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Analytic Hierarchy Process for Classes of Economic Behavior in the Context of Intertemporal Choices

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Abstract

Due to the major crises of the past decade, the need to introduce consumer profiling operations to protect individuals from committing superficial business transactions has been realized in 2014/65/EU Directive. The present paper investigates how consumer behavioral attitudes influence the decision-making process so that the choice results, from a normative point of view, non-rational in the context of intertemporal choice. In addition, the particular focus by European institutions on closing the gender gap in the economic and financial sector motivated this research to enrich the analysis with gender assessments. The study of the relationship between cognitive characteristics and consumer decision-making are deepened with a multidisciplinary approach involving mathematics, behavioral finance, temperament theory and multi-criteria analysis. The results of an experimental investigation confirm that there is not a better temperament or a more adept gender in economic and financial choices.

Keywords: analytic hierarchy process, behavioral anomalies, economic behavior, gender analysis, impatience, intertemporal choice, personalized strategies.
2010 AMS subject classification: 91B08.[‡]

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1. Introduction

Theoretical and empirical investigation of the mechanisms that guide decision-making has become necessary to improve the functioning of economic and financial markets. The Directive 2014/65/EU of the European Parliament and of the Council of 15 May 2014 on markets in financial instruments stresses, due to shortcomings in the functioning and transparency of financial markets, the need to protect investors and to regulate financial instruments. Therefore, following the major crises of the last decade, the creation of investor profiles was necessary to protect savers and to offer products that fit the client profile. In addition to customer profiling, the EU aims to promote equality between men and women in all social, economic, and political activities.

Hebert Simon (1982) was the first to point out that individuals have limited cognitive resources that unconsciously lead to a simplification of the decision-making problem. Assuming that the decision-maker is rationally limited, research is turning to the personalization of decision-making strategies. In this regard, the study and analysis of the errors that characterize the dynamics of individual decisions must be conducted through personality theory. In addition, studies of personal financial skills have revealed an important gender gap (Goldsmith and Goldsmith, 2006) both in terms of approach with respect to investment strategies (Barber and Odean, 2001) and knowledge of financial topics (Hira and Mugenda, 2000). To improve the quality of women's choices and to reduce the gap, it is necessary to accept the existence of the many differences between the male and female genders and to investigate their reasons and consequences (Fonseca et al., 2012).

The present paper proposes a practical application of the multidisciplinary approach presented in Martino and Ventre (2022) addressed to two complementary purpose: the first purpose is to understand the extent to which emotional, cognitive and informational factors, which intervene during the evaluation and selection phase of an alternative, weigh on the economic decision-making process; the second aim is to investigate the effects and differences between the genders to promote the implementation of strategies aimed at closing the gender gap in all areas such as employment, social, political and economic. The disciplines involved in the present work are: mathematical finance for quantifying consumer cognitive and emotional biases; temperament theory for projecting characteristics of individuals into identifying classes; personalized finance for explaining relationships between bias and behavioral attitudes; and multicriteria analysis for quantitatively comparing class and gender characteristics. The multi-criteria decision support technique used is the Analytical Hierarchical Process (AHP) (Saaty, 1980) because it allows to compare elements difficult to compare directly, as shown in Ventre et al. (2022, c) and Ventre et al. (2023). In fact, its mathematical structure makes it possible to break down the analysis of choice into all the components that weigh on the decision. The originality of the present paper consists of an extension of Ventre et al. (2022, c) with gender analysis and in give to it an applicable context of the multidisciplinary approach used.

The analysis conducted by AHP proves that it is not possible to define an optimal strategy for everyone because of different behavioral characteristics. Therefore, consultants and automated devices that provide digital advice must consider the importance of the decision-maker's personality to whom service is provided. With respect to gender analysis, the AHP makes it clear that there is no privileged gender but there are only different attitudes, mostly complementary inclinations dictated by the known "*distance between Mars and Venus*" (Del Giudice et al., 2012).

The paper is structured as follows: in Section 2, a literature review about gender

analysis will be briefly exposed; in Section 3 the main results about anomalies in intertemporal choice will be shown and discussed in terms of emotional impulses; in Section 4, the structure of the AHP will be constructed with reference to Keirsey's temperament theory (1998); in Section 5 the experimental part aimed at constructing the weight of anomalies for each temperament, both in general and by gender, will be implemented; finally, there will be a discussion section and a conclusion section with ideas for future development.

2. Gender differences

Many differences between the behavior of men and women were observed in various domains leading to the hypothesis that they were caused by different preferences between the genders (Croson and Gneezy, 2009). Most theoretical and empirical work analyses gender difference with a comparison between the environment in which the individual develops (Eagly and Wood, 1999) and evolutionary origins (Geary, 2010). In this regard, two main theories can be pointed out: the sociocultural theory (Eagly and Wood, 1999), which focuses the reasons for gender difference on a historical division of labour between men and women; the cognitive theory of social learning (Bussey and Bandura, 1999), on the other hand, which focuses gender differences with children's internalization of existing social norms.

Even in the workplace, gender discrimination is fueled by stereotypes and organizational factors. The study conducted by Bobbit-Zeher (2011) proves how the combination of cultural, structural and organizational factors, together with gender stereotypes, can have a strong impact on gender discrimination. For example, with respect to financial knowledge, Chen and Volpe's study (2002) proved that women are actually even less interested in learning about financial topics and that, also because of social stereotypes, female students are less oriented than their male peers towards financial studies (Hawash et al., 2020). These differences could lead to women being more exposed to financial problems. However, the studies in the literature on social preferences remain incomplete if the interaction between gender and intra-gender variability is not considered (Thoni and Volk, 2021). For this reason, gender differences in preferences have been investigated to deepen social and economic outcomes (Croson and Gneexy, 2009) and they are a good starting point for understanding gender differences in many areas such as education, the labor market and financial decision-making (Buser et al., 2014). The first differences are found in social preferences that express how individuals interact with others. The study conducted by Kamas and Preston (2015) not only proves that gender differences in economic behavior can be deepened and understood by social preferences, but also proves important findings. First, women tend to avoid inequality and this aversion to inequity could be linked to the fact that in trust games they send less. In addition, women are more inclined to charitable activities and equal pay, a preference that can be explained by inequity aversion and lower self-confidence. Some studies also prove that women are more altruistic than males, less present-oriented and reliable (Horn et al., 2022).

A determining factor for social preferences is also age as proven by a study conducted on Swedish and Austrian children and adolescents (Martinsson et al., 2011). Risk preferences are another of the most studied factors for which it is possible to conclude that men are more risk-prone than women. This conclusion confirms previous results of an economic nature (Eckel and Grossman, 2008) and psychological nature (Brody, 2022). In this regard, studies focusing on the portfolio selection problem have also provided direct evidence of gender differences. For example, Graham et al. (2002) have proven

that men invest in pension planning in a less conservative way than women do, and in the domain of financial risk, single women are less risk prone than single man (Sunden et al., 1998; Finucane et al., 2013). A study conducted by Jianakoplos (2002) on gender differences in risk preferences emphasizes that the many differences must be observed and considered by advisors to make appropriate recommendations as risk appetite has a decisive impact on the construction of an asset allocation. Precisely because risk tolerance is a key element in determining appropriate financial advice, some studies have focused on factors that have a strong impact on measurement. The study conducted by Marinelli et al. (2017) on 2,374 investors proves a relationship between low literacy, income, and economic behavior with inconsistency among the most used risk tolerance metrics. Therefore, the analysis of the gender difference in this respect must also incorporate the factors of the individual subjective structure. This gender gap is very evident, and many explanations have been proposed. A first explanation is referred to the concept of "*risk as a feeling*" developed by Loewenstein (2001) referring to the reaction that instinctively develops in a risky decision-making context and from a psychological point of view, women feel emotions more intensely than men. Moreover, in emotional terms, the difference between males and females is not only the intensity of the emotions they feel, but also the emotions felt in the same situation are different (Grossman and Wood, 1993). In this regard, Lerner et al. (2003) have shown that different emotions lead to different attitudes, explaining the different approach to risk. The bias of overconfidence is the second reason that could explain the gender differences because even if overconfidence is shared by both, men are more overconfident than women (Lundeberg, 1994). In particular, Niederle and Vesterlund (2007) have shown that men's more insistent overconfidence than women's leads to men being more convinced of their victories so that everything is seen as a competition in which the belief to win is greater and consequently so is the risk attitude. The way in which the risk situation is interpreted can also be another determining factor in investigating the underlying causes of these differences. While men perceive a risky situation as a challenge, women perceive the context as a threat (Arch, 1993). This implies that the gender difference does not consist of different abilities with respect to the decision-making environment but rather of different motivations driving both genders. At the same time, factors that may be motivating for men may be harmful to women (Block, 1983). Confirming the hypothesis that the gender gap is not a lack of aptitude are numerous studies looking at a sample of professionals for whom the difference between men and women is largely small and almost insignificant (Dwyer et al., 2002; Master and Maier, 1988).

Biological differences, such as different testosterone concentrations, also play an important role in this context (Sapienza et al., 2009). The studies outlined so far emphasize that to promote gender equality and achieve the main goals proposed by the European Union, it is not necessary to reduce diversity but to turn gender inequality into a strength for any sector. Zimmer (1988) suggests that theories that neutralize the gender gap, such as tokenism used to create the illusion of inclusiveness (Hogg and Vaughan, 2008), have a limitation that may even hinder inclusion and gender equality. In fact, in roles where approach and behavior are essential, inattention to gender differences can generate employment bottlenecks. Organizations can therefore reap many benefits from diversity. Indeed, not only does diversity enable them to reach different markets and customers, but it also promotes innovation and better performance (Nair and Vohra, 2015) some empirical evidence shows that diversity has its advantages (Herring, 2009). In addition, a recent study conducted by Shrader et al. (2020) also proves a relationship between the percentage of women at the general management level and better financial performance. In conclusion, to promote gender equality, the classic factors used to argue

gender difference, such as biological, intellectual, emotional, and behavioral aspect, should not be regarded with a negative connotation as caused by prejudice against women (Benschop and Verloo, 2011). Fletcher (2001), with an original and alternative point of view, conceptualizes the main characteristics of the female gender (empathy, vulnerability, connection, relational skills) as strengths and not weaknesses. From a strategic point of view, bridging the gap requires the use of continuous innovation processes (Benschop and Verloo, 2011), based on the combination of gender mainstreaming and intersectionality. Intersectionality refers to the evaluation of each element or trait of an individual as the intrinsic union of all the elements that characterize her identity (Palczewski and DeFrancisco, 2014). However, Holvino (2010) noted that intersectionality is not enough acknowledged by organization studies and gender change projects in organizations must consider the implications of other factors as class, ethnicity, sexuality, and nation.

3. Intertemporal choice and impatience

Most of the decision-making problems we face throughout our lives can be traced back to the typology of intertemporal choices, i.e., those whose consequences manifest only over time. This argument is particularly complex mainly for two reasons: the first one is that, deciding to get a result in the future necessarily implies renouncing to something in the present (Noor, 2011); the second aspect concerns the difficulty of keeping the coherence constant in future objectives (Sayman and Onculer, 2009). Intertemporal choices are studied in various fields such as economics and psychology Skylark et al.(2021) and Read et al. (2003) state that "*the goal of research into intertemporal choice is to understand how these choices are made, and how they should be made*". The Discounted Utility Model (Samuelson, 1937,1952) assumes that the decision-making process of individuals is based on associating a level of utility to each alternative and then choosing the alternative with greater utility. The model introduced by Samuelson has some weaknesses when it refers to the effective decision-making behavior. With the term *anomalies*, we refer to those empirical results that are difficult to *rationalize*. To achieve the objective of customer profiling, the concept of investor's impatience will be used to measure the weight of anomalies. In the context of intertemporal choice, the impatience is defined as "*the amount of money that the agent is willing to lose in exchange for anticipating the availability of a $1 reward*" (Cruz Rambaud and Muñoz Torrecillas, 2016). This analysis is inspired by the experimental method proposed by Ventre et al. (2022, b) in which, after demonstrating a correspondence between the anomaly and the alteration of the degree of impatience, the authors investigate the emotional drives of choice using the value of the hyperbolic factor (Rohde, 2010). Comparing the impatience of different discount functions, a relationship emerges between the speed with which the function varies and the degree of investor impatience: the faster the discount function decreases, the greater the associated impatience (Cruz Rambaud and Muñoz Torrecillas, 2016). Prelec (2004) proved that a decreasing degree of impatience has a significant effect on the selection of suboptimal choices and that variation in impatience underlying the anomalies in the Discounted Utility Model can be seen as a reflection of the decision-maker's bounded rationality. The originality of the present work lies in the fact that the analysis is not limited to the study of abnormal attitudes but deepens their properties by investigating behavioral characteristics in a context of gender to enrich the motivations presented about gender gap and financial anomalies. In practice, by quantifying the weight of emotional factors driving decision-making, it is possible to measure the different impact of cognitive and

emotional biases between men and women. For these reasons, the analysis submitted by Ventre et al. (2022, b) of anomalies will be enriched by behavioral classification and gender analysis.

3.1 Economic model

From an operational perspective, assuming that the decision-makers' preferences are continuous, monotonous, and impatient, the study of intertemporal choices is based on the Model of Discounted Utility (Samuelson 1937,1952).

Fixed X= R^n the set of available results and T=R^+ the set of points of time :

- The N-pla $(x_0, t_0; \dots; x_n, t_n) \in (X \times T)^n$ indicates an intertemporal prospectus: if the prospectus is accepted, the decision-maker will receive the result x_i at the time t_i and a null result for each t_j with j ≠ i;
- The intertemporal utility defined on the prospectus is given by $\sum_{i=0}^{n} f(t_i)U(x_i)$ where $U(x_i)$ is the cardinal utility function associated with the consumption of the outcome x_i at the time t_i and $f(t_i)$ is the individual discount function.

The time lag between the decision and review of the result creates a risk due to uncertainty. The individual perception of this indeterminacy is enclosed in the discount rate $\rho(t) = -\frac{f'(t)}{f(t)}$ that indicates "*the proportional variation of f in a standard period*" (Read et al., 2003). Empirical evidence demonstrates that people violate the discounted-utility theory systematically (Rao and Li, 2011). In fact, the first formulation of the model hypothesized a constant discount rate over time but, due to the systematic deviation from the exponential model predictions, alternative functions were formulated to provide a more accurate empirical description. The main difference between the linear, exponential, and hyperbolic models in Table 1 is that, while exponential and linear functions present a constant discount rate for all future periods, hyperbolic models manifest a discount rate varying over time.

Linear	$f(t) = 1 - rt$		
Exponential	$f(t) = \left(\frac{1}{1+\rho}\right)^t$		
Hyperbolic	Generalized	Quasi-hyperbolic	One parameter
	$f(t) = (1+\alpha t)^{-\frac{\beta}{\alpha}}$	$f(t) = \beta\left(\frac{1}{1+\rho}\right)^t$	$f(t) = \left(\frac{1}{1+\rho t}\right)$

Table 1. Common discount functions in intertemporal choice reported by Read et al. (2003).

To understand the consequences of this aspect from a rational choice perspective, this study considers two outcomes: the first one is minor and anticipated (SS), and the second one is major and delayed (LL). A constant discount rate implies that, whatever the individual's choice, her preference remains stable over time in line with the profile of a

rational investor assumed by classical finance. Empirically, however, since the imminent results appear disproportionately attractive, the decision-maker reverses her preferences, making the choice inconsistent as shown in Figure 1. In fact, with the term *temporal inconsistency*, we refer to a situation in which a subject varies her preferences over time.

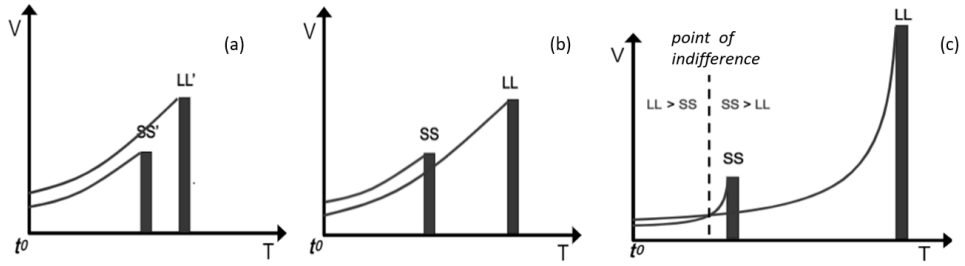

Figure 1. Comparison between SS and LL. The images (a) and (b) describe different situations in which choices are temporally consistent, i.e., preferences remain constant over time. The image (c) shows instead as a variation of the course of the curve involves an inversion of the preferences and therefore temporally inconsistent choices.

Prelec (2004), analyzing the psychological characteristics underlying inconsistency, proved equivalence between the selection of dominated prospects, i.e. those outcomes that are not optimal from any temporal viewpoint , and a degree of impatience that decreases over time. In particular:

Definition 1. The preference ≥ shows a Decreasing Impatience (DI) if $\forall \sigma > 0, y > x > 0, (x, s) \sim (y, t)$ we have $(x, s + \sigma) \leq (y, t + \sigma)$ (strictly decreasing if $(x, s + \sigma) < (y, t + \sigma)$.

Definition 2. An intertemporal prospect (x, s) dominates (y, t) with s<t, i.e. (x, s) >> (y, t), if (x, s) ≥ (y, s) and (x, s) > (x, t).

Prelec (2004), studying dominance violation on two-step decision problems, describes the following attitudes, shown in Figure 2 and Figure 3:

Definition 3. The preference ≥ allows a sophisticated two-step violation of dominance at the time (t, s, r, τ) if the relationship is DI and ∃ x, y:

today (0): (x, t+τ) >> (x, r) ≥ (y, s+τ)

tomorrow (τ): (x, t) < (y, s)

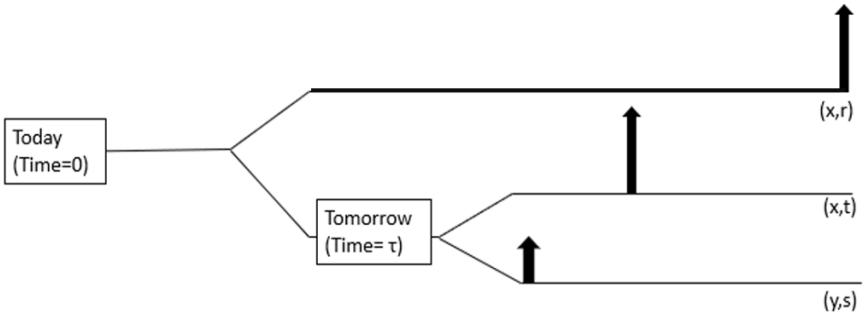

Figure 2. Sophisticated Decision-Maker (DM) predicts the selection of the lower outcome at time τ and commits in advance to the best available outcome at time 0 (Prelec 2004).

Definition 4. The preference ≥ allows a naïve two-step violation of dominance at the time (t,s,r, τ) if the relationship is DI and ∃ x, y:

today (0): (y, s+τ) ≥ (x, r) >> (x, t+τ)

tomorrow (τ): (y, s) < (x, t)

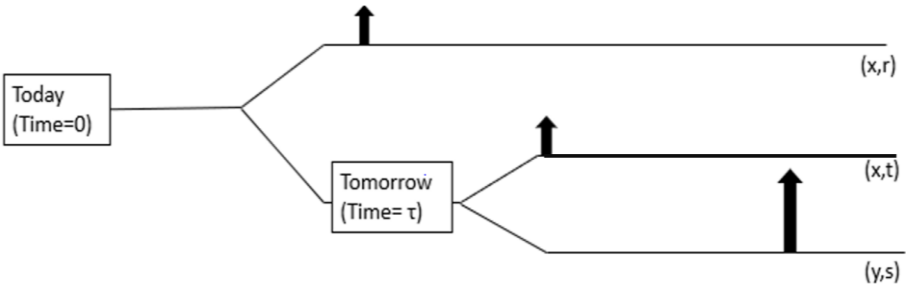

Figure 3. Naïve Decision-Maker (DM) at time 0 the DM prefers the most considerable available outcome at time τ, but his preferences change, and the choice will fall on the lower outcome (Prelec, 2004).

Such attitudes are not only related to a greater degree of decrease in impatience but also to a greater convexity of the discount function. Applying the previous definitions to infinitesimal intervals, it is possible to prove that the greater the degree of DI, the more significant the difference between the rates of impatience and temporal preference. The latter means that the decrease in impatience quantitatively represents the difference between preferring an event to occur and preferring an event to occur sooner. Moreover, the expression that Prelec (2004) proposes for calculating the degree of DI is equivalent to the speed with which the discount rate varies over time, determining a link between the subjective perception of time and impatience. In particular, the more distorted this perception is, the more hyperbolic will be the trend of the discount rate. A direct relationship between subjective perception of time and temporal inconsistency has been proven in Ventre and Martino (2022) and Ventre et al. (2022, a). The tool we exploit in the experimental phase to calculate the degree of DI is the hyperbolic factor formalized by Rohde (2010).

Definition 5. Consider $(x,s)\sim(y,t)$ $(x,s+\sigma)\sim(y,t+\tau)$ s<t, x<y, τ>0. The hyperbolic factor is:

$$H(s,t,\ y,\tau)=\frac{\tau-\sigma}{t\sigma-s\tau}$$

Theorem 1. A pair of indifference can be constructed as follows:

Step I. Fix y≁0 and fix s, t, τ with s<t, and τ>0;
Step II. Find x such that (x, s) ~ (y, t);
Step III. Find σ such that (x, s+σ) ~ (y, t+τ).

3.2 Anomalies and decreasing in impatience

By virtue of the link between inconsistency and decreased impatience, it is possible to relate anomalies in the discounted utility model and the cognitive mechanisms responsible. The cognitive elements that influence our attitude are behavioral biases, and they can be of emotional or cognitive nature: the former is due to factors of the emotional sphere; the latter, instead, are "*shortcuts"* that the decision-maker creates in his mind during the interpretation and processing of information. Jordan and Rand (2018)

emphasized the importance of character in the decision-making process in a broader sense. Given that behavioral anomalies are proper to the nature of decision-makers, even assuming a reasonable and rational investor, it is always possible to analyze anomalous situations from a mathematical viewpoint. In the literature, researchers have identified various types of anomalies; the latter can be related to investors' emotional impulses through the concept of impatience by comparing the preferences associated with a hyperbolic discount and those associated with an exponential discount. The delay effect (Ventre and Ventre, 2012) consists in the inversion of the preferences due to the increase of the period between the decision and the reception of the result. For this anomaly, it is possible to prove that the speed with which the function of a hyperbolic discount is decreasing and, therefore, the impatience of the investor is intense according to the period of evaluation of the results. In particular, by Ventre et al. (2022, b):

Theorem 2. If $(x,s) \sim (y,t) \Rightarrow (x,s+h) \prec (y,t+h)$ holds, then the rate of variation of the discount function $f(t)$ is decreasing.

The interval effect (Read et al., 2003; Read and Roelofsma, 2003) is the anomaly for which the applied discount rate decreases as the length of the interval increases. Therefore, the phenomenon can be studied as a direct consequence of the subjective perception of time whose mathematical proof is in section 4.2 in Ventre et al. (2022, b).

The preferences of individuals are also conditioned by the size of the outcome. The anomaly in question, defined magnitude effect (Benzion et al., 1989), consists in an inversion of preferences due to the size of the results and from a psychological vantage point can be explained considering that the more the figures are important, the more the patience of the investor increases. The investor's attitude is determined by the fact that smaller figures are associated with immediate consumption while larger figures are associated with a future investment idea. It can be proved that the reversal of the preferences in question is related to the difference of the figures considered and not to their ratio, i.e. (Ventre et al., 2022, b):

Theorem 3. Let x and y, with $x < y$, and X and Y, with $x < X < Y$, such that $\frac{U(y)}{U(x)} = \frac{U(Y)}{U(X)}$. If $(x,s) \sim (y,t)$, then $(X,s) \prec (Y,t)$ if, and only if, $U(y) - U(x) < U(Y) - U(X)$.

Finally, the sign effect (Loewenstein and Thaler, 1989), also called gain-loss asymmetry, consists of the tendency of individuals to anticipate losses more than gains of the same magnitude. The first approach to studying the anomaly in question is the emotional loss aversion bias for which the disutility associated with a loss is greater than the utility associated with a gain of the same amount. The discount rate is, therefore, steeper in the context of a loss because the investor's haste toward payment is greater. The second approach is based on Prospect Theory (Kahneman and Tversky, 2013). In this regard, the anomaly can be justified by replacing the instantaneous cardinal utility function with the utility function proposed by the theory concerned as proven by Ventre et al. (2022, b):

Theorem 4. If the utility of a result is calculated as $V(x)$, where $\varepsilon > 1$ (according to the prospectus theory) and U is concave ($U'' < 0$), then, for every $0 < x < y$ and $s < t$, $(x,s) \sim (y,t)$ implies $(-x,s) \succ (-y,t)$.

3. The AHP model applied to economic behavior

To implement an AHP, it is first necessary to define a structure representing the problem. Our aim is to define strategies that best fit the investor's profile. The first level representing the general objective, i.e. "*selection of the best strategy*" will be followed by behavioral criteria taken by Keirsey's temperament theory. Keirsey believed that individuals can be divided into four major temperaments, each with specific behavioral characteristics. Pompian (2012) overlaid Keirsey's four temperaments with four types of behavioral investors through behavioral finance studies with the goal of relating cognitive biases to an individual's attitude in the financial market. Table 2 shows the relationship that exists between the four Keirsey's temperaments and the BIT.

Keirsey's temperaments	Artisan	Guardian	Idealist	Rational
Types of behavioral investors	Accumulators	Conservative	Followers	Independent

Table 2. Relationship between Keirsey's temperaments and types of behavioral investors

Since the financial personality is related to temperament and each behavioral investor is characterized by specific behavioral biases, the third level is composed of the anomalies of the discounted utility model studied in Ventre et al. (2022, b). The last level has as vertices the investment strategies assuming that a strategy can be viewed as combinations of the domains in which the anomalies develop. The final structure is shown in Figure 4.

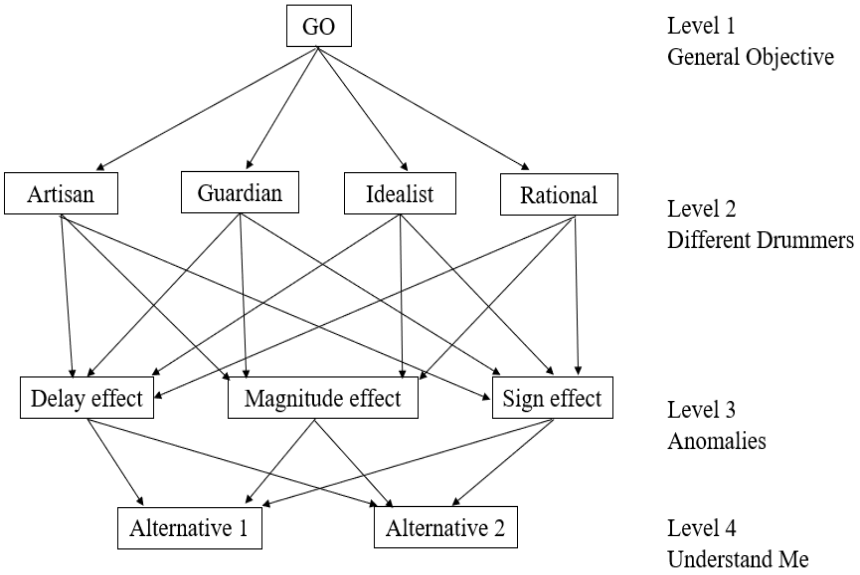

Figure 4. AHP structure based on four different levels. The present paper aims to determine the weights of Level 3 compared with Level 2.

"*Different Drummers*" and "*Understand Me*" refer to the book "Please Understand Me II. Temperament Character Intelligence" (Keirsey, 1998) of which was used The Keirsey FourTypes Sorter test for the determination of temperament. The quiz, consisting

of sixteen questions with four alternatives to be ordered by decreasing preference, provides us with the intensity of the four temperaments in each individual. The obtained scores, observing that the main temperament corresponds to the minimum value, allow calculating the weights of level 2 with the following pairwise comparison matrix reported in Table 3.

GO	Artisan	Guardian	Idealist	Rational
Artisan	1	G/A	I/A	R/A
Guardian	A/G	1	I/G	R/G
Idealist	A/I	G/I	1	R/I
Rational	A/R	G/R	I/R	1

Table 3. Pairwise comparison matrix for the weights of GO with respect to each temperament. The score of each temperament is given by The Keirsey Four Types Sorter test (Keirsey, 1998, p.348).

In addition to empirically testing the relationships in section 3, this study tries to estimate the relative importance of anomalies with respect to higher-level items. To accomplish this, assuming that the degree of decrease in impatience reflects the non-rationality underlying the preference reversal phenomenon, the questionnaire is created by constructing the indifference pairs given in Theorem 1. The hyperbolic factor provides us with a measure of the altered degree of impatience for each anomaly that makes up level 3. For each trait that composes in level 2, the median of the hyperbolic factors is calculated based on the main temperament of each individual. In this way, for each main trait, the matrix of the pairwise comparison shown in the Table 4 is obtained. In the Table 4, $H(s,t,\ y,\tau)$ denotes the hyperbolic factor in a prospectus in which s, t, y and τ are fixed. The respondent is free to choose for each question the values of x and σ obtaining the indifference pairs $(x,s)\sim(y,t)$ and $(x,s+\sigma)\sim(y,t+\tau)$ identified by the Theorem 1.

Dominant Trait	Delay effect	Magnitude effect	Sign effect
Delay effect	1	$\frac{\text{MedianH}(0,6,500,12)}{\text{MedianH}(0,6,50,12)}$	$\frac{\text{MedianH}(0,6,500,12)}{\text{MedianH}(0,6,-500,12)}$
Magnitude effect	$\frac{\text{MedianH}(0,6,50,12)}{\text{MedianH}(0,6,500,12)}$	1	$\frac{\text{MedianH}(0,6,50,12)}{\text{MedianH}(0,6,-500,12)}$
Sign effect	$\frac{\text{MedianH}(0,6,-500,12)}{\text{MedianH}(0,6,500,12)}$	$\frac{\text{MedianH}(0,6,-500,12)}{\text{MedianH}(0,6,50,12)}$	1

Table 4. Pairwise comparison matrix for the weights of the temperaments with respect to the individual anomalies. Underlying this construction is the hypothesis that the degree of decrease in impatience represents the non-rationality underlying the inconsistency.

4. Results

To analyze the relationships among the four temperaments we consider the median of the hyperbolic factors of individuals according to the dominant trait. The median is recommended because the data exhibit high variability. In fact, it is possible to prove that the maximum reference value that can be obtained on the basis of the data set is $H(s, t, y, \tau)$= 66.50 while the lower value is not defined. Before proceeding with the presentation of the main results of the experimental phase, in Table 5 we report the distribution of the sample.

Temperament	Rational	Idealist	Guardian	Artisan
Distribution	38.5%	26.9%	19.2%	15.4%

Table 5. Distribution of the sample. The quiz administration sample consisted of 52 persons, ages ranging from 18 years old and 65 years old, of which 48.08% were women.

Table 6 shows the results for the hyperbolic factor H(0,6,500, 12). The maximum degree of decrease in impatience indicates strong impulsiveness. Artisans, in general, are more focused on the short term and therefore prefer more immediate gratification. In fact, Artisans manifest the major median while Idealists, due to their general disinterestedness, stand out among all temperaments being the only ones not to realize in maximum value.

Main temperament	Minimum value and distribution	Maximum value and distribution	Median
Artisan	0.50 (12.50%)	66.50 (25.00%)	7.83
Guardian	0 (10%)	66.50 (20%)	2.83
Idealist	0 (7%)	28.40 (7.14%)	1.83
Rational	-0.02 (5%)	66.50% (25.00%)	1.83

Table 6. H(0,6,500,12). Distribution and median for each temperament.

Table 7 shows the results for the hyperbolic factor where lesser digits are involved in the indifference pairs of Theorem 1. Comparing the values in Table 6 and Table 7, the distribution of the maximum value is doubled in the case of less important digits. In line with predictions, the medians are all greater than the factor H(0,6,500,12) . As for Artisans, their strong impulsiveness is even more evident with a distribution of the maximum value of 62.50%. The case of the Guardians is particularly interesting. In fact, this category presents the maximum value for the ratio H(50) /H(500) which, from a cognitive perspective point of view, can be explained by the mental accounting bias for which money is categorized by subjective criteria. This is equivalent to saying that the prevalence of impulsiveness over self-control breeds inconsistency. Also, the Idealists realize H=66.50 unlike the case reported in Table 6. The Rationales present less inconsistency among the choices involving figures of different entity.

Main temperament	Minimum value and distribution	Maximum value and distribution	Median
Artisan	2.69 (12.50%)	66.50 (62.50%)	28.4
Guardian	0 (10%)	66.50 (30%)	18.12
Idealist	0.06 (7.14%)	66.50 (35.71%)	4.83
Rational	-0.02 (5%)	66.50 (40.00%)	4.17

Table 7. H(0,6,50,12). Distribution and median for each temperament.

Table 8 shows the comparison between hyperbolic factors H(0,1,50,1) and H(0,6,50,12) with the purpose of understanding how much and how the applied discount varies with the length of the intervals involved. It is evident that the greater part of the variation of the degree of impatience happens in the first period confirming the hypothesis of a decreasing speed in the time. Moreover, as the width of the interval increases, the applied discount also increases. This outcome involves all temperaments.

	H (0,1,50,1)		H (0,6,50,6)	
Minimum value and distribution	0 (7.69%)		0 (3.85%)	
	M (25.00%)	F (75.00%)	M (50%)	F (50%)
Maximum value and distribution	32.33 (48.08%)		66.50 (40.38%)	
	M (64.00%)	F (36.00%)	M (61.90%)	F (38.10%)
Median	13.29		18.12	

Table 8. Comparison of H(0,1,50,1) and H(0,6,50,12).

Table 9 highlights how many individuals, just by varying the sign of the outcomes considered, exhibit different hyperbolic discounts. Analyzing the median for temperaments, particular attitudes characterize each category. The Artisans , for example, generally show a high value for the hyperbolic factor, underlining that the serenity with which they face the payment prevails over the displeasure of the payment itself. This is because Artisans are the most flexible with respect to losses. On the other hand, the Guardians have a different approach, as evidenced by the finding of the smallest maximum value of the entire experimental phase. This temperament suffers the payment because it is seen as a reduction of its assets. In fact, when investigating the timing with which individuals would prefer to act in a loss and gain situation, Guardians are the ones that most postpone losses among the four temperaments as shown in Figure 5.

Main temperament	Minimum value and distribution	Maximum value and distribution	Median H (-500)
Artisan	0.03 (25.00%)	66.50 (62.50%)	66.50
Guardian	0 (20.00%)	7.83 (20%)	2.83
Idealist	0 (7.14%)	66.50 (14.29%)	1.83
Rational	0 (5%)	66.50% (50.00%)	31.17

Table 9. H(0,6,-500,12).

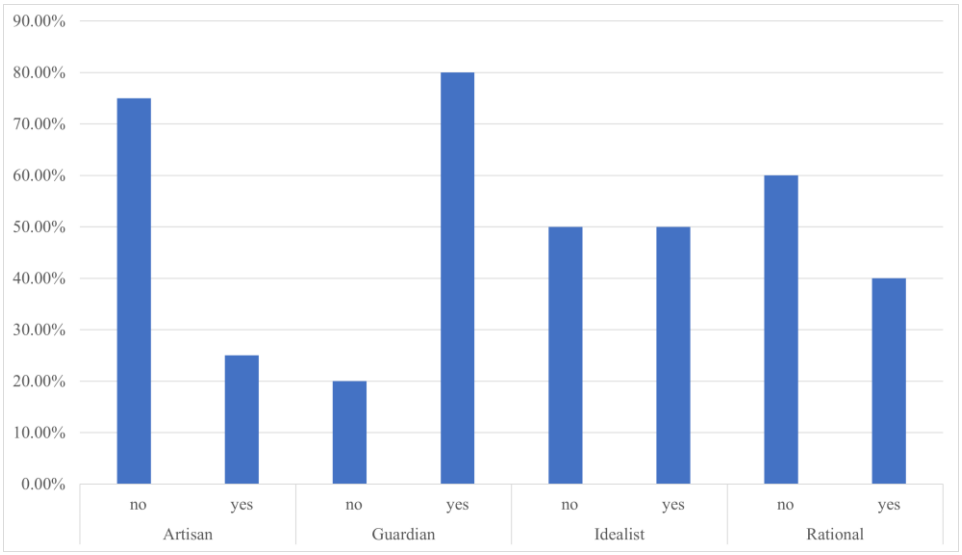

Figure 5. Distribution of individuals who defer payment. Guardians take an attitude that sets them apart from other temperaments in such a situation.

Figure 6 shows that Rationals despite being the least emotional are prone to particular distortions such as the overconfidence bias. In fact, Rationals present themselves as more irrational than the other temperaments in this circumstance in that, although they manifested a moderate hyperbolic factor, they were the individuals who would pay higher amounts than they had stated they would receive.

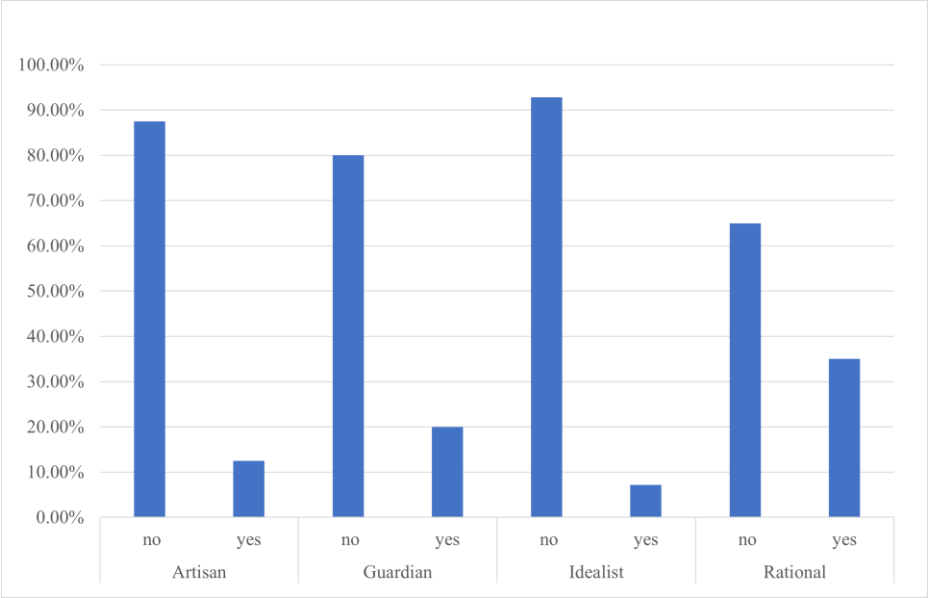

Figure 6. Distribution of individuals who would unconsciously increase the amount payable. For the bias of excess of confidence that characterizes them, the Rationales prefer to pay more than they would like to receive.

The analysis ends by calculating pairwise comparison matrices for each temperament and determining the relative weight of the anomalies relative to the top level. The values obtained are shown in Figure 7.

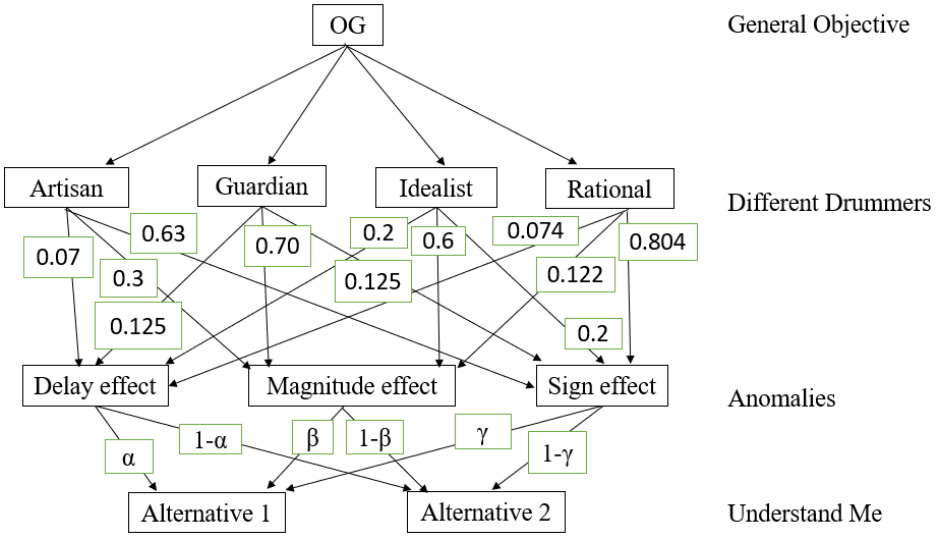

Figure 7. Final structure.

By coasting the pairwise comparison matrices for each temperament as shown in Table 4, the local priorities of the affected level were estimated. These priorities did not vary across individuals. Therefore, it could be a method to homogenize heterogeneous categories.

5.1 Results by genders

To investigate and deepen the differences between the genders, we repeat the analysis with the aim of creating two different AHP. In this way, it will be possible to quantify the strengths and weaknesses of both genders. The distribution of the sample with respect to gender (48.08% female, 51.92% male) is sufficient and this allows us to proceed with the analysis. The table 10 shows the medians of hyperbolic factors with respect to the genders.

	H(0,500,6,12)	H(0,50,6,12)	H(0,1,50,1)	H(0,-500,6,12)
Male	1.83	6.50	32.33	1.83
Female	7.83	28.41	3.00	6.50

Table 10. Medians of hyperbolic factors with respect to the genders.

The H(0,500,6,12) column in Table 10 shows that women are generally more impatient than men. In particular, the value corresponding to women is approximately 4.28 times greater than men. What has been said is equivalent to affirming that women are more prone to exhibit a dynamic inconsistency. This trait is still evident when we consider the magnitude effect. First, we observe that both genders undergo an important variation of the hyperbolic factor when smaller figures intervene, leading us to conclude that the magnitude effect has an equivalent impact on men and women. In fact, the ratio of the medians reported in column two of the Table 10 is 4.37, similar to the previous one, still highlighting the greater impatience of women. The last column of the Table 10,

relating to the median of H(0,-500,6,12), again underlines a different approach in intertemporal choices between the genders, in this case with respect to losses. To investigate this result, the Figure 8 and the Figure 9 show who would pay more and who would postpone payment more according to gender.

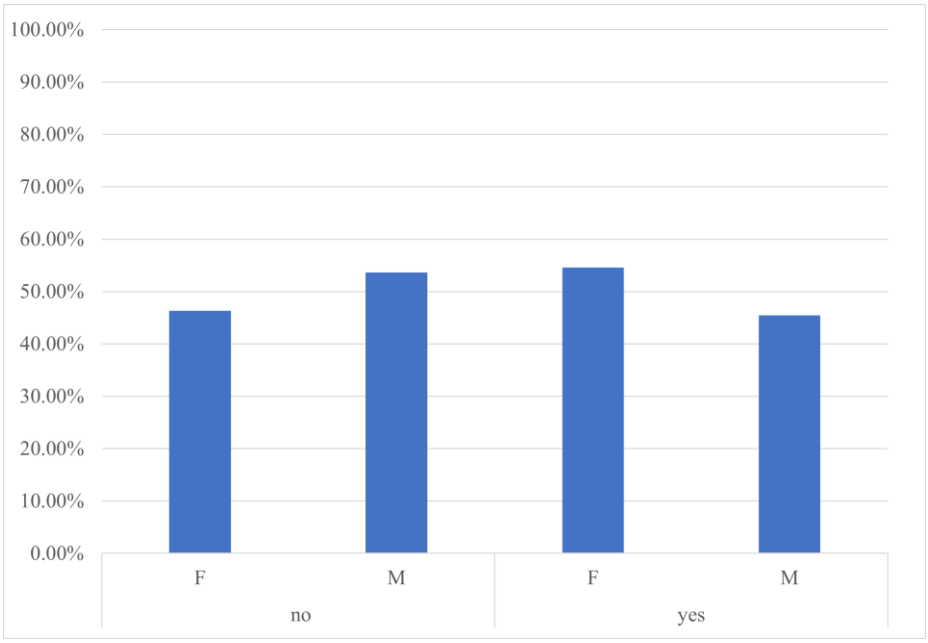

Figure 8. Distribution of individuals who would unconsciously increase the amount payable according to gender.

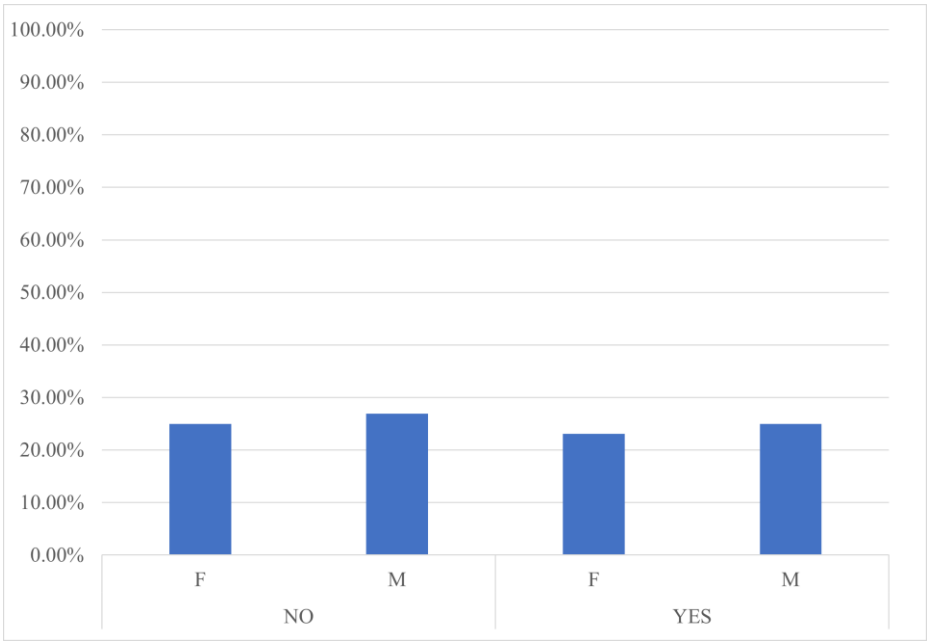

Figure 9. Distribution of individuals who defer payment according to gender.

Women, in accordance with a lower aptitude for the financial environment, account for a higher percentage in Figure 8, while, with respect to Figure 9, the percentages are almost similar, and no further differences are evident. Finally, about the hyperbolic factor H(0,1,50,1) it is possible to observe the only case in which men show greater impatience than women.

Although the gender distribution is uniform, we cannot be satisfied with our analysis after observing in section 5 many important differences between the four temperaments. In fact, we believe that the distribution of temperaments with respect to gender has a non-negligible impact on the medians shown in the Table 10. Table 11 shows the gender distribution in the four temperaments, whose inhomogeneity confirms our hypothesis.

	Artisan	Guardian	Idealist	Rational
Female	25.00%	70.00%	64.29%	35.00%
Male	75.00%	30.00%	35.71%	65.00%

Table 11. Distribution of gender with respect to each temperament.

To understand to what extent, the gender-temperament combination affected the gender analysis, we propose again an analysis of the medians of the four temperaments with respect to gender. Let's beginning again with H(0,500,6,12) for each temperament. The medians are reported in Table 12. It can be observed that the medians of the female gender are much higher than the respective medians of the male gender. For the male gender, in this case, we still find that the highest median is manifested by Artisans and the lowest by Guardians, as was the case with the general evaluation. For women, on the other hand, the highest median is manifested by Guardians and the lowest median by Idealists. This result underlines that gender difference has a great impact on the temperament of the Guardians in the delay effect.

	Artisan	Guardian	Idealist	Rational
Female	18.12	28.40	1.83	7.83
Male	5.83	0.17	0.83	1.83

Table 12. H(0,6,500,12)- distribution and median for each temperament by genders.

To see if the attitude of Guardians is uniform with respect to anomalies, we proceed with the magnitude effect. From Table 13, which shows the medians for each temperament according to the gender of H(0, 6, 500, 12), it is possible to say that one cannot generalize what happens for the delay effect. In fact, although the magnitude effect is confirmed by the fact that the values of the medians of H(0, 6, 50, 12) are for the most part greater than the medians of H(0, 6,500, 12), it is evident that the financial behavior of the genders is different. The lack of uniformity in the survey confirms that each anomaly is driven by different psychological principles.

	Artisan	Guardian	Idealist	Rational
Female	28.40	28.40	7.83	1.83
Male	66.50	0.17	1.83	6.50

Table 13. H(0,6,50,12) - distribution and median for each temperament by genders.

The first thing to note is the relationship between the temperament of the Guardians and the Artisans. In fact, while the female gender of these two temperaments has the highest median, the male gender shows totally opposite values: it is highest for Artisans and lowest for Guardians. Moreover, the Rational female gender shows a median that is about four times lower than the respective male temperament. Therefore, women are not always more impatient than men. To analyse the financial behaviour with respect to the length of the intervals involved, we compare H(0,6,50,12) with H(0,1,50,1). In Table 14 we can observe that the temperament of the Artisans is confirmed for both genders with a greater impulsiveness evident in the high degree of decreasing in impatience.

	Artisan	Guardian	Idealist	Rational
Female	22.81	3.00	3.00	13.29
Male	32.33	1.00	33.33	3.35

Table 14. H(0,1,50,1) - distribution and median for each temperament by genders

Particularly interesting are the Idealists and the Rationales: the former, of the male gender, show a decrease in impatience equal to that of the Artisans; the latter, of the female gender, suffer a very strong impact from this type of anomaly as can be seen by the wide variation ranging from 1.83 to 13.29. However, it is clear to all that the change in the degree of impatience occurs in the first period of the prospectus. The behavior of the male Guardians stands out: emphasizes the cautious nature of this temperament.

From Table 15 it can be seen how strong the impact of the sign effect is on Guardians, the only temperament that shows a lower median of H(-500) than H(500). When analyzing the data with respect to gender, however, those who suffer most from the payment are women of this temperament, a result also shown in Figure 10. In fact, women, much more than men, tend to postpone payment.

	Artisan	Guardian	Idealist	Rational
Female	66.50	3.83	4.83	7.83
Male	47.50	0	8.18	65.00

Table 15. H(0,6,-500,12) - distribution and median for each temperament by genders.

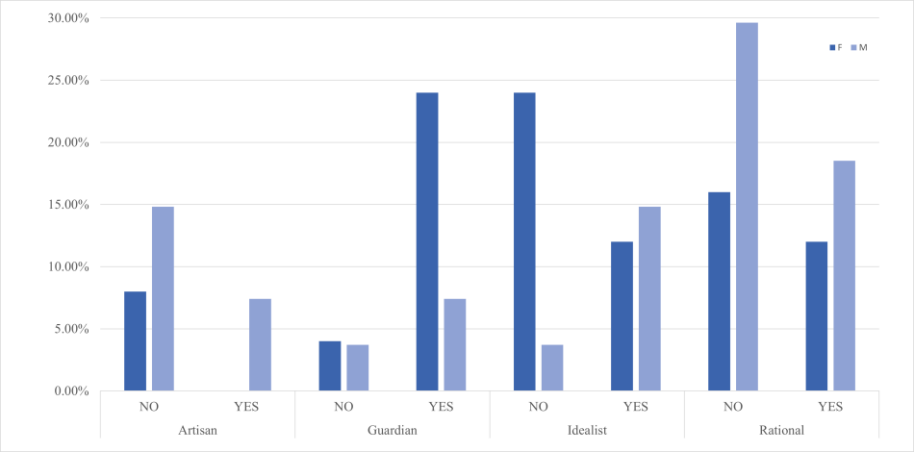

Figure 10. Distribution of individuals who defer payment divided by gender.

To investigate how the overconfidence bias that characterized the Rationales in the general analysis in section 5 is distributed over gender, figure 6 has been enriched with the gender in Figure 11. It can be observed immediately that most of the Rationales who would pay more than they want to receive are about 60% male.

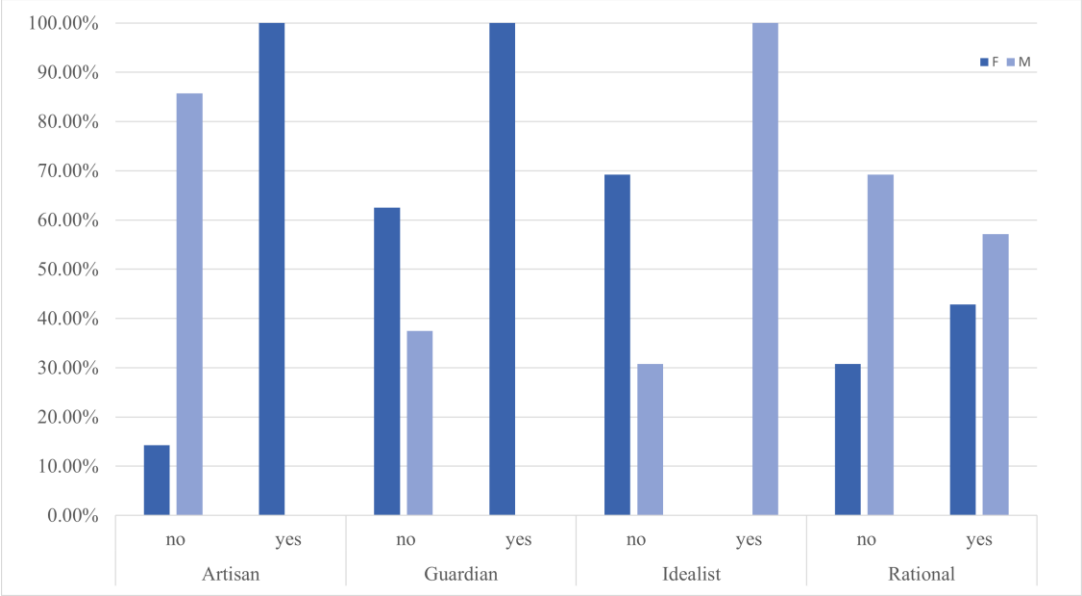

Figure 11. Distribution of individuals who would unconsciously increase the amount payable divided by gender.

Figure 12 and Figure 13 show the final structures of the female and male genders respectively.

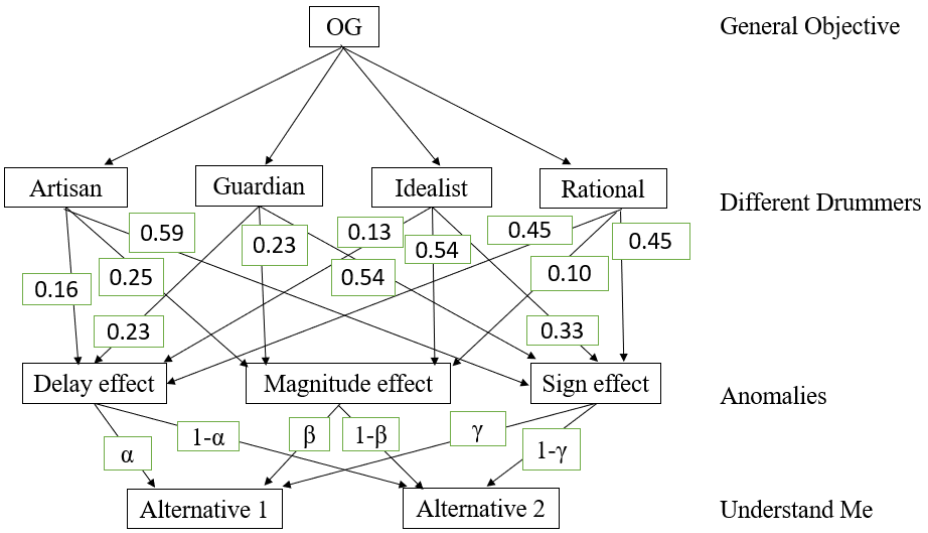

Figure 12. Final structure for female.

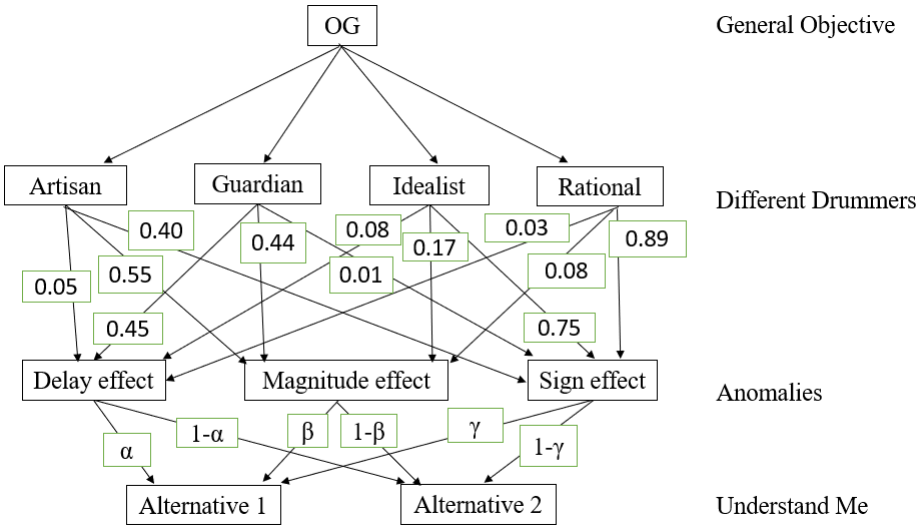

Figure 13. Final structure for male.

5. Discussion

This paper has applied AHP method in the context of intertemporal choices to decompose the economic behavior and to promote a better understanding of the dynamics of the decision-making. In particular, the applicability of the present research addresses to two necessary EU goals: costumer profiling profiles and gender equality. The Directive 2014/65/EU (Art. 24 section 11 and Art. 25) emphasizes the need for information to understand whether a specific financial transaction meets the following objectives with respect to the client: matching the client's objectives and risk tolerance; a financial nature such that the client is able to bear the risks in relation to its investment objectives; a financial nature such that the client has the necessary knowledge to understand the transaction and the risks involved.

To address these needs, in this paper proposed a method to classify the investor by interweaving Keirsey's temperament theory and the concept of decreasing impatience in intertemporal choices. The anomalies of the Discounted Utility model studied in Ventre et al. (2022, b) are deepened and investigated from a behavioral point of view according to the temperament and gender of the respondents. The short section 2 on gender difference underlines the need to break down the decision-making process to understand the differences between men and women. In fact, to implement a strategy that aims at gender equality in any field and customer management, it is necessary to consider the diversity that characterizes men and women as a starting point. In section 3, the theoretical concepts necessary to understand the experimental framework were outlined, emphasizing that the decrease in impatience is a measure of the non-rationality of the decision-maker due to the emotional drives that develop during the evaluation and selection phase of an intertemporal prospectus. In this context, the theoretical results proven in Ventre et al. (2022, b) with respect to the interval effect, delay effect, magnitude effect and sign effect were recalled in section 3.2. After presenting the essential tools, the construction of the experiment is based on by the implementation of an Analytical Hierarchical Process. The mathematical structure of the AHP makes it possible to

decompose the decision-making process into all its elements and to explain their relationships in quantitative terms. Indeed, Figure 7 shows important differences between the four temperaments, confirming the need to design strategies that can adhere to the profile of the individual investor without ever generalizing their effectiveness. In fact, it immediately emerges that: the greatest weight obtained by AHP is shown by the Rationales with respect to the sign effect anomaly, with a value of 0.804; Guardians, have similar weights to the Rationales but with a greater influence of the magnitude effect; Guardians, on the other hand, have lower weights than the sign effect anomaly but are the temperament with the highest weight with respect to the magnitude effect; the Idealists, finally, is the temperament with the highest weight with respect to the delay effect.

The reported results can be further deepened and analyzed by considering not only the first behavioral trait but also the remaining ones. In fact, from the obvious differences between the temperaments we expect that a Rational with Guardian as second trait would behave differently towards the magnitude effect than a Rational with Artisan as second trait.

Gender analysis made it possible to further investigate the relationship between temperaments and anomalies. It emerges that there is not a better temperament or a more capable gender. In some temperaments, the male and female genders behave in almost opposite ways. For example, as can be seen for the Rationales with respect to the delay effect (0.45 for women and 0.03 for men), or for the Guardians with respect to the sign effect (0.54 for women and 0.01 for men). However, these results do not work against women. It is enough to look at the behavior of Artisans with respect to the magnitude effect (0.55 for men, 0.25 for women), or Idealists with respect to the sign effect (0.75 for men, 0.33 for women). The analysis presented and the quantification of differences in intertemporal preference can foster gender mainstreaming in the financial world through the inclusion of specific measures aimed toward women.

Finally, we stress that the structure of the AHP can be expanded with other non-negligible information, such as age and initial wealth. In this way it is possible to describe more and more defined classes of clients, describing the individual as the combination of multiple dimensions of identity and recalling the concept of intersections, allowing dominant and subordinate factors to be included at the same time (Atewologun et al., 2016)

With respect to the distribution of the data, the inhomogeneity of temperaments with respect to gender does not allow to draw definitive conclusions with respect to the combination of gender and temperament, but certainly highlights the importance of the subjective structures of the decision-maker during a choice. Moreover, during data collection, women were more reluctant to submit to the test, except for the temperament of the Guardians and Idealists. Therefore, in order not to distort the male-female distribution, it was difficult to obtain homogeneity in the temperaments. This attitude of refusal is certainly linked to a cultural gap, in which women feel less skilled and qualified in the field of finance than men. In this respect, various other factors such as age, social class and level of education play a role. Our work is an invitation to consider these elements to understand why it is necessary to define consumer classes. In fact, the analysis of the data did no more than experimentally confirm the requirements of the decree 2014/65/EU. Our work offers an original method that quantifies diversity and legitimizes anomaly.

6 Conclusions

The multidisciplinary approach used made it possible to conduct an original analysis on gender differences and consumers classification. Such attitudes have defined over the years a break between the theoretical model and actual actions of individuals. The basis of this discrepancy is the assumption of a rational investor, capable of making decisions always favoring her interests. Behavioral finance, which studies investor behavior in the financial market, describes "*special cases of deviation from rational action*" (Rubaltelli, 2006) through regular and systematic patterns of behavior for which the subject is rationally limited. Classical theories overlook the numerous distortions of individual decision-making arising from emotional drives and the complexity of the environment in which the choice is made. This is equivalent to state that non-rationality is part of human nature. Decision-makers do not always process information correctly and impartially and, as a result, make choices that worsen their condition.

From a pratical point of view, consumer profiling operations have been introduced in European directives as written in Directive 2014/65/UE of the European Parliament and of the Council. The aim is to protect clients by designing financial products that correspond to individual profiles, client by client. To exploit the full potential of personalized advice, it is then necessary to know how to construct a strategic communication plan to improve client choices. The intersection between strategic customization and the understanding of gender differences is evident in different risk preferences and risk management. In fact, advisors consider the risk appetite index a key element for asset allocation modelling and the numerous empirical evidences presented in Section 2 underline the need to take into account the different risk perceptions between men and women in order to improve personalised finance services.

In addition, the analysis of gender differences using the intertemporal choice theory can also contribute to understanding important behavioral differences such as the propensity to depression, addictions and procrastination mechanisms. In fact, Prelec (2004) also proved that irrational degeneration of definition 3 and definition 4 lead to attitudes of procrastination and promotion of consumption, described in Figure 14 and Figure 15.

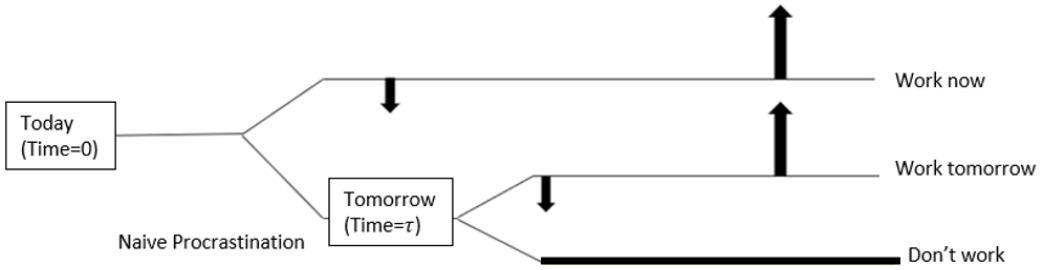

Figure 14. Procrastination*:* the procrastinating Decision-Maker prefers to do the work immediately rather than not do it at all but keep putting it off (Prelec 2004, p.221).

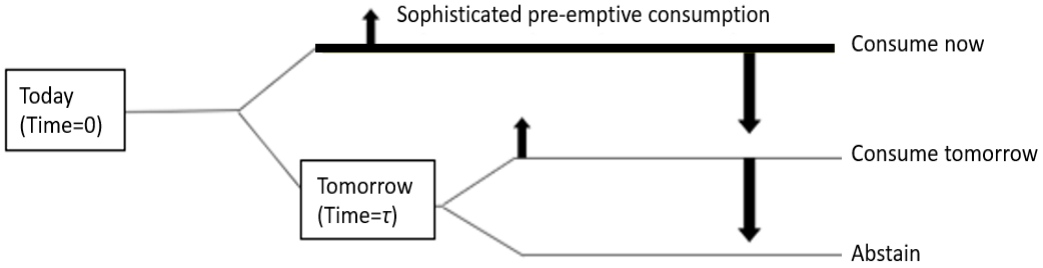

Figure 15. Pre-emptive consumption: the Decision-Maker anticipates the choice by deciding to consume today despite this being a less preferred option than abstaining (Prelec 2004, p.221).

The work presented can provide methodological support for studies that aim to understand gender differences in topics such as suicidal ideation, stress, alcohol use and depression (e.g., Rich et al., 1992). Understanding the differences that exist between individuals and accepting that each identifying element (such as gender, age, culture...) has a non-negligible impact on decision-making are necessary research processes to then to nudge the individual toward a better option using the same cognitive boundaries (Thaler and Sunstein, 2014). Nudges are intended to influence social behavior without significantly limiting freedom of choice. Various studies have shown that these interventions have positive results (Pe'er et al., 2019). Nudging has emerged as an efficient technique to improve the quality of individuals' choices to address this problem. The nudge technique is based on using behavioral biases to the individual's advantage through a variation in the decision-making environment. In this way, the decision-maker is nudged toward the best option without denying the freedom to choose the other alternatives. Such an intervention has been studied and implemented by Rubaltelli and Lotto (2021) to increase the pension funds of freelancers. To improve the nudging technique, two important observations must be considered. First, individuals' response to pushing can vary from subject to subject based on age, gender, and character; second, change necessarily involves an alteration in one's state. Therefore, a determining factor in optimizing interventions of this type is an analysis of the tendency to maintain one's status. In this regard, Gal (2006) refers to a "*psychological law of inertia*" to indicate, in the context of loss aversion, the tendency of individuals not to alter their habits. So, to optimize choice architecture, we need to move towards customized interventions. Describing anomalous attitudes in terms of inconsistency among decision-making processes involving choices defined over a short or long period allowed us to quantify the inconsistency of individuals' choices. The direct consequence is the possibility of being able to quantify how much behavioral bias weighs in individual decision-making. Decision theory makes it possible to implement a personalized choice architecture. Choice architecture plays the key role in implementing nudging. Indeed, if decision-makers are influential because they are rationally constrained, the decision-making environment can be organized to influence toward the best individual option. The methodology proposed in the present paper could be a framework to help the selection of the best choice architecture because behavioral differences show the necessity to diversify the strategies. The use of AHP allows for a construction of the decision context that fits the individual by modeling the structuring of options and the description of options based on the cognitive mechanisms involved. Our approach can be expanded in three different ways. First, one can consider sixteen temperaments instead of four. Keirsey divided the four temperaments into two categories, each with two variants by relating each group to

the sixteen types of the MBTI (Myers, 1980). This makes it possible to study the relationship between anomalies and personality in more details. The second development of our approach requires the inclusion within the structure of other levels that contain increasingly personal information such as age. Other anomalies in the discounted utility model such as delay-anticipation asymmetry (Loewenstein, 1988). and preference for sequences of outcomes (Loewenstein and Sicherman, 1991; Chapman, 2000) can also be included, too. Anticipation-delay asymmetry consists of the phenomenon whereby the discount function is steeper if an outcome is postponed than if it is anticipated. Loewenstein (1988) interpreted this anomaly through loss aversion, and it can therefore be quantified in terms of variation in the degree of impatience. Sequence preference indicates the situation in which a negative discounting of time prevails and is a phenomenon related to various psychological mechanisms. It would be interesting to investigate how the degree of decrease in impatience varies in these contexts. The third possible development is to deepen the analysis by studying relationships as a function of non-dominant traits. We believe that non-dominant traits also have a significant weight and this confirms the need to refer to a structure that can encompass all the nuances of the decision-maker.

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