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**THE FINANCIAL MARKETS AND  
WEALTH EFFECTS ON  
CONSUMPTION**

*AN EXPERIMENTAL ANALYSIS*

**Matteo Ploner**

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# THE FINANCIAL MARKETS AND WEALTH EFFECTS ON CONSUMPTION

*AN EXPERIMENTAL ANALYSIS\**

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## **ABSTRACT**

The paper investigates the effects exerted by the ownership of quoted equities on intertemporal wealth allocation. To this end, it reports an experiment conducted with human subjects. The fact that an increasing share of household balances is allocated to equities raises numerous questions on the nature and magnitude of so-called 'wealth effects'. The traditional theories are based on the assumption of perfect rational agents and do not consider wealth effects in detail. The empirical literature on the topic is heterogeneous and does not give a uniform description of such effects. The decision to work with experimental tools was prompted by the idea that this approach would shed light on the behaviour of subjects asked to decide on simulated consumption/saving decisions. The neutral position taken up with respect to the traditional theory when designing the experiment enabled us to compare the outcomes of the laboratory experiment against the theoretical findings of Hall's (1978) model, which describes a Random Walk in consumption. This analysis yielded a much more complex picture than would have been obtained in the perfect rationality framework which supports the traditional theories of life cycle-permanent income. In trying to understand and give a theoretical framework to the behaviour observed in the laboratory, we consider models taken from both the economic and the psychological literature. The analysis furnishes interesting insights, which are described and considered as future directions for research.

## INTRODUCTION

Decisions on the intertemporal allocation of wealth constitute one of the building blocks of modern economic theory. This field of inquiry comprises models that are widely accepted and appear in all the economics textbooks (*life cycle, permanent income*). There are also numerous empirical studies on time series. The contradictions apparent in the empirical literature, and the criticisms brought against the strong rationality requirements and computational capacity pretensions of the traditional theories, prompted us to tackle the problem using an alternative approach open to the contributions of both psychological and economic studies, the intention being to reconcile theory with the real computational, motivational and decisional factors of the human mind. Within this general framework, the paper describes an experiment conducted with human subjects in order to observe how decisions regarding the intertemporal allocation of wealth are taken in a controlled environment.

The experiment comprised three different sessions, during which each subject working independently from the others. The starting point of each session was a given amount of wealth which had to be changed into consumption within a given and known time horizon. At the end of this time interval, the subject was rewarded with an amount of real money proportional to the consumption recorded in the three sessions. The sessions were of increasing difficulty, and in the last one the subjects were at risk of having insufficient wealth to "survive" until the end.

In the main sessions of the experiment (the last two), we investigated the behaviour of individuals whose portfolios were stochastic determined in value – as are the portfolios of those who possess equities. The number of households that allocate their wealth in financial markets is increasing, and this feature, together with sharp changes in stock values like those observed in the 1990s, may generate unexpected effects on aggregate consumption.

Although experimental analysis is becoming increasingly frequent in economics, there are still topics that are not appropriately considered in this framework. A case in point is decisions regarding the intertemporal allocation of wealth. Other experimental studies on intertemporal allocation (Hey, 1998; Anderhub-Guth-Müller-Strobel, 2001) have shown the difficulties encountered by researchers when seeking to reproduce the intertemporal context in a laboratory. In consideration of previous studies on the matter, we tried to impose the least constraints possible on the subjects' decisions. We assumed only that individuals obey the monotonicity axiom and hence prefer a larger

reward to a smaller one. We also adopted a deterministic and known life horizon so that the subjects were not given an excessively burdensome computational task.

The first section of the paper gives a short description of wealth effects, taking consideration of the point of view adopted by the standard theories and empirical studies on time series. Section 2 briefly illustrates the behavioural implications of consumption/saving decisions, referring to specific models taken from both the economic and psychological literature. Section 3 describes the experiment and its theoretical underpinnings. Section 4 illustrates the experimental design and gives some technical details. Section 5 continues the presentation, focusing on the three sections which constituted the experiment. Section 6 analyzes the data collected, while the final section verifies the behavioral hypothesis set out in Section 2 against the outcomes of the experiment. On the basis of this analysis, some possible future directions for research are described.

## 1. THE WEALTH EFFECTS ON CONSUMPTION

Quoted stocks are becoming an increasing component of the wealth of households. This is due both to the increase in direct ownership and to the spread of pension wealth programmes. If the value of owned stocks increases (decreases), there will be a direct effect on the intertemporal budget constraint, which will expand or diminish respectively. Because decisions about current consumption or saving are based on this budget, a change will be observed in the strategy of intertemporal allocation. The mechanism described, which starts from the financial markets and leads to the decision whether to save or consume, is called the *wealth effect*. The effect is then termed 'direct' because it works on the budget constraint. The situation in which the financial markets influence consumption as a proxy for future economic activity is called the 'indirect' effect.

The standard theories on intertemporal wealth allocation (permanent income-life cycle) do not discriminate among variations in wealth by nature and source. The variation recorded in consumption is determined only by the marginal propensity to consume. This coefficient is independent of wealth and is defined by the interest rate and by the residual life perspectives. This result is a derivation of the strong assumption of the perfect rationality of agents. Individuals are supposed not to be bounded in their computational capacities for intertemporal planning, nor in their amount of will power.

Numerous empirical studies based on time series have sought to assess the nature and magnitude of wealth effects. The outcomes of these studies are not

unambiguous, and in particular they do not furnish evidence for "regular" wealth effects like those described by life cycle-permanent income theories. In trying to answer the equity premium puzzle, Mankiw-Zeldes (1991) highlights how expenditures by subjects with equities in their portfolios are much more closely correlated to stock market behaviour than are those of subjects that do not hold stocks.

As a general result, one corroborated by other studies as well, it seems that on the occasion of sudden and large falls in stock prices the link between markets and consumption is weak, but when events are more prolonged the link becomes closer and more in line with the models' forecasts. With reference to the magnitude of wealth effects, one should bear in mind the official FED estimate, which sets the effect at between 3% and 5% in the period of wealth variation. Dynan-Maki (2001), in a study based on Consumer Expenditure Survey data, estimate a rather wide range for wealth effects: from 5% to 15% over two years. Starr-Mccluer (2000), when considering interviews conducted with American families, found that the majority of these families had not altered their level of consumption in response to financial market trends.

An important element to consider when studying wealth effects is the marked heterogeneity of stock ownership. Palumbo-Maki (2001) divide microeconomic data according to income levels. This division is a good proxy for stock ownership, because the higher the income the greater the share of stocks in total wealth. The main finding of this work is that households in the highest income quintile, which are also those with the largest stock ownerships, are the same ones that displayed a considerable decline in the propensity to save during the 1990s. Households in the lowest three quintiles exhibited an increasing propensity to save in the same period. Another interesting study which takes account of heterogeneity in stock ownership is Poterba-Samwick. The conclusions of this study are less clear-cut than those of Palumbo-Maki, but they nevertheless seem to confirm the presence of a direct wealth effect.

It thus seems possible to state that there is no single point of view on the nature and magnitude of wealth effects. It is possible to observe, however, that they certainly make a contribution to determining consumption volatility. Starting from this consideration, here we shall study volatility in consumption linked to stock values, seeking in particular to detect the possible psychological motivation underlying this specific aspect of consumption behaviour. The data collected will be analyzed with reference to standard theories of intertemporal allocation. This method seems to be the most appropriate one, given that values defined with reference to standard models are characterized by minimum variance, and in terms of psychological contents are only characterized by maximization principle. For these two reasons, data originating from standard

theories, and specifically from Hall's model, are good benchmarks for evaluation.

## 2. BEHAVIOURAL ASPECTS INVOLVED IN THE EXPERIMENT

When designing the experiment, we considered both the possibility of comparing outcomes with the theoretical benchmark represented by Hall's model and the possibility of highlighting specific forms of behaviour. As regards the behavioural aspect, we referred to models proposed in both the economic and the psychological literature.

The first of these behavioural models is the well-known *Prospect Theory* (Kahnemann-Tversky, 1979) based on empirical observation and which divides essentially into two phases: *editing* and *evaluation*. In the first phase all the possible options are organized so that the subsequent evaluation phase is easier. The evaluation stage is developed by considering the variation in wealth instead of its final state. Evaluation of losses and gains starts from a *reference point*, and the value attributed to losses and gains depends on a value function. The shape of this value function is such that for the same wealth variation in absolute value losses have a greater impact in terms of value (*loss aversion*).

When designing the experiment, we provided the subjects with an amount of virtual stocks with an implicit anchor value represented by the value of the equity at time zero. Our decision to keep this value as an anchor value can be justified by citing the fact that the value considered is a round number (i.e. 10 Euros). Confirmation of the previous guess is provided by the observation of clearly distinct forms of behaviour relative to values above or below 10 Euros. It should be borne in mind, however, that stocks are not purchased, so that the experimental situation lacks the important component of the initial cash payment. Doubts can be cast on the effective emotional involvement of experimental subjects with respect to changes in equity value. In reply to these doubts we would point out that equity value directly influences the magnitude of consumption on which the final return is computed. Values in equities must thus be perceived as a key variable in the successful maximization of the final reward.

Fundamental for understanding subjects' behaviour may also be *Mental Accounting* theory (Thaler, 1980; Kahnemann-Tversky, 1981). The main contention of this theory is that individuals do not act according to the principle of the fungibility of wealth. In the real world, the nature and origin of wealth influence the way in which it is considered and spent. This position is

supported by a large body of empirical evidence.<sup>1</sup> With reference to our experiment, we would point out that in all the sessions total resources were distinguished into two categories: one "familiar" and certain, named current account (C/C in short) and one which is "riskier", because it is random in value, called "equities". The two sources are perfectly equivalent in terms of consumption possibilities, so that the two sources of wealth are perfectly fungible even if they are different in nature. A possible hypothesis is that, in experiments as in real world, subjects will exhibit different approaches to the two sources in terms of consumption. This differentiated behaviour may emerge in particular during the third phase of the experiment, when a "calibrated" use of stocks and liquidity is indispensable.

A third interesting theoretical contribution in the field of intertemporal decisions is the concept of *Choice Bracketing* (Read-Loewenstein-Rabin, 1999).<sup>2</sup> This concept refers to the time horizon adopted by subjects in making their decision. To this end, each session of the experiment was constructed as a sequence of finite and separable periods. It should be borne in mind that, in the perfect rationality framework, decisions taken in different periods must not be considered separately. The experimental setting allows one to determine whether the behaviour of the subjects observed is more oriented towards a *Narrow Bracketing* view, which represents each phase in isolation, or towards a *Broad Bracketing* view, which implies a global representation of the problem. If the former attitude prevails, it is likely that subjects will react sharply to high stock values. If stock values are high in the first phases, this will lead to a very fast use of stocks. It should be noted that using a broader framework determines a behaviour in line with the values of the theoretical benchmark considered. Using a Broad Bracketing approach instead of a Narrow Bracketing one proved very important in the third session. The structure of this session "forced" the subjects to use a narrow approach because scarce resources had to be "wisely" split among the whole subset of phases. It is possible that the subjects understood that this was the appropriate behaviour, but it might also be the case that they preferred to work on each phase in isolation, because this involved less computational effort.

The theory of *Cognitive Dissonance* (Festinger, 1956) must also be considered, since this can aid understanding of the well-known bias that causes different reactions to losses which are realized and losses which are not. This is

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<sup>1</sup> For an interesting survey on Mental Accounting and its application in various fields, see Thaler (1999). For connections between MA and financial markets see Shefrin and Statman (1995) and Shiller (1998).

<sup>2</sup> Another related work is Benartzi-Thaler (1995) on Myopic Loss Aversion in the context of Equity premium Puzzle to which Loewenstein-Prelec-Rabin refer.

a phenomenon that does not fit with the perfect rationality assumption underlying all the standard theories on intertemporal decisions. Enlarging the frame makes it possible to model this apparently irrational behaviour: everyone has a projection of themselves as coherent choosers, but when the reality does not fit this representation (i.e. the value of the stocks is diminishing), subjects may develop an anti-dissonant representation of the part of the world included in their decision. In the specific case of the investor, this corresponds to the decision to ignore the real value of equities and thus postpone the painful decision of selling bad stocks. In this case, only the monetary event (selling stocks) generates the psychological discomfort of regret (Loomes-Sugden, 1982).

Cognitive dissonance-driven behaviour has been observed by Shefrin-Statman (1993) among a large group of stock owners. This is known as the *Disposition Effect*. It refers to the paradoxical behaviour of stock owners who rapidly sell their shares with good fundamental values and hold "bad" shares in their portfolios for a long time. To be noted is that the observation of behaviours connected with cognitive dissonance in cases of share ownership is closely correlated with the guesses of subjects about future values. In a pure random process, like the one in the experiment, subjects are not supposed to figure out any future path of the value for themselves. The best approximation of the future value is today's value. But it may be that subjects use some sort of *Judgement Heuristic* (Kahneman-Tversky, 1974) which helps them to construct a possible future path of the value by considering past observations. Behaviour of this kind is not acceptable when a strict-rationality approach is used, but it is nevertheless observed in the real financial markets (Shiller, 1998). The most appropriate heuristic in the specific environment of our experiment was the one known as *availability* (see Table 1 for a brief description). This heuristic seems particularly suited to describing behaviour during peaks in stock prices. Since this phenomenon has a major impact and is easily recordable, it can be assumed that individuals will tend to replicate previous observed trends and adapt their behaviour accordingly.

There are consequently numerous behavioral aspects to be considered when analysing the intertemporal allocation of wealth (see also Table 1 for a summary). The foregoing brief survey should be seen as a working hypothesis which was tested by means of an experiment. A good result would either validate or disprove the initial hypothesis.

**Table 1 - Summary of the behavioural models considered**

BEHAVIORAL MODEL	DESCRIPTION
Prospect Theory (Kahneman and Tversky, 1979)	PT has been derived from empirical observation. It divides essentially into two phases: <i>editing</i> and <i>evaluation</i> . In the first phase all the possible options are organized so that the subsequent evaluation phase is made easier. The evaluation stage is developed by considering the variation in wealth rather than its final state. Evaluation of losses and gains starts from a <i>reference point</i> , and the value attributed to losses and gains depends on a value function. The shape of the value function is such that for the same wealth variation in absolute value losses have a greater impact in terms of value ( <i>loss aversion</i> ).
Mental Accounting (Thaler, 1985; Kahneman-Tversky, 1984)	Subjects tend to develop mental accounts in which they ideally "store" their wealth. Every account has its own weight in the global decision process. The attribution of weights does not respect the principle of wealth fungibility. The amount of each of these weights depends on elements like the origin of wealth, the extension of the time interval considered, and the general environment.
Myopic Loss Aversion (Benartzi-Thaler, 1995) Choice Bracketing (Read-Loewenstein-Rabin, 1998)	<u>Myopic Loss Aversion</u> is a particular form of behaviour by share owners who alter their assessment of stock performances in a given time interval according to the frequency of their observations of performance. <u>Choice Bracketing</u> concerns the way in which subjects group sequential choices on different time intervals. The grouping action may be broad oriented (broad Bracketing) or with narrow scope (Narrow Bracketing).
Cognitive Dissonance (Festinger, 1957) Regret Theory (Loomes-Sugden, 1982)	Individuals want to behave coherently with their self-representations in different contexts. If reality returns messages which conflict with these self-representations (cognitive dissonance), psychological discomfort will arise (regret). Responses to this discomfort will be different and may work either on the external situation (social and physical environment) or on the internal situation (perception).
<b>Judgement Heuristics</b> (Kahneman-Tversky, 1974)	<u>Representativeness</u> is the tendency to determine probabilistic frequency by considering only the similarity among events, not the general context. <u>Availability</u> is the propensity of decision-makers to determine the probability of an event by referring only to the mental availability of this event. <u>Adjustment and Anchoring</u> : when individuals form their beliefs, they fix a point of reference from which they process context information.

### 3. GENERAL DESCRIPTION OF THE EXPERIMENT

When designing the experiment, great effort was made to maintain a neutral position *vis-à-vis* theoretical models of the intertemporal allocation of wealth. The reward was designed so that the subjects could express "free" behaviour, and not behaviour that might have been imitative of that described by a specific model. By way of example, consider the possibility of assuming a concave function as a rule of payment. This would have led to a unique best solution corresponding to homogeneous choices. An experiment of this kind would have been merely a validation of standard theories, and not, as we intended it to be, an observation of decisions taken in a controlled environment. Adopting a concave function as a rule of distribution would have reduced the participants' task to mere understanding of the instructions.

We also had to provide the appropriate incentive for the subjects to obey the fundamental principles of dominance, monotonicity and salience (Friedman-Sunder, 1994). In the light of these considerations, we opted for a retribution system based on the principle that reward must be directly proportional to the quantity of consumption allocated over all the three sessions. The coefficient of retribution was fixed according to the budget available to us, and it was such that for each unit of consumption the subject received 3/10000 Euros.

The model used as the evaluation benchmark was the life cycle-permanent income model, and specifically for sessions 2 and 3, the version of it developed by Hall (1978). This version is a strict derivation of neoclassical models and assumes that part of the total resources of individuals is governed by a random process (cf. Romer, 1996). In the original formulation, this component is income, while in our specific environment the random component was represented by stocks.

The maximizing condition which subjects obey was:

$$[1] u'(C_t) = E \left[ u'(C_{t+1}) \frac{(1+r)}{(1+\rho)} \right]$$

where  $C_t$  stands for consumption during phase  $t$ ,  $u'(C_t)$  is the marginal utility of consumption during phase  $t$ ,  $r$  is the real interest rate and  $\rho$  is the intertemporal discount factor. Having assumed that  $r = \rho$  and assuming that utility function is additive and constant with respect to time we obtain:

$$[2] C_t = E_t [C_{t+1}]$$

which guarantees that, with constant information, consumption is constant in all periods. Consumption may change only as a response to new information which alters conditional expectation  $E_t$ .

Recalling the intertemporal budget constraint, and leaving aside problems related to time discounting, it follows that at time  $t = 1$

$$[3] \sum_{t=1}^T C_t \leq A_1 + \sum_{t=1}^T Y_t$$

where  $A_1$  is wealth at time  $t = 1$  (constant throughout the experiment),  $Y_t$  is a random variable which in Hall's original model represents income at time  $t$ ;  $T$  is the last life period. Introducing uncertainty, we obtain:

$$[4] \sum_{t=1}^T E_1[C_t] = A_1 + \sum_{t=1}^T E_1[Y_t]$$

and from [2] it is possible to derive the left hand side of [4], which is equal to  $TC_1$ , so that by substitution we obtain:

$$[5] C_1 = \frac{1}{T} \left( A_1 + \sum_{t=1}^T E_1[Y_t] \right)$$

On the basis of [5], subjects would consume a constant quantity ( $1/T$ ) of their total resources in each single phase. The specific experimental design adopted permitted the assumption of an discount intertemporal rate equal to zero, because every session was of "instantaneous" nature.<sup>3</sup> As regards the interest rate, in the instructions given to subjects this was specified as being equal to zero.

Before we consider each session individually, it may be helpful to provide a general sketch of the experiment. The three sessions which constituted the experiment had a similar structure, but in each of them certain parameters were changed as described below. A feature shared by all three sessions was the initial amount of resources available to the subjects. These resources had to be distributed among the remaining phases of each session, and the participants had to bear in mind that part of the resources consisted of a deterministic component ( $C/C$ ) and part of a variable component (stocks). Put in algebraic form, the initial resources can be described thus:

$$[6] X_t^i = Y_t^i + A_t^i V_t$$

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<sup>3</sup> This does not rule out the possibility that with different experimental designs, the nature of the intertemporal discount rate could be investigated.

where  $X_t^i$  are total resources at time  $t$  of subject  $i$ ,  $Y_t^i$  is the amount of virtual money on  $C/C$ ,  $A_t^i$  are titles in portfolio, and  $V_t$  is the value of stocks at time  $t$ .

The value of equities was determined with a random numbers generator based on a uniform distribution with zero average. During the experiment all the subjects face the same values.

The subjects' task was to define the quantity of the consumption good that they wanted to purchase in each phase with the resources at their disposal in that phase.  $C_t$  represents the units of unique consumption good consumed in phase  $t$ . Because price  $p$  of the consumption good is constant and equal to 1, in each phase:

$$[7] C_t = \frac{c_t X_t}{P} = c_t X_t$$

where  $c_t$  represents the marginal propensity to consume during phase  $t$ .

The retribution warranted by the experiment was directly proportional to total consumption. Assuming that the subjects had monotonic preferences with respect to final retribution, they faced the following maximization problem:

$$[8] \max \sum_{t=1}^T C_t$$

subject to the following constraints

$$(a) X_t \geq S$$

$$(b) C_t \leq X_t \quad \text{for any } t \quad 1 \leq t \leq T$$

$$(c) C_t \geq S$$

where  $S$  was a minimum consumption level constant throughout the session and  $T$  was the last phase of each session. Whenever constraint (a) was not respected, the subject would be excluded from the current session and his/her return from that session was equal to zero. Whenever constraints (b) and (c) were not respected, the subject would be asked to restate his/her decisions for that phase. The implications of the linearity of the retribution function are described above. It should finally be noted that each single consumption decision was not independent from the others, because resources in one phase depended on decisions in previous ones, according to a relation of the following kind:

$$[9] Y_t = Y_{t-1} - C_{t-1}^Y$$

$$[10] A_t = A_{t-1} - C_{t-1}^A$$

$$[11] C_t = C_t^Y + C_t^A$$

where  $C_{t-1}^Y$  stands for consumption from C/C in phase t-1 and  $C_{t-1}^A$  is consumption deriving from the sale of equities in the portfolio during the same phase.

#### 4. THE EXPERIMENTAL DESIGN

The experiment was conducted with the assistance of the Computational and Experimental Economics Laboratory (CEEL)<sup>4</sup> of the University of Trento. Each experimental subject was asked to work on a personal computer running a model of the experiment. This model had been constructed using the popular application Microsoft Excel<sup>®</sup>, with the standard framework enriched with Visual Basic input/output masks.<sup>5</sup> This language was also used to impose control devices on the subjects' choices. The experiment took place in a room of the Faculty of Economics of Trento where it was possible to have the twenty participants work individually and simultaneously. The funds kindly made available by the University of Trento enabled us to fix an upper bound on the retribution of 15 Euros for each single participant. The subjects were recruited through channels customarily used by the CEEL. The participants were students at the University of Trento. The experiment with retribution took place on 28/05/2002 after a check experiment with non-retributed subjects had been conducted the week before. The instructions were read out loud before each of the three sessions of the experiment and clarifications were made if necessary. The experiment started at 10:25 and the last participant left the room at 11:23. The average working time recorded was about 40 minutes.

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<sup>4</sup> <http://www-ceel.gelso.unitn.it>

<sup>5</sup> I am indebted to Matteo Forti for first suggesting the use of input masks. I am grateful to Marco Tecilla for his technical assistance and operational support, and to Dino Parise and Macrina Marchesin for their help during the experiment. A special acknowledgement goes to Dominique Cappelletti for her support in compiling the instructions and structuring the experimental framework.

## 5. SESSION BY SESSION DESCRIPTION OF THE EXPERIMENT

### 5.1 SESSION I

The aim of the first session was to train the participants for subsequent ones. Nevertheless, useful insights could be gained from observations during this session as well. In particular we expected to find traces of *Mental Accounting*-oriented behaviour in terms of the differential treatment of wealth depending on its source. In this session the subjects could rely on an amount of wealth composed as follows:

- 8000 Euros in a virtual C/C which paid zero interest;
- 200 equities with zero dividend yield and whose unit value was fixed equal to 10.

A subject's life lasted ten years (phases) and the unitary cost of the unique consumption good (u.c.g.) was 1 Euro. The participants were asked to define for each phase the quantity of u.c.g. that they were willing to purchase in that phase knowing that their reward in real money would be proportional to the total quantity of the good being purchased.

The quantity of consumption good purchased was determined both by C/C use and by the sale of equities. The effective equity sale value was instantaneously converted into consumption during the selling phase. The lower bound on consumption in each phase was 500 units of the good. Whenever a subject had insufficient resources to satisfy this constraint, s/he was automatically excluded from the session and transferred to the next one. His/her payoff for the session from which s/he had been excluded was zero. This "punishment" seemed sufficiently strong and perceivable to force the subjects into conceiving a strategy that enabled them to "survive".

In the first session there was no single strategy that ensured maximization of the final payoff. The only conditions that had to be observed in order to maximize the payoff was constraint (a) above and complete spending of the wealth for the session. It is arguable that as to minimize their computational mental effort the subjects had to develop a static strategy, which in this specific case consisted in using 800 Euros from C/C and selling 20 securities for any single phase.

## 5.2 SESSION II

In this session the subjects possessed an amount of wealth composed as follows:

- 15000 Euros in a virtual C/C which paid zero interest;
- 300 equities with zero dividend yield and whose unit value was variable.

The nature and magnitude of the variations was not possible to forecast *a priori* because they were determined by a computer generator of random numbers. The unit value of securities at the beginning of phase 1 was equal to 10 Euros. Lifetime in this session was known to the subjects and it consisted of 30 phases. At the beginning of each phase the value of the stock in that phase was communicated to the participants, with a frame which also showed the variation with respect to the previous phase. The participants were asked to define for each phase the quantity of u.c.g. that they were willing to purchase in that phase knowing that their reward in real money would be proportional to the total quantity of the good being purchased. The unit price of the good was 1 Euro, and the subjects could use either C/C or stocks to consume it. Effective equity sales were instantaneously converted into consumption during the selling phase. In this session, as in the previous one, the minimal amount of consumption per phase was 500 Euros (or units of the good, as the price per unit was unitary). Whenever a subject had insufficient resources to satisfy constraint (a), s/he was automatically excluded from that session and transferred to the next one. His/her payoff for the session from which s/he had been excluded was zero.

The theoretical reference model, as depicted above, is that developed by Hall. In our specific case it was:

$$[12] C_t = \frac{E_t(X)}{P(T-t)} = \frac{Y_t}{P(T-t)} + \frac{A_t E_t(V)}{P(T-t)}$$

where  $C_t$  = consumption in phase  $t$ ;  $Y_t$  = C/C value at time  $t$ ;  $A_t$  = amount of securities owned at time  $t$ ;  $E_t(V)$  = expected value of securities at time  $t$ ;  $T$  = length of life (session);  $P$  = price of consumption good;

Because the process underlying the equity's evolution was a Random Walk it follows that

$$[13] V_{t+1} = V_t + \mu_t \Rightarrow E[\mu] = 0 \Rightarrow E(V_{t+1}) = V_t$$

and this implies, taking account of the wealth fungibility principle, the following version of Hall's equation:

$$[14] C_t = \frac{X_t}{(30-t)} = \frac{Y_t}{(30-t)} + \frac{A_t V_t}{(30-t)}$$

Behaviour which evolves following equation [14] is clearly behaviour that makes consumption the most homogeneous in the entire session. Moreover, again from [14], we have that share selling is constant and equal to 10 units in each single phase of the experiment. This behaviour is justified by the fact that the process underlying the equity's price is a random walk; the best forecast of the future price in a process of this kind is current value, so that this must be the reference value for sales in the current and future periods. Homogeneity-oriented behaviour is depicted by a marginal propensity to consume which is linear with respect to time and makes share selling constant in every phase.

It should be pointed out, however, that in the specific experimental design adopted for this session the deterministic resources (C/C) sufficed to achieve the important – in terms of maximization of the final reward – goal of survival. Thanks to this setting, the strategy in equity sales can be separated from that of reaching the end of the session. The timing of equity sales must be seen from another perspective as well: in a random walk process it is impossible to define the value at time  $t + k$  *a priori*, so that selling the stock when the price seems high will result in a wrong decision if the value is higher in the future. A situation such as the one depicted represents a loss in terms of total consumption and therefore a loss in terms of final retribution. It is thus clear that if we apply the same reasoning to the symmetrical case of a decline in stocks value, the best *a priori* strategy that takes account of the nature of the process underlying equity values and the fact that the equities sold go directly into the consumption account is the one described by [14] (Hall's model).

The incentive to make homogeneous use of the C/C derived from considerations about the certainty of survival. Indeed, only this strategy ensured that the subject could reach the end of the session and would therefore able to convert consumption into real retribution.

**Table 2 –Values of equities in session 2**

Phase	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Value	10	10,40	9,31	13,24	10,91	13,92	13,94	13,92	10,8	9,51	8,65	9,78	7,44	7,51	5,88
Phase	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

Given the above-reported trend in prices, the theoretical behaviour as described in equation [14] takes the following form (assuming constant consumption out of deterministic resources):

**Figure 1- Possible evolution à la Hall (Benchmark)**

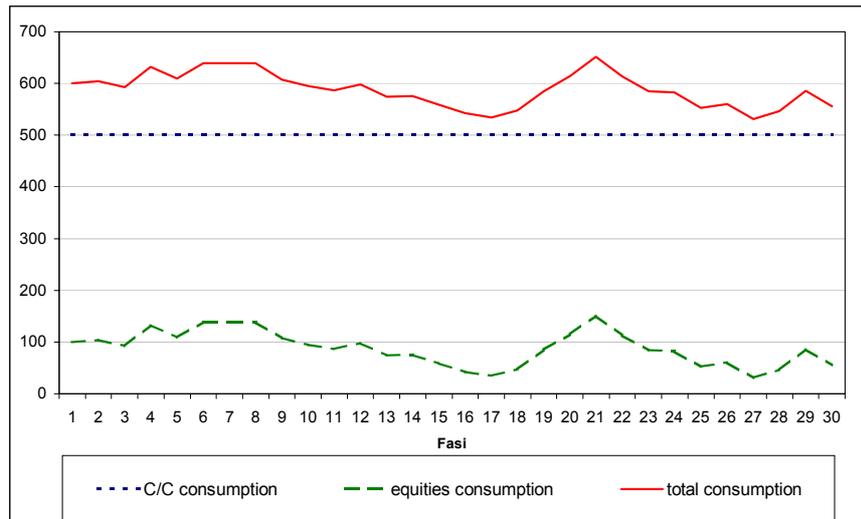


Figure 1 shows that in the benchmark model total consumption changes in direct proportion to the value of equities, and also that this relation is a linear one. Despite variance in the equity wealth, total consumption is rather homogeneous, with limited variability (standard deviation = 33,50).

### 5.3 SESSION III

As seen, in session 2 the deterministic resources represented by C/C ensured the certainty of survival in that session. For session 3 we decided to increase the minimum consumption level to 600 units of good for each phase. With this change in the experimental design equities assumed an active role in the survival strategy and were no longer to be considered only in "speculative" terms. *A posteriori*, however, it should be pointed out that the average of the values of equities was greater than 10 Euros and large enough to guarantee survival.

In a context like the one depicted above it is not possible to find a single strategy that ensures survival *a priori*, and neither does Hall's model give values which are valid beforehand.

One possible strategy for the subjects could have been to "anchor" themselves to the minimal subsistence value of 600 units in each phase. Using a strategy of this kind, total consumption could have consisted mainly of equities when their value was relatively high, and mainly of C/C when their value was relatively low. A possible guess is that the initial value of 10 Euros would be the discriminating factor between the two strategies. This is because the total initial value of equities and C/C was 18000 Euros, which was the sum that enabled the subject to reach the end of the session consuming exactly 600 units in each phase.

Elaborating a strategy in session 3 was a quite complex undertaking, and this suggested that a number of "deaths" would occur during the session. It is of interest to observe how the participants dealt with the change from a situation with a manageable risk of default to one in which survival was strictly linked to the random walk in equity values (see Table 3).

**Table 3 – Values of equities in session 3**

<b>Phase</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>13</b>	<b>14</b>	<b>15</b>
Value	10	7,81	4,97	1,94	4,32	6,57	6,34	9,93	13,4	10,14	11,64	14,87	11,15	11,36	9,05
<b>Phase</b>	<b>16</b>	<b>17</b>	<b>18</b>	<b>19</b>	<b>20</b>	<b>21</b>	<b>22</b>	<b>23</b>	<b>24</b>	<b>25</b>	<b>26</b>	<b>27</b>	<b>28</b>	<b>29</b>	<b>30</b>
Value	10,98	12,88	12,51	10,75	7,56	8,01	8,18	11,11	14,3	16,24	16,02	18,01	15,89	13,41	13,7

## 6. DATA ANALYSIS

For a graphic representation of the data collected by means of the experiment see the appendix. There now follows an analysis session by session of the data collected.

### 6.1 SESSION I

As described above, the main aim of first session was to let subjects learn the general framework of the experiment so that they could more easily tackle subsequent phases. As regards the instructions, retribution in this phase ranged from the minimum amount of 0 Euros to the maximum of 3 Euros. Since the first session was characterized by a static environment, the only explanation for this result is that the instructions were misunderstood. Only three (15%) of the participants were able to maximize their return, and subject number 8 even used

up all her resources before the end. As a general statement, one notes that behaviour was rather random in this session, and it is difficult to find typical reactions by the experimental subjects. This impression is confirmed by the high average volatility observed in each phase. It should be pointed out, however, that the size of this indicator was increased by the anomalous behaviour of subject 8, who in this sense should be considered an outlier.

## 6.2 SESSION II

Inspection of the results from session 2, which are summarized in figures 2a and 3a in the appendix, shows that there were four subjects who did not respect constraint (a) and were therefore forced to leave this session with zero retribution. We got this result although the easiness to develop an elementary strategy for surviving in this session. On the other hand, it should be stressed that eleven subjects used all their resources properly, thereby displaying better understanding of the instructions with respect to the previous session. In this sense the subjects proved able to learn from their actions.

On disaggregating the consumption, one notes that there were different underlying approaches to equities and C/C in terms of consumption. Of the subjects who reached the end of the session considered, fourteen sold all their equities and only eleven used their C/C completely.

Average total consumption was very high in the first phases, also because there were two outlier subjects (8 and 14) who used their C/C extensively in these phases. As expected, excessive volatility in consumption led to premature exhaustion of resources. As regards final retribution, it should be noted that, on average and in relative terms, the reward was bigger in this session than in the previous one; and in general that the subjects acted properly with respect to the residual wealth in their portfolios in the last period (complete use was a necessary condition for the maximization of final retribution).

The standard deviation of consumption computed in each phase among the subjects was still rather high, revealing a lack of homogeneous behaviour among the subjects. The standard deviation for each subject across the entire session was also rather high. Of interest is comparison between average standard deviation in consumption (218.9) and the same measure for the benchmark, which was 33.50 and represented the best "smoothing" behaviour given the variability of the stock values. To be noted as regards variance is the behaviour of subject 4, who fixed her consumption in each phase to 500 units and used equities when their value was relatively high, and C/C if they were not.

As regards the distribution of equities selling by quantities, Figure 6 in the appendix shows that this was heavily asymmetrical to the left. Small quantity selling, up to 10 units, predominated. The distribution of frequencies considered refers only to the decisions to sell taken by subjects alive in that phase. All values equal to zero are not considered in tables 4 and 5, because associated with this value are both decisions not to sell in that phase and the forced behaviour of the excluded subjects. The frequency distribution of selling decisions was rather dishomogeneous, with a clear predominance of the two lower classes, a central cluster for quantities between 30 and 60, and some isolated action for larger quantities up to 180-190 units (the appendix contains the detailed frequency tables). Table 4 shows that larger quantities of equities were sold when prices of equities were higher. This was an expected observation. Less expected, though, was the amount of selling observed in the first phases and the pronounced reaction in terms of selling after that price rose above the entry price of 10 Euros.

As shown by figure 3a, the selling of equities was sensitive to the trend in values, especially when they were markedly above the entry price of 10 Euros. It should be remembered, however, that the interdependency of the phases made the response of consumption to the values observed biased as time went by.

Analysis of the C/C should bear in mind that in the first phases the presence of "outlying" subjects 8 and 14 added a great deal of noise, and that in the last phase the considerations on maximizing the final retribution altered the behaviour of the subjects. In the other phases, the consumption deriving from C/C was in the neighbourhood of the survival limit of 500. This suggests that a "speculative" approach was taken to equities, which were used as a function of observed, and implicitly forecasted, values. Inspection of individual behaviour shows that three subjects consumed exactly 500 Euros of C/C in each single phase.

#### 6.2.1 COMPARISON WITH THE THEORETICAL BENCHMARK

As stressed when presenting the experiment, session 2 was designed to permit comparison of the behaviour observed with the theoretical benchmark derived from Hall's model (see section 5.2). This comparison is possible either for total consumption or forequity sales. In the theoretical model, the latter are equal to 10, independently of the trend in prices.

A concise representation of the observed average consumption and of that deriving from Hall's model is given by Figure 5, from which it is possible to conclude that up until phase 4 there was excessive average consumption with

respect to the benchmark, while from phase 5 to phase 9 the two lines more or less overlapped. From period 10 onwards, the consumption observed was slightly less than the theoretical one and in the neighbourhood of the subsistence level of 500. To be noted is the peak on phase 21, when the value is at its maximum (15,16). The subjects reacted instantaneously to this event, and observing the average value it is understandable that this reaction should be rather homogeneous. Also to be noted is that in the last period the consumption stands above the benchmark and reaches a peak in the last phase. The last movement is indicative of better understanding of the instructions in this phase than in the previous one, but it also reveals that the subjects were unable to allocate resources coherently across the entire session. This difficulty in choosing a broad strategy also emerges from figure 3a, where the trend in values and average equities selling is plotted. In the last phase, subjects sell residuals equities and, unlike in the other phases, the two lines move specularly rather in the same direction.

To be pointed out, too, is that the aggregate observation is influenced by the distorting behaviour of subjects 8 and 14 (see also figure 8), who used all their resources in the first phases, thereby revealing a clear lack of understanding of the instructions. Again referring to the theoretical model, but observing individual behaviour (figure 8), it is evident that the behaviours observed are generally more fragmented than the smooth theoretical one, in particular when peaks in the values are observed. Another relevant observation is that a minority of subjects (3) adopted behaviour similar to that prescribed by Hall's model.

### 6.3 SESSION III

In session 3 the salient feature emerging from individual data is the high death rate. Indeed, 12 out of 20 subjects did not conclude the session because they had used up all their resources before the end. Among the subjects who developed a successful strategy it is possible to observe a rather strong anchoring to the survival threshold of 600 Euros in total consumption. This kind of cautious behaviour is also observable in the total consumption standard deviation per subject, which is in general lower than in session 2.

Comparison of figure 6 with the trend in equities values shows that on average surviving subjects developed some sort of "rule" on the sale of equities and the use of C/C: when the value is relatively high use equities, and when it is relatively low use C/C. Consumption was generally near to 600 units but in the last phases a large increase in consumption took place.

Evident in figures 3b and 4b is the strong reaction in terms of equities sales, and consequently of total consumption, with respect to "high" values. To be stressed is that, although the resources were limited, the two observations, quotations and consumption, moved closely together, especially in the first stages. A more cautious approach would have been more oriented to homogeneity in consumption and to using resources in more balanced manner. With regard to this argument, brief discussion is required of the rule described above. This operational device was biased because it did not take account of the random process governing the trend in values, and it gave rise to consumption which was strongly correlated with the same process. However, as an *a posteriori* observation, this biased rule proved efficacious in achieving the final goal of survival. Given the uncertain nature of the session, a biased rule helped the subjects to make their choices.

With regard to individual behaviours, attention should be paid to the numerous defaults recorded (12). This large number testifies to the difficulty encountered by many of the participants in developing a "good" strategy. To be noted is the behaviour of subject 18, who set her consumption at the minimum level in each phase but sold equities when their value was low and used C/C when their value was high, thus developing an unsuccessful "counter-rule". The behaviour that adhered most closely to the above rule was that of subject 4, who also set consumption to the minimum level but used the two kinds of resources in a "reasonable" manner.

As a general consideration one may say (see also figure 5) that even if the C/C consumption was negatively correlated to the trend in equities, there were small changes in its levels, and throughout the session it remained close to the survival threshold.

Of some interest, too, is the frequency of equities sales (see figure 7 and table 4), which also in this case refers only to positive decisions to sell in the stage considered. As depicted in figure 6, the distribution assumes a more homogeneous shape in this session than in session 2. Most of the observations refer to the 0-5 class, but in this session a closer concentration is observable in the classes from 35 to 60. To be noted is that there are no cases of large entity selling, given that a decision of this kind was not compatible with a coherent strategy in this session. The observation of frequencies seemingly reinforces the guess that survivors followed the simple rule of selling equities when their value was considered high and using C/C when it was not.

## FINAL REMARKS

From the foregoing analysis of the data we may develop some considerations with regard to the behavioural hypothesis set out in section 2. As regards *Prospect Theory*, it emerges that for most of the subjects the initial value of 10 Euros was an important reference point for subsequent selling decisions. Many subjects responded to a value below this threshold in central stages with a very small quantity sold. The behaviour described seemed to be widespread, but as an example we may take the average selling in phase 12, when the value rose from 8.66 to 9.79 and the recorded selling value was 2.88. Compare this with the decision in phase 21, when the unit value rose from the 5.16 of the previous phase to 11.37 and the corresponding value was 5.05 (figure 3a). The difference in values is even more striking if we consider the general tendency to sell more in earlier phases. It should be borne in mind, however, that drawing too firm conclusions in terms of prospect theory is dangerous in the experimental setting proposed. The reference point described is less strong than the one observed in reality, where there is a monetary cost of equities, and this may alter the evaluation of losses and gains with respect to the model's indications.

The different approaches to C/C wealth and equities can be better understood by referring to *Mental Accounting* theory. As stressed above, 14 out of the 16 subjects who successfully completed session 2 sold all the equities at their disposal, and only 11 completely used their C/C. Explanation for this behaviour may be provided by a Mental Accounting approach, but it may also, at least partially, reside in a misunderstanding of the instructions. More evident in terms of Mental Accounting is the behaviour observed in the third session. Observation of the 12 subjects who used up their resources before the end of the session shows that C/C consumption was rather high in all phases, even when the value of equities was high. Default by the participants was due to a lower than expected reaction of C/C consumption to the values of equities. In this respect the selling of equities was much more sensitive to the values observed than was the use of C/C. It is consequently possible to argue that the subjects regarded the C/C as a reserve value on which to define their consumption, and considered equities more as a "speculative" resource. Behaviour of this kind seems to be in line with the hypothesis of non-fungibility of wealth which is the bottom line of the Mental Accounting theory. The Mental Accounting framework is also applicable to subjects who successfully completed the session. The difference between the two groups is that the "winners" were able to allocate resources more appropriately, taking the values of stocks into consideration. From this perspective, maintaining

different mental accounts for equities and C/C could foster correct behaviour, because this facilitated the calibration of equities and C/C in an uncertainty governed session like the third one.

In the last session a high death rate was expected, but not so for session 2, when contrary to expectations 4 subjects did not keep enough resources. A possible explanation for this observation may be forthcoming from the concept of *Choice Bracketing*, and in particular a Narrow Bracketing attitude of the participants. Strong support for this consideration is also provided by the selling of equities recorded in session 2 (figure 3a). Inspection of the average values shows that in the first phases, in particular up until phase 8, sales were rather high. Another interesting point concerning average values is the high level of sales in the last phase. It is possible to deduce from the individual data that behaviour such as that recorded at an aggregate level was due to the interaction between two different profiles of wealth allocation. One group sold a large amount of equities in the first stages, and in so doing the subjects prematurely consumed all their resources. The subjects belonging to the other group sold a few equities during the session and concentrated their sales in the last phase. In both cases it is possible to envisage the existence of a narrow framework to the subjects' decisions. In the former situation, indeed, the decision-maker failed to consider the total length of the experiment. In the latter, the subjects were too cautious in their selling activity and saw the last phase in isolation, in which they concentrated all their considerations about maximizing the final retribution. Hence the fact that the peak in selling activity is very sharp in the last phase seemingly confirms the hypothesis that the subjects tended to develop a step by step vision of the experiment, rather than a global one. The observed average volatility was rather high, particularly when compared with that of the theoretical model described above, which also represents a Broad Bracketing benchmark. It is possible to state that in general the divergence of an observed behaviour from the model is indicative of a narrow bracketing approach.

As regards the contribution of cognitive dissonance to the experiment's outcomes, reference must necessarily be made to the above statement about anchoring at the 10 Euro price. With reference to the selling trend observed from phase 18 to phase 21 in session 2 (figure 3a), one notes that four consecutive positive observations are recorded. At the beginning of phase 18 the value is 4.78, at phase 19 it is 8.5, at phase 20 it is 11.49, and finally at phase 21 it is 15.16, which is also the absolute maximum in this session. The average variation in sales between phase 18 and 19 is +0.8 units, and between the subsequent phases it is +9.5 units. Between phases 20 and 21 the recorded variation in selling is +23 units. These figures confirm the hypothesis about

behaviour around the "barrier" of 10 Euros. After values cross the entry quotation the owners of stocks exhibit increasing anxiety. This feeling may be determined by rejoicing feelings associated with the belief that one can "forecast" the future trend of prices, maybe by developing a heuristic based on past values. With reference to the possibility of detecting a heuristic in the subjects' behaviour it is interesting to consider phase 21. If the availability heuristic hypothesis were true, we would not observe a single peak in sales, because the previous peak between phase 3 and 7 had a two-peak shape. The scant evidence of heuristics is probably due to the shortness of each session, and consequently to the impossibility of accumulating enough experience. However, although it is not possible to discern specific heuristic-driven behaviour the participants sought to figure out the future evolution of values by themselves. This evidence underlies session 3 and in general plays a major role in the correlation between stock values and selling decisions. The decision to sell substantial amounts when the price is high suggests that the subjects assumed that future prices would be no higher than current ones. A stronger anchoring to the value of 10 is observed, as expected, in session 3 (figure 4b). Important in this regard is comparison of average values between phase 8 and 9. From a methodological standpoint, comparison of adjacent phases has the major advantage of obtaining a more homogeneous distribution of wealth among individuals. At phase 8 the value is 9.93, which is very close to 10, and sales amount to 9.84; at phase 9 the value rises to 13.38 and sales reach the high amount of 14.632.

In general, there may be further confirmations for the hypothesis besides the one summarized above. A first important implication of the experiment is that the behaviour observed is in general more complex than that envisaged by standard theories. The subjects tended to ignore the Random Walk nature of equity values and to figure out possible future paths of evolution of the prices for themselves. In session 3, behaviour of this kind seems to facilitate successful conclusion of the session. Further strong evidence is the tendency to consider each phase in isolation, rather than develop a global framework around the sessions. Moreover, C/C wealth and equity wealth are approached differently in terms of opportunity of consumption. When high values are observed, marked peaks in consumption are recorded as well, and the behaviour at phases with high quotations accounts for most of the overall volatility in consumption. As regards the reaction of consumption to low values in price, it should be noted that the experimental setting had a structural limitation in evidencing this decision character due the bottom line represented by the zero value. As also shown in table 6, when the value is below 7 sales are on average

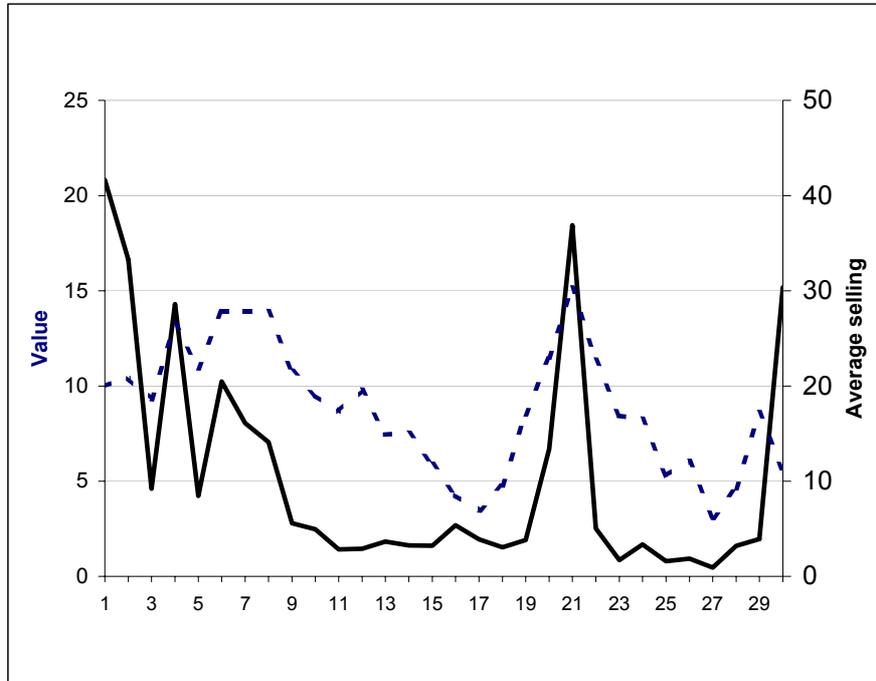
around 6 units per phase. The downward change in selling seems proportionally less strong than the upward one. This observation on experimental data resembles the empirical finding with regard to financial markets which highlights the fact that when sharp falls in the stock values are observed, consumption shrinks to a lesser extent than one would expect from the traditional theories. It should be pointed out, however, that the psychological forces underlying experimental choices and real choices may be different in this case. It is likely that experimental observations are driven more by the irrational belief that the value could fall further in the future. Choices in the real world can probably be better explained by concepts like consumption habits and the lack of monetization of nominal losses.

Given that the phenomenon studied in this paper is complex, and given that the sample used was small, it is important to make clear that the correspondences found between the working hypothesis and the experimental data are mainly an incentive for research to continue in this field using experimental tools. Indeed, it emerges from the research that there is room for analysis of this kind in the intertemporal context. Besides the specific study presented here, there are numerous aspects to be investigated in this field. One such aspect might be the differing impact of losses on consumption when they are effective or when they are only nominal.

Experimental tools coupled with closer attention to the behavioural aspect of decisions in an intertemporal context seem to be a good basis for the development of further research in this field.

Figure 2 - Comparison between values of equities (dotted line and left-side vertical axis) and average selling of equities (continuous line and right-side vertical axis).

2a) Session 2



2b) Session 3

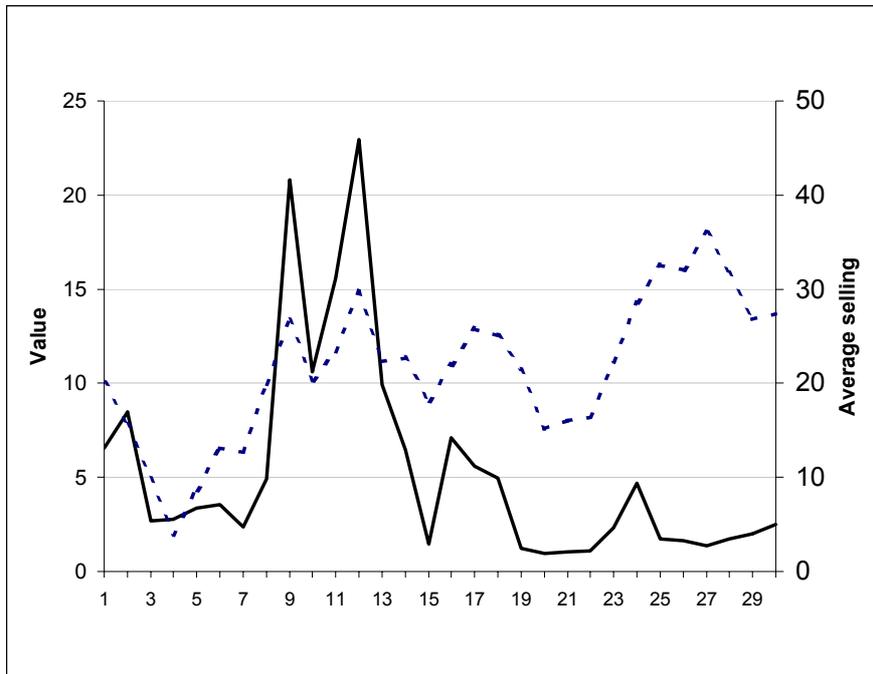
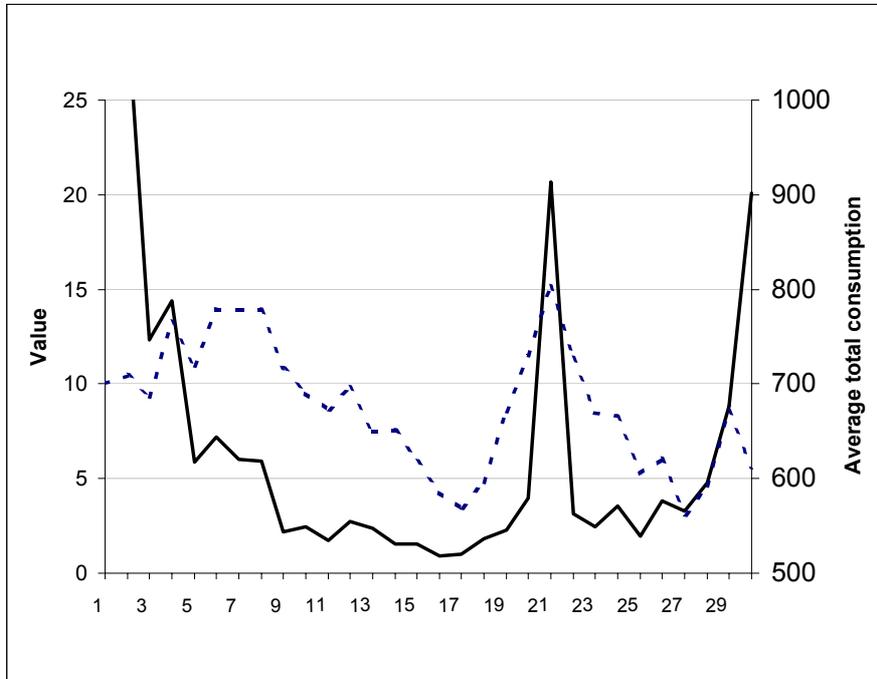


Figure 3 - Comparison between values of equities (dotted line and left-side vertical axis) and average total consumption (continuous line and right-side vertical axis).

3a) Session 2



3b) Session 3

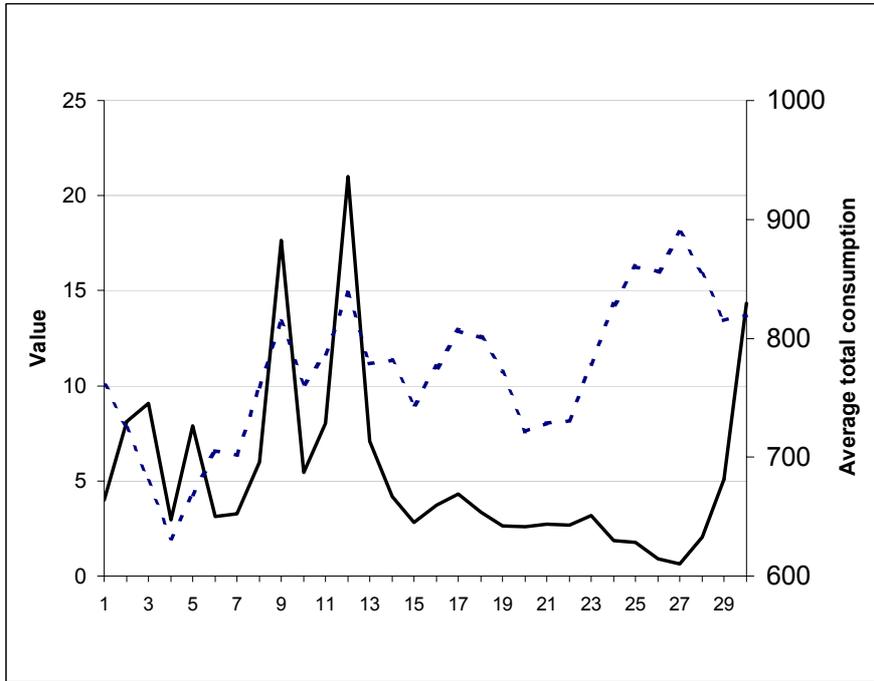


Figure 4 - Comparison between average consumption observed in session 2 (continuous line and right-side vertical axis) and theoretical values of the Hall's model (dotted line and left-side vertical axis)

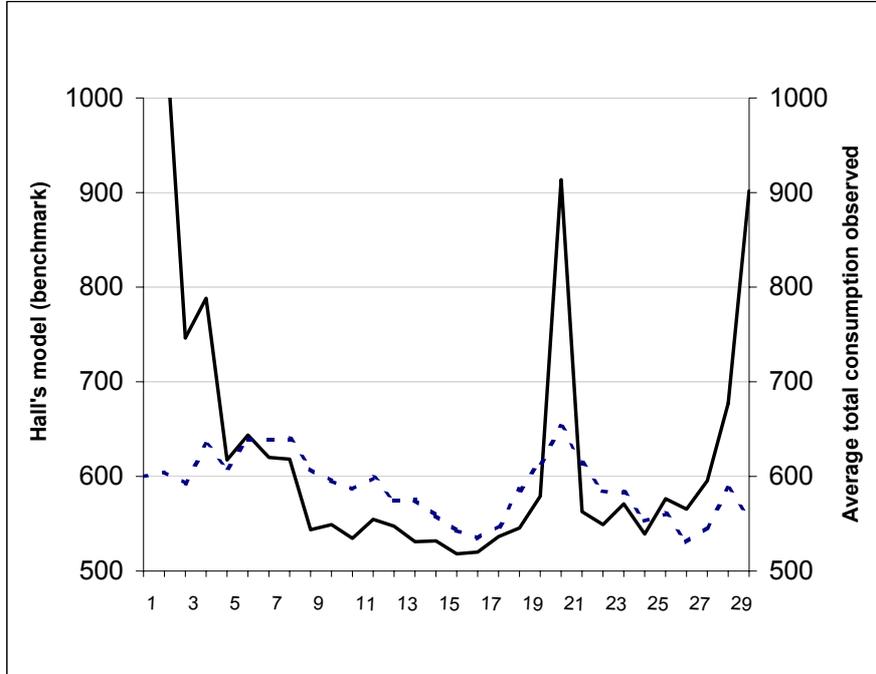


Figure 5 - Average consumption behavior in terms of equities and C/C of survived subjects in session 3 (the height of the bars gives the total consumption)

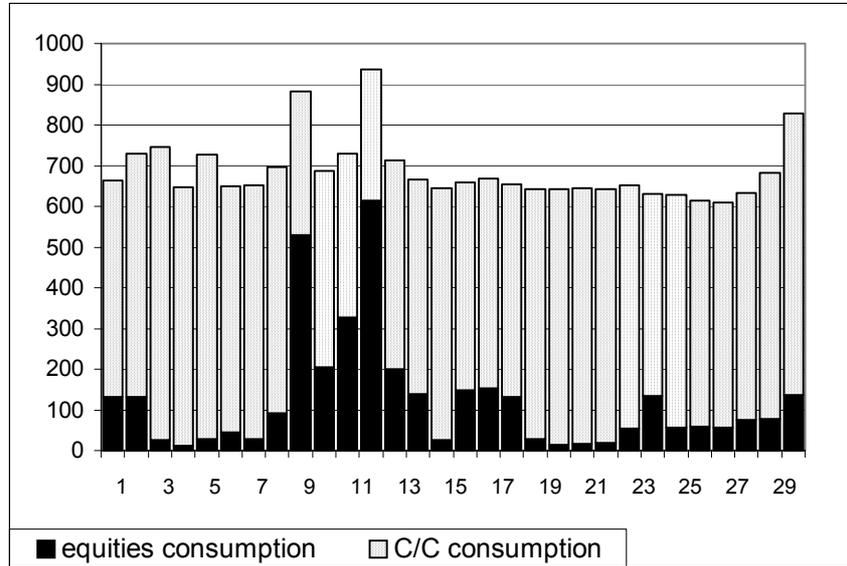


Table 4 - Frequency by class of sold equities in session 2

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		0,0		0	0,0000	0	0,0000
1	0,0	10,0	5,0	111	0,4784	111	0,4784
2	10,0	20,0	15,0	68	0,2931	179	0,7716
3	20,0	30,0	25,0	14	0,0603	193	0,8319
4	30,0	40,0	35,0	13	0,0560	206	0,8879
5	40,0	50,0	45,0	12	0,0517	218	0,9397
6	50,0	60,0	55,0	1	0,0043	219	0,9440
7	60,0	70,0	65,0	1	0,0043	220	0,9483
8	70,0	80,0	75,0	2	0,0086	222	0,9569
9	80,0	90,0	85,0	1	0,0043	223	0,9612
10	90,0	100,0	95,0	6	0,0259	229	0,9871
11	100,0	110,0	105,0	0	0,0000	229	0,9871
12	110,0	120,0	115,0	0	0,0000	229	0,9871
13	120,0	130,0	125,0	0	0,0000	229	0,9871
14	130,0	140,0	135,0	1	0,0043	230	0,9914
15	140,0	150,0	145,0	0	0,0000	230	0,9914
16	150,0	160,0	155,0	1	0,0043	231	0,9957
17	160,0	170,0	165,0	0	0,0000	231	0,9957
18	170,0	180,0	175,0	0	0,0000	231	0,9957
19	180,0	190,0	185,0	1	0,0043	232	1,0000
above	190,0			0	0,0000	232	1,0000

Mean = 20,5431    Standard deviation = 25,4141

Figure 6 - Frequency by class of sold equities in session 2

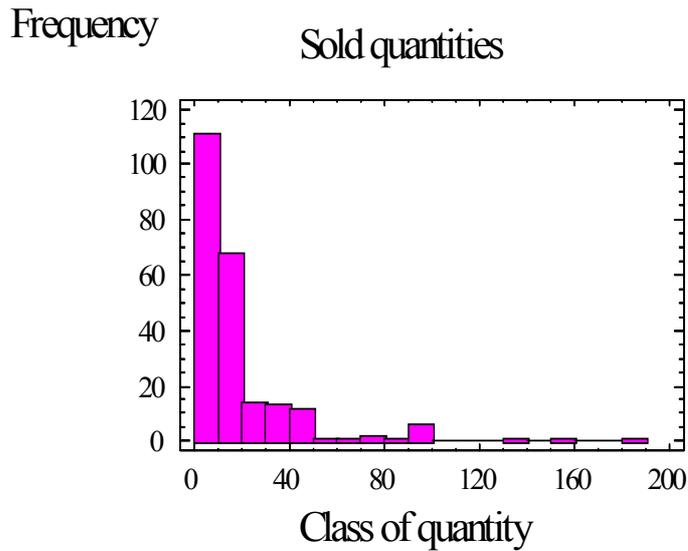


Table 5 - Frequency by class of sold equities in session 3

Class	Lower Limit	Upper Limit	Midpoint	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
at or below		0,0		0	0,0000	0	0,0000
1	0,0	5,0	2,5	34	0,3579	34	0,3579
2	5,0	10,0	7,5	7	0,0737	41	0,4316
3	10,0	15,0	12,5	2	0,0211	43	0,4526
4	15,0	20,0	17,5	7	0,0737	50	0,5263
5	20,0	25,0	22,5	2	0,0211	52	0,5474
6	25,0	30,0	27,5	6	0,0632	58	0,6105
7	30,0	35,0	32,5	0	0,0000	58	0,6105
8	35,0	40,0	37,5	5	0,0526	63	0,6632
9	40,0	45,0	42,5	9	0,0947	72	0,7579
10	45,0	50,0	47,5	4	0,0421	76	0,8000
11	50,0	55,0	52,5	8	0,0842	84	0,8842
12	55,0	60,0	57,5	10	0,1053	94	0,9895
13	60,0	65,0	62,5	0	0,0000	94	0,9895
14	65,0	70,0	67,5	0	0,0000	94	0,9895
15	70,0	75,0	72,5	0	0,0000	94	0,9895
16	75,0	80,0	77,5	1	0,0105	95	1,0000
17	80,0	85,0	82,5	0	0,0000	95	1,0000
18	85,0	90,0	87,5	0	0,0000	95	1,0000
above	90,0			0	0,0000	95	1,0000

Mean = 25,2632 Standard deviation = 22,635

Figure 7 - Frequency by class of sold equities in session 3

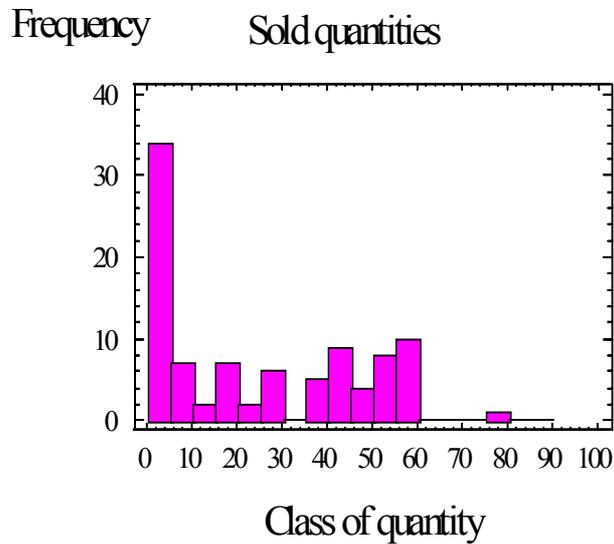


Table 6 - Sellings of equities in session 2 divided into "high" values (>13) and "low" values (<7) of the price of the equities.

6a) High values (>13)

		Phase				
		4	6	7	8	21
<b>Subject</b>	<b>1</b>	15	15	15	10	50
	<b>2</b>	30	30	0	0	140
	<b>3</b>	0	0	0	0	0
	<b>4</b>	30	35	35	35	26
	<b>5</b>	13	14	13	14	16
	<b>6</b>	38	36	37	37	33
	<b>7</b>	11	20	20	10	15
	<b>8</b>	80	5	5	10	0
	<b>9</b>	38	37	25	0	30
	<b>10</b>	0	0	0	0	190
	<b>11</b>	50	50	50	50	33
	<b>12</b>	11	12	14	14	15
	<b>13</b>	5	10	10	10	0
	<b>14</b>	5	0	0	0	0
	<b>15</b>	20	10	10	0	0
	<b>16</b>	100	20	10	0	0
	<b>17</b>	100	50	20	30	80
	<b>18</b>	7	12	12	13	10
	<b>19</b>	5	20	20	25	10
	<b>20</b>	14	13	10	10	16
<b>Alive subjects</b>		20	19	19	19	18
<b>Average Sellings</b>		29	20	16	14	37
<b>Standard Dev</b>		31	15	13	15	50
<b>Value of equity</b>		13	14	14	14	15

## 6b) Low values (&lt;7)

		Phase								
		15	16	17	18	25	26	27	28	30
Subject	1	0	0	0	0	0	0	0	0	155
	2	0	0	0	0	0	0	0	0	100
	3	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0
	5	5	4	3	4	1	1	1	1	92
	6	0	0	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	20	40
	10	0	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	0	67
	12	10	2	15	15	5	10	5	10	0
	13	20	20	20	0	0	0	0	0	0
	14	0	0	0	0	0	0	0	0	0
	15	0	0	0	0	0	0	0	0	0
	16	0	0	0	0	0	0	0	0	0
	17	0	0	0	0	0	0	0	0	0
	18	15	15	17	10	15	14	0	0	0
	19	2	50	10	20	0	0	5	10	3
	20	6	6	5	6	6	7	4	10	29
Alive Subjects		18	18	18	18	17	17	16	16	16
Average Sellings		3,2	5,4	3,9	3,1	1,6	1,9	0,9	3,2	30
Standard Dev		5,7	12	6,5	5,7	3,6	3,9	1,7	5,5	44
Value of equity		5,9	4,3	3,5	4,8	5,3	6,1	3,1	4,6	5,6

Table 7 - Sellings of equities in session 3 divided into "high" values (>13) and "low" values (<7) of the price of the equities.

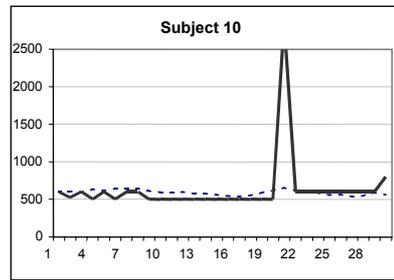
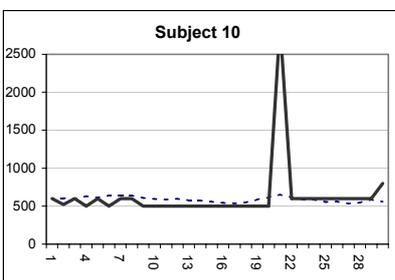
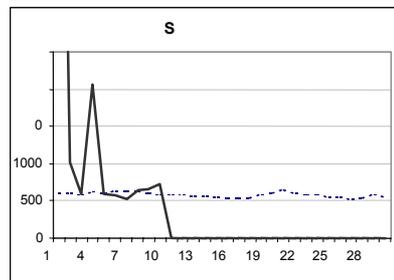
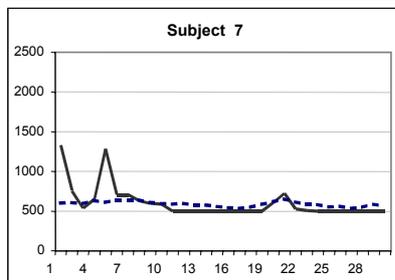
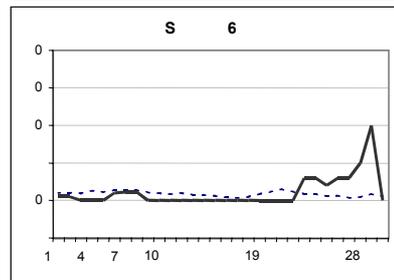
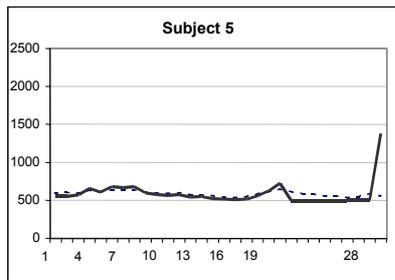
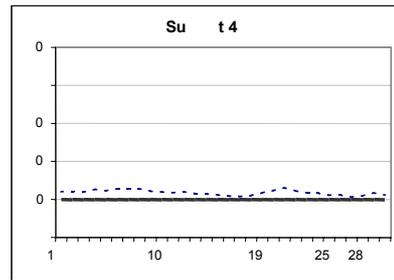
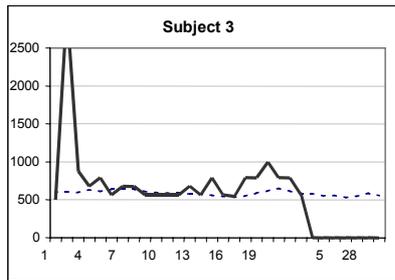
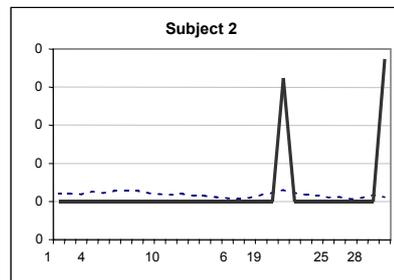
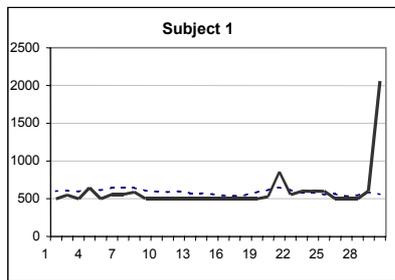
7a) High values (>13)

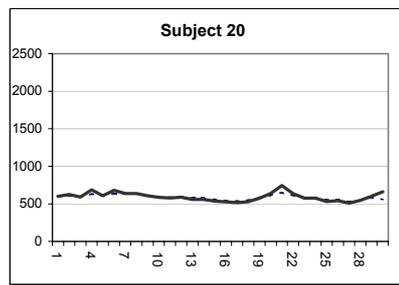
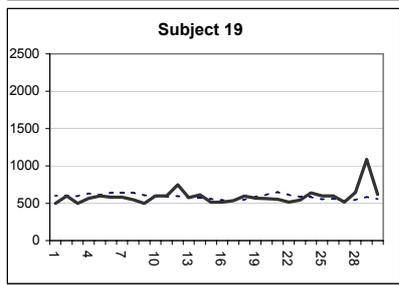
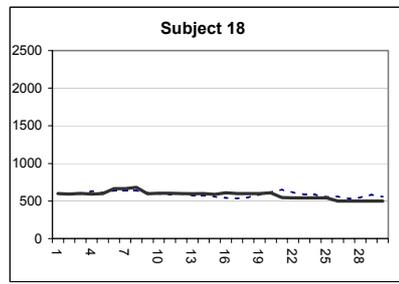
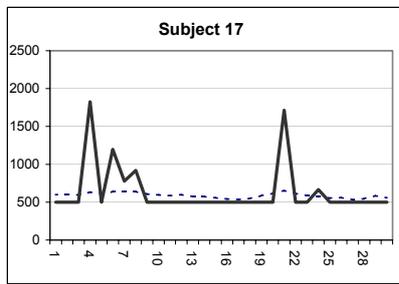
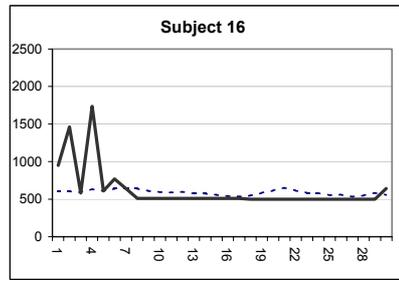
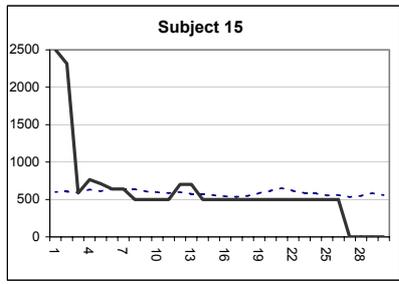
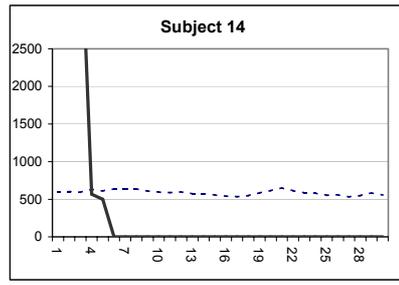
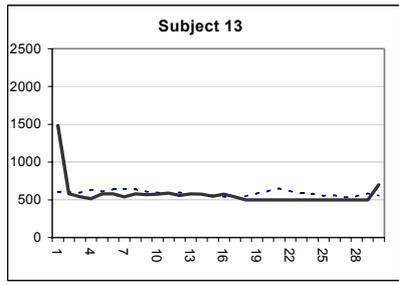
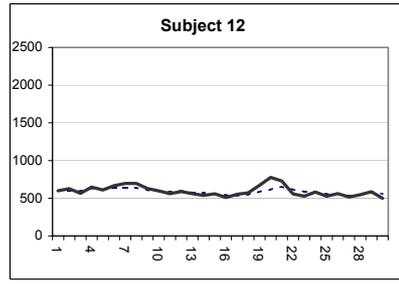
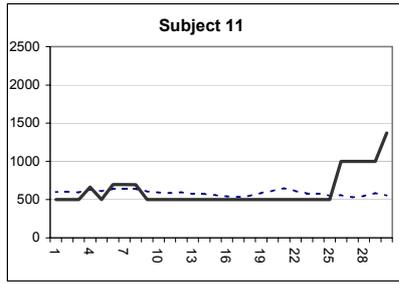
		Phase								
		9	12	24	25	26	27	28	29	30
Subject	1	60	60	3	0	0	0	0	0	0
	2	45	41	43	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0
	4	44	40	0	0	0	0	0	0	0
	5	1	1	1	1	50	40	50	55	80
	6	46	41	10	5	0	0	0	0	0
	7	100	100	0	0	0	0	0	0	0
	8	27	5	0	0	0	0	0	0	0
	9	45	40	0	0	0	0	0	0	0
	10	0	60	60	0	0	0	0	0	0
	11	45	45	42	16	0	0	0	0	0
	12	16	20	15	5	0	0	0	0	0
	13	10	10	0	0	0	0	0	0	0
	14	20	10	0	0	0	0	0	0	0
	15	30	40	4	0	0	0	0	0	0
	16	140	150	0	0	0	0	0	0	0
	17	50	100	0	0	0	0	0	0	0
	18	7	5	6	4	4	2	6	9	0
	19	30	40	20	10	0	0	0	0	0
	20	15	18	15	18	1	0	0	0	0
<b>Alive Subjects</b>		19	18	17	17	17	16	16	16	16
<b>Average Sellings</b>		41,6	45,9	9,3	3,4	3,2	2,68	3,5	4	5
<b>Standard Dev</b>		33,8	38,6	13,3	5,4	11,1	8,9	11,2	12,3	17,9
<b>Value of equity</b>		13,3	14,9	14,3	16,2	16,0	18	15,9	13,4	13,7

7b) Low values (<7)

		<b>Phase</b>				
		<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>
<b>Subject</b>	<b>1</b>	0	0	0	0	0
	<b>2</b>	0	0	0	0	0
	<b>3</b>	0	0	0	0	0
	<b>4</b>	0	0	0	0	0
	<b>5</b>	1	1	1	1	1
	<b>6</b>	0	0	0	0	0
	<b>7</b>	0	0	0	0	0
	<b>8</b>	30	10	30	5	8
	<b>9</b>	0	0	0	0	0
	<b>10</b>	0	0	0	0	0
	<b>11</b>	0	0	0	0	0
	<b>12</b>	11	12	12	15	12
	<b>13</b>	30	50	30	30	20
	<b>14</b>	10	10	10	20	10
	<b>15</b>	1	1	20	20	5
	<b>16</b>	0	0	0	0	0
	<b>17</b>	0	0	0	0	0
	<b>18</b>	15	18	16	14	14
	<b>19</b>	0	0	5	20	10
	<b>20</b>	10	10	10	10	10
<b>Alive Subjects</b>		20	20	20	19	19
<b>Av S</b>		5,4	5,6	6,7	7,1	4,7
<b>Standard Dev</b>		9,6	11,8	10,1	9,5	6,2
<b>Value of equity</b>		5	2	4,3	6,6	6,3

Comparison between total consumption in session 2 (continuous line) and behaviour à la Hall (dotted line)





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