the same meal (left) respectively drink (right) identical (two repetitions) for the three periods. This figure shows that all subjects choose the same meal respectively drink for the three periods and in more the share of simulations. One can

conclude that there is a priori presence of habit formation in the behavior of consumer's.

Figure 3 shows as well, that the choice of the same meal at least 2 times, is on average 90%. We have almost the same result with the drink; indeed, 32 to 51% choose the same drink during the 3 periods and an average of 87% choose the same drink over, at least, 2 periods. All these figures indicate the presence of habit formation in the behavior of subjects.



**Fig 4:** Mean repetitions of meals (black) and drinks (grey) per simulation for 31 subjects studied in the second experiment session

Figure 4 describes the average of repetitions of the meals (black) and the drinks (grey) by simulation for the 31 subjects. From this figure, the average of repetitions of meals increased from simulation 2 (85%) to simulation 3 (90%). The incidence of this is that the

average of repetitions of drinks decreased between these two simulations (from 84% to 80%). This is due to the fact that the subjects are laid out to sacrifice drinks in favor of meals. We conclude that all preceding figures show the presence of habit formation in the subject's behavior and the habit formation hypothesis in the behavior of consumption of the subjects is quite evident.



### 3.2 Elasticity

To confer importance on our analysis, one must introduce the concept of elasticity price. The economic results of the first experiment session (price varies across the simulations) and the second experiment session (price varies across the simulations and periods) are reported in table 5. To confirm the experimental results previously found, we can base on economic concept such as elasticity meal/price of the six meals to show the effect of such a variation of the prices of the meals on the choices of the subjects. An elasticity meal/price in  $[0, 1]$

means that the request for this meal is inelastic and the subject chooses the same meal (habit formation) independly of the variations in prices. However, when elasticity meal/price is superior to the unit this means that the request is elastic. The subject in this case is sensitive to the variations of the prices of the meals and it will choose a different meal during the other time (no habit formation). Table 5 reports the calculated elasticity for the six meals and selected simulations. Based on this table, we distinguish between 3 types of elasticity:

**Table 5:** Elasticity on the demand of the 6 meals offered to the subjects for the two experiments sessions

Elasticity		
	Experiment session 1	Experiment session 2
Tuna & French Fries	0.171	0.825
Escallop	0.540	0.000
Greek Sandwich	0.076	1.225
Salami & French Fries	1.562	0.052
Merges	0.540	0.760
Cheese & French Fries	2.100	0.435

A null elasticity, the request does not vary when the price varies. The request remains stable whatever the price and it is perfectly inelastic. It is in particular the case of meal 2 of the second experiment session: although the price varies across the simulations and the periods, the request for this meal is maintained because the subject prefers the same meal for at least two periods. This explains that there exists habit formation in the behavior of the subject.

An elasticity in  $[0; 1]$ , the request does not vary when the price varies. In this case, the request is inelastic and it is the case of meals 1, 2, 3 and 5 of the first experiment session and meals 1, 4, 5 and 6 of second experiment session. The request of these meals is not sensitive to the price and is maintained because subjects prefer to consume the same meals in the future periods. An elasticity superior than 1, a small change of price involves a great change of request. It is the case of meals 4 and 6 of the first experiment session and meal 3 of second experiment session. The variation in the price of these meals changes decisions choices and the structure

of consumption in the behavior of the subjects. The request in this case is elastic which means that few of the subjects change their choices in the future.

Based on these results of elasticity, we conclude that in general the subjects present a habit formation in their behaviors and their request is not sensitive to the variety of prices of meals which cannot redirect their choices in the future.

### 3.3 Nonparametric Analysis

Another way to show if the preferences of consumers exhibit a habit formation consists in the measure of the dependence between inter-temporal choices. The Fisher Exact [10], the Wilcoxon [11] also known as respectively "Mann-Whitney" and the Spearman [11], [12] nonparametric tests are the most popular techniques. Each of the three tests estimates the association between paired samples and computed the value of the test. They use different measures of association, all in the range  $[-1, 1]$  with 0 indicating no association. Then, it is possible to construct a correlation test where the null hypothesis is  $H_0$ : Absence of habit formation of consumers' behavior (Absence of correlation between periods) is used.

**Table 6:** Power nonparametric tests between studies periods of meals choices for the two experiments sessions

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Nonparametric test	P <sub>1</sub> *-P <sub>2</sub>	Experiment session 1		Experiment session 2		
		P <sub>1</sub> -P <sub>3</sub>	P <sub>2</sub> -P <sub>3</sub>	P <sub>1</sub> -P <sub>2</sub>	P <sub>1</sub> -P <sub>3</sub>	P <sub>2</sub> -P <sub>3</sub>
Fisher Exact	0.173	0.516	0.093	0.109	0.111	0.072
Wilcoxon	0.083	0.052	0.106	0.187	0.999	0.162
Spearman	0.130	0.185	0.054	0.051	0.062	0.093

\*means studies periods

As we can see in table 6, since the p-value are greater than 5%, the three tests confirm the same result of previous sub-section. Thus, we can accept the hypothesis of correlation with a significant level of 95%, indicating the presence of dependence between the subjects' choices of meals for the three periods. Thus, we can say that in general subjects present a habit formation in their behaviors and their choices are not directed by the prices of goods in the future. Given a budget of 3 TND in each period, the subject chooses the same meal that he prefers and maintained his choice for the future periods regardless of prices.

The present work is a first attempt to test the assumption of the habit formation at the behavior consumers' level within a context of certainty and reparability of income (no savings and no loans). Experiments undertaken in a laboratory to the level of two Tunisian universities out of 66 subjects enabled us to have at the end of 8 simulations 528 data of consumption over 3 periods. The play consisted in making a choice of menu (meals and drinks) knowing a periodic income of 3 TND.

From this paper, we can distinguish three types of results: The first is based on the graphics and it concerns the experimental results. The percentage of one and two repetitions of meals and drinks is superior to zero repetition. This means that most of subjects' consumers choose the same basket of meals for the three periods. The second is based on the elasticity and it concerns the economic results. From table 5, we see that most of the values of elasticity are inferior to 1 which means that the request of subjects is maintained across the simulations and periods. The last is based on Fisher Exact, Wilcoxon and Spearman tests and concerns the nonparametric analysis. The p-value of these tests is in general greater than 5%. Thus, we can accept the hypothesis of correlation with a significant level of 95%, indicating the presence of dependence between the subjects' choices of meals for the three periods.

All preceding results show the presence of the habit formation in the subjects' behavior and the assumption of dependence between choices carried out by the participants is quite visible. A glance over the three periods reveals that there were a certain persistence of

choice of the meal and drink; more of the third make the same choice during the three periods. Nonparametric tests of Exact Fisher [6], Wilcoxon [7] and Spearman [10] also confirm the existence of dependence in the subjects' choices.

Overall, it was suggested by these tests that the choices of the subjects were not conditioned by the prices of the meals over time. It is worth noting that in the behaviors of the subjects there persists habit formation at the level of consumption. These results can only confirm the existence of habit formation at the level of consumption of the individuals.

This study is not without limitations, the first is related to the number of periods. Even if we think that our results are not skewed too much, it would have been more interesting if the periods were longer. We had a financial constraint. The second, with whom we reflected too much, it is the periodicity, day laborer, weekly etc. The first, one could not retain since for a certain balance of the contributions of food in vitamins, the human being has to diversify its food. The third is the restrictive assumption of the reparability of the incomes. It is well-known in the protocol of the experiments, which one can measure the effect of a parameter only by neutralizing the others. Future experimental research could attempt to consider these limitations in order to determine how habit formation effects unfold in more complicated settings.

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