

## GENDER DIFFERENCES IN FINANCIAL RISK AVERSION (THE ROLE OF HORMONES IN FINANCIAL MARKET)

Ana Njegovanović  
Voćarska 38, 10000 Zagreb, Hrvatska  
Telefon : + 385 95 8855055, e-mail: ana.njegovanovic@gmail.com

### ABSTRACT

*The present work encourages the exploration of the theoretical literature on the relationship between steroid hormones, the preference of financial risk and the performance of retailers (eg Dreber and Hoffman, 2007; Garbarino et al., 2011); (Apicella et al., 2008 and Coates and Page (2009), and the role of testosterone and cortisol which have organizational and activating effects on the financial risk aversion of men and women which affects their careers. (Sapienza et al., 2009, Barnea et al., 2009). Research has been done on the effects of biology and genetics on the attitudes of risks taking with regard to the sexes (Sapienza et al., 2009; Barnea et al., 2010). Even though social identity shows the stereotypical behavior society attributes to men and women (Akerlof and Kranton, 2000), manipulations by using signs of gender identity are possible.*

*Heterogeneous preferences and beliefs have great implications on labor market dynamics (Killingsworth 1987), financial markets (Garlean and Panageas) and macroeconomics (Chien et al., 2014). Gender heterogeneity is particularly relevant - each group includes half of the population, and there are systematic differences in the preferences of men and women, which on the other hand have great effects on economic outcomes (Cros and Gnees 2009, DellaVigna et al., 2013, Bertrand et al., 2015).*

**Keywords:** Gender; hormones; Effects of Endogenous Financial Risk; Neuroeconomics, Neuroscience

## 1. INTRODUCTION

Physiological research has shown that steroid hormones (i.e. testosterone) affect the risk preference. High levels of testosterone are associated with a greater, even excessive, amount of risk behavior (Apicella et al., 2008; Garbarino et al., 2011), while cortisol influences the risk preference and predictability of market instability (Cueva et al., 2015). Furthermore, hormones affect behavior, the outcome of such actions may in turn affect hormone levels. In case of testosterone, the level increases/decreases in response to success/failure. There are many systematic differences between men and women in this regard; men tend to have higher levels of testosterone, experiencing higher fluctuations at their levels than women (Kivlighan et al., 2005). Laboratory experiments have shown that gains and losses from financial trading lead to higher variations in male hormone levels and risk predisposition than women (Dreber and Hoffman, 2010).

Research conducted by Subir Bose, Daniel Ladley, and Xin Li of the University of Leicester, Department of Economics, Leicester, UK, by analyzing the effect of hormones in a simple trading model (De Long et al., 1990b) shows that traders have different preferences of risk affecting their portfolio selection. It was established that the risk of preference is not only distinguished among individuals but also over time for a particular person in response to individual outcomes. Profit-traders have a lower risk aversion than those who make losses, but have aversion to risk.

Base testosterone level is less known when it comes to effects of changing testosterone levels on financial risk, namely testosterone change after monetary gains and losses predicting future financial risk taking. Some events can not be explained by traditional economic theory, where it is assumed that the participants are rational, so understanding is possible through endocrine behaviors. Namely, one factor which directly mediates in financial decision-making is the hormone testosterone. While the basic differences in testosterone are explained by individual differences in taking financial risk (Apicella et al., 2008; Stanton et al., 2011), some observed gender differences in risk taking are also taken into consideration (Sapienza et al., 2009). Namely, there are suppositions that transient changes in testosterone can also affect the financial risk taking (Goudriaan et al., 2010). If so, the changes can be explained by documented behaviors such as the sensitivity of the economic markets to sporting outcomes. Testosterones act as a physiological modulator of behavior by a changing social environment (Oliveria, 2004). Men enter into risky and competitive behavior in response to increased testosterone. Testosterone has a motive effect on men to compete and risk. A transient increase in testosterone acts in a way as to promote socially competitive and risky behaviors in men leads to profitable behavior. (Oliveria, 2004; Apicella and Cesarini, 2011; Elsenegger et al., 2011).

The testosterone pathway, which produces its motive and competitive effects is not clearly defined. Studies show that testosterone has positive hedonistic effects by activating mesolimbic dopaminergic pathways involved in stimulation such as ventral striatum (Hermans et al., 2010) and especially nucleus accumbens (Fry

et al., 2010). Research on functional magnetic resonance imaging fMRI included these same paths in feelings of positive excitement and expectation of financial awards (Knuston et al., 2001). Namely, greater accumulation of core accumbens has been observed before individuals choose the risk of safe monetary gambling, but this activation is not observed before certain relatively risky decisions are made (Matthews et al., 2004).

Behavioral plasticity at different levels of testosterone is likely to have developed on average in men (Oliveira, 2004), but this can also lead to irrational decision-making. If the changes in testosterone affect the decision-making of men, this can help explain the behavior of economic phenomena such as: a) the effect of in-house money (increased risk seeking after previous gain) (Thaler and Johnson, 1990), b) a fall in the national stock market after the country's athletic team suffered a defeat (Edmans et al., 2007).

Several studies have investigated changes in testosterone affecting the financial risk taking and the relationship between testosterone to overall economic decision-making. Correlations between financial risk taking and testosterone base (Apicella et al., 2008; Stanton et al., 2011) and digits 2D: 4D (Sapientza et al., 2009; Branas-Garza and Rustichain, 2011); Proxies for Exposure to Primal Testosterone . While Apicella et al. (2008) published a linear relationship between salivary testosterone concentrations and the amount of money invested in risky investments, Stanton et al., (2011) found that men with high and low levels of testosterone were not at risk, while middle-sized individuals with testosterone were uncomfortable. Other studies have found no link between testosterone base and financial risk (Sapientza et al., 2009) and economic competitiveness (Apicella et al., 2011). In a study of the organizational effects of testosterone on the brain during the critical development period, (for example) a smaller ratio between 2D: 4D is thought to reflect increased exposure in the uterus (Manning et al., 1998) is associated with increased profit and risk taking in high-frequency trading Coats et al., 2009; Coats & Page, 2009). Negative relationship between 2D: 4D and financial risk was found in less specialized populations (Branas-Garza and Rustichini, 2011, Dreber & Hoffman, 2007). Yet Apicella et al. (2008) found no relationship between 2D: 4D and financial risk in a heterogeneous ethnic sample of men. Also, Sapientza et al. (2009) did not find a significant relationship between 2D: 4D and financial risk taking in a sample of mixed student genders, though students with lower 2D: 4D were more likely to choose financially risky careers. One of the answers may lie in transient testosterone changes that may be important in mediating risk-related behavior.

Do the natural changes in testosterone after winning and losing money in the monetary competition affect the future takeover of financial risk? Since there is much evidence that the amount of testosterone responses in men varies (Cohen et al., 2009), the increase in testosterone affects other behavioralities associated with competition and risk taking.

The period of financial market uncertainty is explained by: debt accumulation (Minsky, H. P., 1992); misconceptions about the earnings process (Barberis, N.,

Shleifer, A. & Vishny, R. 1998); arbitrary restrictions (Shleifer, A. & Summers, L. H., 1990); (Avery, C. & Zemsky, H. P., 1992, P. 1998; Lee, A 1998; Hugh, H & Stein, JC markets, 1999), Shiller, RJ & Akerlof, G. A. 2009). M. Keynes originally understood the idea of “animal ghosts”: a “spontaneous drive to action” ultimately responsible for our decision to take a risk, and not after a careful calculation process (Keynes JM General theory of employment, interest and money, 1936) Alan Greenspan and Robert Shiller later used the term “irrational buoyancy” to describe the possible cause of property market overestimation (Greenspan, A. The Challenge of Central Bank in a Democratic Society, 1996; Shiller, R.J. Irrational Exuberance, 2015). Despite the importance of this idea, the physiological basis of “irrational growth” has only recently begun to be explored (Smith, A., Lohrenz, T., King, J., Montague, P.R. & Camerer, C.F. Irrational exuberance market bubbles, 2014). Neuroscience and Neurofinance make their contribution to the analysis of the irrational behavior of retailers in stock and finance markets, which represent the future of the tool for explaining behavior in financial markets.

Trading in financial markets is extremely stressful in the unmerciful competitive environment and unscrupulous rules. Such conditions are associated with two endogenous steroid hormones: cortisol and testosterone. Increasing cortisol is related to mental or physical stress, it is particularly susceptible to novelty and uncertainty or threatening situations. Increasing cortisol stimulates fear, physical excitement and seeks sensation (Dickerson, SS & Kemeny, ME). Acute stressor and cortisol responses: a theoretical integration and synthesis of laboratory research (Erickson, K., Drevets, W. & Schulkin, J. Glucocorticoid regulation of various cognitive functions in normal and pathological emotional states, 2003). Increasing testosterone is associated with predicting success and confidence in competitive encounters, winning effects (Chase, I. D., Bartolomeo, C. & Dugatkin, L. A. Aggressive Interactions and Inter-contest Interval: How Long Do Winners Keep Winning?, 1994). The perception of social status is also related to the level of testosterone (Mazur, A., & Booth, Testosterone and Dominance in Men, 1998). In men, elevated levels of testosterone are associated with increased aggression and sexuality function (Anderson, RA, Bancroft, J. & Wu, FC The Effects of Exogenous Testosterone and Sexuality and Mood of Normal Men, 1992, Archer, J. Testosterone and Human Aggression: An Evaluation of the Challenge Hypothesis, 2006). Evidence suggests a possible role in modeling individual preferences.

Can steroid hormones also serve as a destabilizer of the financial market? The fundamental value of assets in the financial market is the aggregate of the stochastic flow of future dividends; trading at prices above the core value is profitable only when there is a widespread belief that traders will continue to buy at prices far beyond fundamental values. Therefore, there is an increased willingness to take over the risks of price bubbles and market instability. However, direct evidence supporting the link between the hormone and the behavior of the investor is limited and can be generalized from all of these findings in trading on financial markets where confidence and ability are emphasized (Van den Boss, R., Hartveld, M. & Stoop, H., 2009; Putman, P., Antipa, N., Cryovergi, P. & van der Does, WA,

2010; Apicella CL, Dreber, A. & Mollerstrom, J., 2014). The studies cannot answer the question of aggregate market effects. Hence, endogenous hormone variations are insufficient in the analysis of market destabilizer.

## 2. GENDER DIFFERENCIES

Why are there few women trading in the markets? In many professions, the percentage of women exceeds 50% (see, for example, Chambers Partners, 2014, Kaiser Family Foundation, 2015, Catalyst, 2016). Still, some professions remain firmly out of this evolution. Finance is one of these sectors. Although women represent more than half of the workforce in financial services (Sethi et al., 2013), they typically have marketing related and HR job positions (Jäkel and Moynihan, 2016). Data show that women make up 15% of younger investment and trade roles (Green et al., 2009; Lietz, 2012).

The causes of this imbalance between the sexes are still not sufficiently clear. Some professions are present in the academic and practical literature on the relative absence of women: some suppose that there are fundamental differences in the knowledge (eg, Sapienza et al., 2009), there are some psychological differences (Charness and Rustichini, 2011), and some explain the social factors that represent behavioral differences (Byrnes et al., 1999; Saqib and Chan, 2015) which correspond to differences in representation.

There is a significant part of the research on gender differences in risk attitudes. One of the most common evidence in the literature is the issue of preferential risk: men are more prone to risk than women (Powell and Ansic, 1997, Byrnes et al., 1999, Eckel and Grossman, 2002, Croson and Gneezy, 2009). Croson and Gneezy (2009) discussed gender differences in risk resolution, which includes emotions, over-trust, and perceiving risk as a challenge or threat. The quest for the roots of these gender differences has revealed the role of androgen hormone testosterone. Testosterone (T) is an androgenic hormone that plays a key role in sex differentiation. This organizational role of testosterone is what changes the course of fetal development. In addition to this organizational and differentiating role, testosterone is also considered to modulate behavior in many ways (Ronald et al., 2003), as well as dominance (Mazur and Booth, 1998).

One of the differences between men and women is in testosterone levels. Coates et al. (2010) suggested a hypothesis suggesting that irrational acquisition of wealth was observed during market bubbles mediated by testosterone. They guessed that men and women traders would probably behave differently, with the behavior of male marketers linked to market instability. Time pressure is a key aspect of financial decisions on the store floor. Traders make decisions on financial markets within a few seconds after new information becomes available (Busse and Green, 2002). In the light of this, gender difference in time pressure may be one of the factors that affect the gender imbalance observed in these environments. If men and women make different decisions in time pressure, then it might be asserted that the market

favors a decision-making profile over the other, thus favoring one sex over the other. Kocher et al. (2013) found that the risk aversion was robust under the pressure of time, while the search for loss risks turned into risk time lags. A mixture of gains and losses, the respondents were unprincipled in loss and sought more gain in the pod pressure of time. Nursimulu and Bossaerts (2014) found that time-varying sensitivity translates into a reduced risk aversion and an increased probability of distortion for gains under extreme pressure. Capraro et al. (2017) examined the effect of time pressure and the degree of reflection on the decisions on allocation of funds.

Investigating variations in time pressure risk preferences indicate that research preferences are not as stable as they have been assumed so far. Both explicit factors, such as time pressure (Kocher and Sutter, 2006), and implicit, such as hormone cortisol levels (Kandasamy et al., 2014), mean that people make different choices. Research in many areas has shown that time pressure affects the nature of interpersonal interaction, such as levels of co-operation (Rand et al., 2012, 2014; Capraro and Cococcioni, 2015, 2016; Rand, 2016). Nevertheless, the impact of time pressure largely neglects the economy (Kocher and Sutter, 2006, De Paola and Gioia, 2016). The work rooted in experimental psychology investigated speed and precision. Fast decisions are considered to be of inferior quality because time pressure prevents efficient processing of information. This in turn leads individuals to return to heuristics instead of the information presented (see Kocher and Sutter, 2006). When estimating risk appetite, most studies suggest that risk is taken when there is time pressure (Huber and Kunz, 2007; Young et al., 2012; Kocher et al., 2013; Hu et al., 2015).

A question is still posed about why women are under-represented in many areas of finance. Is it important that these areas are dominated by men? Diversity has been well served by markets as a means to pursue herd instincts. A market that has slipped into the benefit of hiring men can therefore cause itself a problem. Some researchers, for example, Coates et al. (Coates et al., 2010) suggest that improving sexual diversity can improve market stability. This is corroborated by experimental evidence that the genus (Cueva and Rustichini, 2015) and hormonal diversity (Cueva et al., 2015) improve market stability. Although there are many explanations for aggregate behavior in financial markets, gender effects, preferential stability, and hormonal exposure may have significant consequences.

### 3. RELATED LITERATURE

Investigations in the field of physiological effects on economic behavior investigated the relationship between hormones, the preference of financial risk (Apicella et al., 2008; Garbarino et al., 2011; Dreber and Hoffman, 2007); and association between circulating testosterone and financial risk preference. Research has explored different experimental settings and found that increasing testosterone leads to overall optimism and risk taking. Individual cash prizes affect their high performance and high blood pressure hormone levels are associated with high levels of testosterone. In male and female retailers, differences are manifested in variations in hormone

levels after gain/loss affecting their subsequent risk taking and thus the result of trading (Kvilighan et al., 2005; Dreber and Hoffman, 2010). Hormone levels in men are more responsive to loss than women's. The cause of the difference is in the brain and early exposure to testosterone (Cronqvist et al., 2015). The association of hormones, especially testosterone, and social behavior has been explored in numerous biological researches. The relationship between awards/penalties and post competitions (Mazur and Both, 1998; Van Honk et al., 2004; Schultheiss et al., 2005) indicate that increased testosterone levels are associated with rewards and reduced testosterone levels are associated with penalties. Irrational behavior of retailers is found in Friedman, 1953, which suggests that traders can not influence property prices in the long run because they consistently lose money. Arguments are further processed by Muth, 1961; Fama, 1965; and Lucas 1972, and research on market efficiency in the presence of noise at retailers (Kyle, 1985; De Long et al., 1990; Campbell and Kyle, 1993; Guo and Ou-Jang, 2015). De Lang et al. show that fraudulent traders can survive under certain conditions while Saacke, 2002, and Kogan et al., 2006, show that irrational traders can affect prices and persist for long periods in the markets. Such models are presented as in Brock and Hommes, 1998, where the interaction of the trading strategy results in persistent and significant deviations from fundamental values.

#### 4. PROCEDURE OF RESEARCH METHODS

Research on the role of cortisol and testosterone in taking risk 2015 (Carlos Cueva, R. Edward Roberts, Tom Spencer, Nisha Rani, Michelle Tempest, Philippe, N. Tobler, Joe Herbert & Aldo Rustichini) and gender differences were conducted according to approved protocols by the Ethics Committee for Human Biology Research, the Cambridge University Human Biology Research Ethics Committee and the Norfolk National Research Ethics Committee.

In the experimental research of the property market, 142 healthy men and women aged 18-30 (69 men, 73 women: middle age 21,9 years) participated. The commercial task was programmed using z-tree 79. The markets were experimentally organized using a dual-machine computer mechanism (Noussair, C., Robhin, S. & Ruffieux, B. Price, 2009, Smith, VL, Suchanek, GL, & Williams, A. 1988, Porter DP & Smith, VL, 1994).

In the statistical analysis, endogenous cortisol or testosterone and behavioral trading on experimental property markets were analyzed using linear regression separately for men and separately for women traders where each subject provided a unique observation of the dependent variable (mismatch or trade activity).

In the study of cortisol and testosterone, 34 healthy men aged 18 to 30 participated in the study. For the testosterone study, 41 healthy men aged 18 to 30 participated. Participants were hired at the University of Cambridge campus and all the participants were acquired from a volunteer list and on-line advertising.



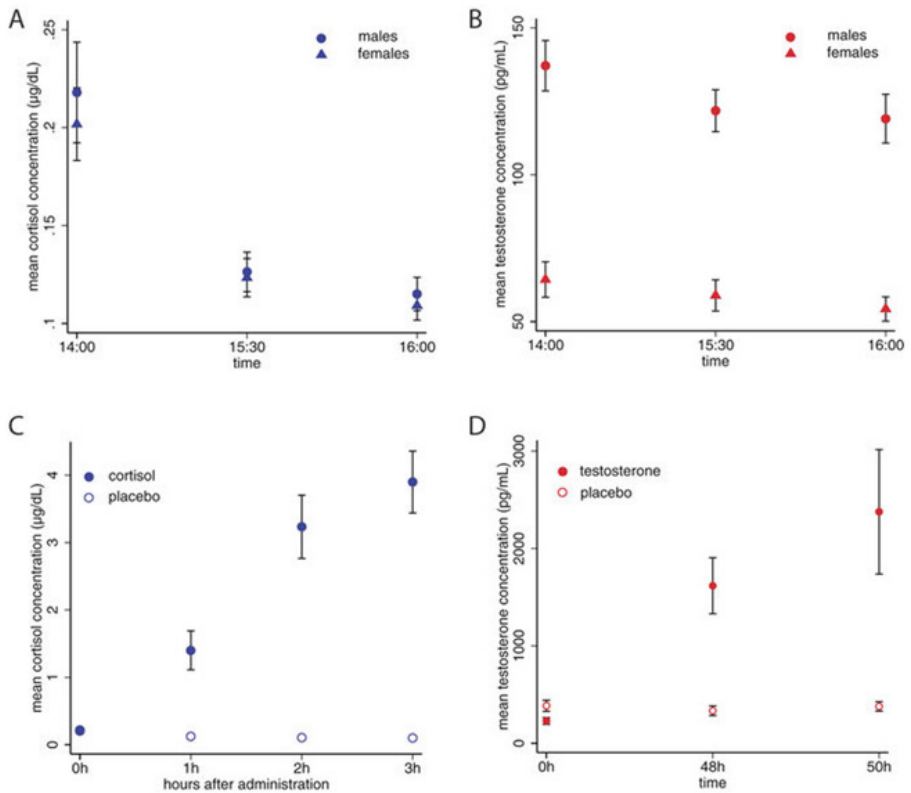
To eliminate any mistakes and reduce the risks of possible interactions by using any hormone, a qualified clinician performed all examinations (blood pressure, height, weight) and remained available during the experiments. All participants had to meet the medical criteria, those who did not satisfy were excluded, hence personal history: cardiac patients, diabetes, high blood pressure, gout, asthma, prostate disorder, kidney damage, neurological or psychological problems (alcoholism, depression, schizophrenia or bipolar disorder) epilepsy, family history of health: history of cardiac arrhythmia or sudden death syndrome, head injury, recent major surgery, smoking, or consuming recreational drugs. In the cortisol study, subjects were examined by Beck's Depression Inventory (BDI) and the Mood Questionnaire Profile (PoM).

In the experiment, a double blind placebo was used which was controlled by balancing the crossover design.

The correlation between hormones (testosterone, cortisol) and behavioral relationships was widely studied among male competitors, and significantly less among women's competitors (studying the members of the nationally recognized women's rugby group 2015). Seventeen players (aged 18 to 22) gave saliva samples 24 hours prior, 20 minutes before and immediately after five league games. Subjects reported aggression, team attachment, state of mind, performance after the game, and whether the opponent was more or less challenging than expected. The results showed that levels of testosterone and cortisol increased in anticipation of matches. Post-game levels of both hormones were higher than pre-game levels. The previous increase in testosterone was associated with this association, aggressiveness and focus, but was not related to the perception of adversarial skill. Changing testosterone during the game was not related to victory or loss, personal performance estimates, or the perception of an opponent's threat. Changes in cortisol games were positively associated with player evaluations whether the opponent was more challenging than expected and negatively related to loss. These results are compared with the patterns of hormone behavior found among male competitors and are interpreted in the recent theory of gender differences in response to the challenges.

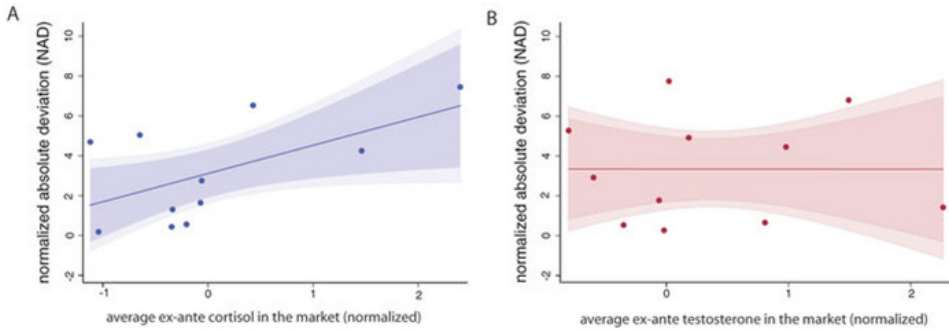
The association between endogenous hormones on the experimental property market investigated natural variations of testosterone and cortisol that predict individual differences in trading behavior and aggregate price stability in real-world markets. The cortisol and testosterone levels were measured before and after each trade session (attached to Figures 1a and b)



**Figure 1. Concentration of salivary hormone**

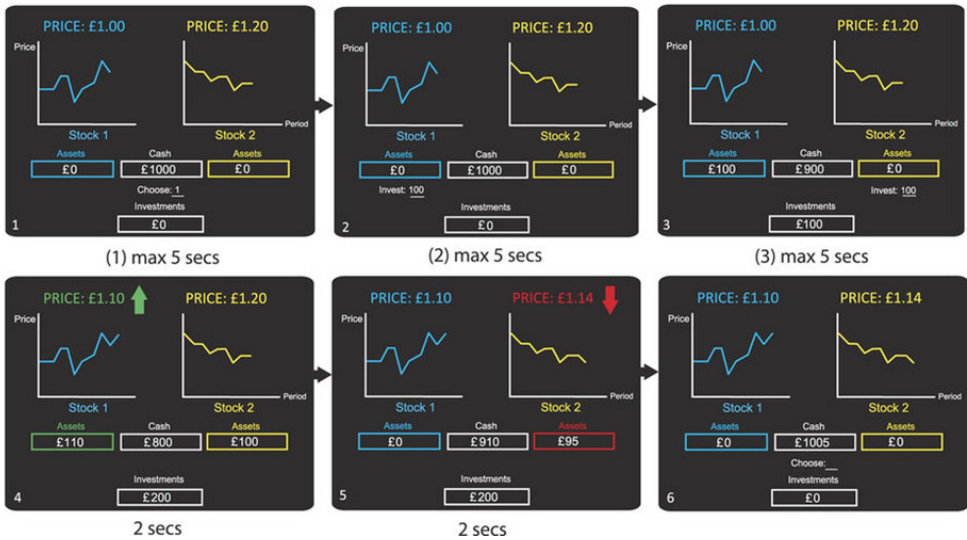
**A** Experiment on the Property Market; The average concentration of cortisol in men and women just before the property market (14:00), right after the property market (15.30) and half an hour later (16:00).

**Figure 2. Aggregate price far from baseline value and ex-average endogenous cortisol (A) and testosterone (B)**



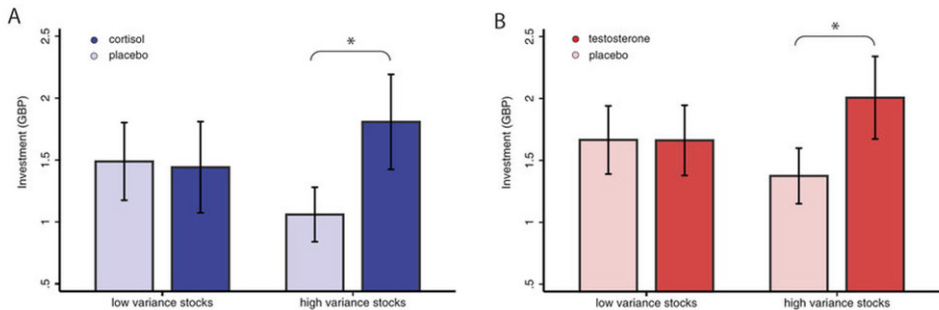
Each point of data represents one market (excluding the market for women only)

**Figure 3. Schematics of a Commercial Task (Hormone Experiments)**



Stock prices and money status are updated as shown.

**Figure 4. From: Cortisol and testosterone increase the financial risk and can destabilize the market.**



Average net investment in low variation and large variance shares. (A) Cortisol administration experiments.

## 5. CONCLUSION AND DISCUSSION

Neuroscience researchers have studied the effects of winning athletes, gamblers, and investors. What did they learn? Winning leads to elevated levels of testosterone, which leads to increased risk taking.

In his book “The Hour Between Dog and Wolf,” a neuroscientist and former merchant derivative John Coates discusses how long-term investment success can undermine the perception of our abilities. According to Coates and other researchers, bull market and market bubbles may arise from a phenomenon known as “The Winning Effect.

It seems that athletes produce a kind of natural narcotics that can turn individual traders - even the financial communities - into extremely self-confident, fearless warriors, shaped for more difficult battles. Each consecutive win supplies a competitor’s brain with more chemicals that cause euphoria, especially testosterone. And every testosterone dose leads to a new rise in confidence and risk taking.

However, as this loop of success, testosterone and aggression accelerates, investors can become overwhelmed with success, making irrational and scrupulous decisions that can lead to disaster.

People have been recognizing the traps of extreme success for centuries. It is said that in old Rome, when a winner would have his triumphal procession through the city, a slave would ride in the carriage with him holding a human skull - called the memento mori, “a reminder to death” - and whispered in the general’s ear: “Remember that you are dead”. The ancient Romans knew that winning lines could sow the seeds of failure. What the Romans did not know was that the knots resulting from winning lines had a chemical base - the same hormone that causes men to grow beard also plays a key role in behaviors such as aggression and domination. In

our history of hunters and collectors, the chemical response of the human brain to success has helped the most powerful men survive to pass on their genes. But the “effect of the winner”, which 100,000 years ago helped human survival, can now stimulate bubbles in financial markets.

In real-time environment, Coates has determined that the morning level of testosterone markets predicts the profitability of the day. He also found that the cortisol of the traders increases with both the variations in its trading results and the volatility of the market. According to Coates, “it is known that testosterone and cortisol have cognitive and behavioral effects, so if elevated steroids continue or increase as volatility increases, they can shift risk preferences and even affect the ability of a trader to engage in rational choice.”

The advanced spiral of the winner’s effect can not last forever. At some point, elevated testosterone begins to have the opposite effect on success and survival. According to Coates, “the animals who have experienced this spiral testosterone and victory spell have been found after some time to fight more and spend more time outdoors, and as a result, mortality rate was increased. As testosterone levels increase, confidence and risk taking lead to the feeling of excessive security and reluctant behavior. “

It is interesting to note that women have about 10-20 percent of testosterone levels of men. Could it be that market gains such as a bitcoin wave (“bubble” if you want) are persecuted primarily by young male investors, partly boosting the winner’s performance and the loop of testosterone recovery? If so, we expect the winning line of testosterone to become the victim of their own success. Then, inevitably losing, other chemicals become prominent - the one that causes traders to focus more on the risk. While testosterone is the hormone of success, cortisol is the hormone of failure.

Cortisol levels raise in the adrenal glands in response to moments of high physical stress, such as “fighting or escaping”. Cortisol prepares us for the possible action by releasing glucose and free fatty acids in the blood. It also suppresses bodily functions that are not needed during a crisis - such as a digestive, reproductive and immune system.

From an evolutionary point of view, cortisol motivates a defeated animal in the Winner’s Effect to retreat and lick its wounds because another clash with the winners can mean death. A series of defeats could result in a cortisol back link loop, causing the loser to become more and more cautious. It is important in humans that cortisol has grown strongly in uncertain situations, such as volatility in financial markets.

In a study published in the National Academy of Sciences Science Proceedings (USA, 2015), researchers have found that elevated cortisol has been found in risk-averse traders. This effect was more pronounced in men than in women. The study concluded that: “Physiologically induced shifts in risk pruning may be insufficiently acknowledged causes of market instability”. Coates calls testosterone “hormone of economic bubbles” and cortisol “hormone of the economic busts”. Those who remember 2009 after the financial crisis (a smaller group) may recall the almost

tangible level of risk aversion of investors after many were defeated by the market. It may be time for traders to copy ancient Romans and put their skulls on their desks beside their computers, so as not to become deceived by the roughness (and hormones) in taking foolish risks. If so, we expect the winning line with testosterone to become the victim of their own success. Then, as the inevitable losing is set, other chemicals become prominent - one that causes traders to focus more on the risk.

It is necessary to refer to the methods and protocols implemented. When researching financial markets for the role of testosterone and cortisol in taking risk and gender differences in time pressure, we encounter various combinations and statistical analyses. Each research carried out in this text has its own weaknesses but also offers a wide range of research opportunities. By applying neuroscientific tools and mathematical methods we can extend the boundaries and enrich the scientific literature. There is a need for interdisciplinary research that provides us with broad insights and enriches economic science.

Professor Joe Herbert, a co-author of "Hormone Therapies May Destabilize Financial Markets" from the Cambridge University Clinical Neuroscience Department, reported in an earlier field study that traders achieved significantly higher profits in days when their morning testosterone levels were above the daily average, and increased profitability variability and market uncertainty were strongly associated with an increase in their cortisol levels.

Man is often a creature of impulse, a feature that has led many times to their own failure. However, apart from the plethora of speculation, science failed to prove the biological reason for this impulsive behavior. A recent study has shown that hormonal changes during stressful situations can directly affect the risky behavior, but only in men.

Excessive value on asset markets is a permanent problem that has undoubtedly led to many harmful and misguided trades. Such information can be particularly useful to policy makers as they try to create a more stable financial institution.

Imagine the world in which people act as computers, consistently taking, analyzing, and responding to all their sensory impressions. These "rational" actors should not show unstable and inconsistent changes in preferences, so their future choices should be predictable on the basis of past behavior. We can hardly imagine such a world because it is not the world we live in. To explain the financial risk taking, theorizing decision makers object to the objective statistical characteristics of the financial possibilities or subjective emotional experience of individuals. Are these different accounts conflicting or complementing and can they be reconciled?

By completing the discussion and the expanding review of the conducted research, the future of finance economics lies in the activating neuroscience and neurofinance tools that can provide a holistic image and thus become the real lever of the experimental economy with new mathematical and statistical methods.

## RODNE RAZLIKE U SKLONOSTI FINANCIJSKOM RIZIKU (ULOGA HORMONA NA FINANCIJSKOM TRŽIŠTU)

Ana Njegovanović

Voćarska 38, 10000 Zagreb, Croatia

Telephone : + 385 95 8855055, e-mail: ana.njegovanovic@gmail.com

### SAŽETAK

*U radu se potiče i istražuje teorijska literatura o relacijama među steroidnim hormonima, preferencijama financijskog rizika i performansama trgovaca (e.g. Dreber and Hoffman, 2007; Garbarino et al., 2011), asocijacijama između cirkulacijske razine testosterona (Apicella et al., 2008; Coates i Page, 2009) te ulogama testosterona i kortizola koji imaju organizacijske i aktivacijske učinke na averziju financijskog rizika kod muškaraca i žena utječući i na njihove karijere s ciljem uvida u to kako promjena ravnoteže spolova trgovaca utječe na njihovu učinkovitost i stabilnost financijskog tržišta. Dosadašnja istraživanja proučavala su učinke biologije i genetike na stavove rizika u spolovima (Sapienza et al., 2009; Barnea et al., 2010). Nasuprot tome, društveni identitet pokazuje stereotipno ponašanje koje društvo pripisuje muškarcima i ženama (Akerlof i Kranton, 2000) te su moguće manipulacije znakovima rodnog identiteta.*

*Heterogene preferencije i uvjerenja imaju velike implikacije na dinamiku tržišta rada (Kilingsworth, 1987), financijska tržišta Garleanu i Panageas i makroekonomiju (Chien et al., 2014). Heterogenost među spolovima osobito je relevantna – svaka skupina uključuje polovicu stanovništva, a postoje sustavne razlike u preferencijama muškaraca i žena što ima velike učinke na ekonomske ishode (Croson i Gneezy, 2009; Dela Vigna et al., 2013; Bertnard et al., 2015).*

**Ključne riječi:** rod; hormoni; učinci endogenog financijskog rizika; neuroekonomija; neuroznanost

## LITERATURE

1. Anderson, R. A., Bancroft, J., Wu, F. C. (1992). The effects of exogenous testosterone and sexuality and mood of normal men. *The Journal of Clinical Endocrinology & Metabolism*, 75(6), 1503–1507.
2. Apicella, C. L., Dreber, A., Campbell, B., Gray, P. B., Hoffman, M., Little, A. C. (2008). Testosterone and financial risk preferences. *Evolution and Human Behavior*, 29(6), 384-390.
3. Archer, J. (2006). Testosterone and human aggression: an evaluation of the challenge hypothesis. *Neuroscience & Biobehavioral Reviews*, 30(3), 319-345.
4. Avery, C., Zemsky, P. (1998). Multidimensional Uncertainty and Herd Behavior in Financial Markets. *The American Economic Review*, 88(4), 724-748.
5. Barber, B. M., Odean, T. (2001). Boys will be boys: gender over confidence and common stock investment. *The Quarterly Journal of Economics*, 116(1), 261-292.
6. Barbieris, N., Shleif, A., Vishny, R. (1998). A model of investor sentiment. *Journal of Financial Economics*, 49, 307-343,
7. Booth, A., Shelly, G., Mazur, A., Tharp, G., Kittok, R. (1989). Testosterone and winning and losing in human competition. *Hormones and Behavior*, 23(4), 556-571.
8. Branas-Garza, P., Capraro, V., Rascon, E. (2016). *Gender differences in Altruism: Expectations, Actual Behaviour and Accuracy of Beliefs*. Preuzeto s <https://ssrn.com/abstract>.
9. Chase, I. D., Bartolomeo, C., Dugatkin, L. A. (1994). Aggressive interactions and inter-contest interval: how long do winners keep winning? *Animal Behaviour*, 48(2), 393-400.
10. Coates, J. M., Gurnell, M., Sarnyai, Z. (2010). From molecule to market: steroid hormones and financial risk- taking. *Philosophical Transactions B*, 365(1538): 331–343.
11. Coates, J. M., Herbert, J. (2008). Endogenous steroids and financial risk-taking on a London trading floor. *Proceedings of the National Academy of Sciences*, 105(16), 6167- 6172.
12. Cueva, C., Roberts, R. E., Spencer, T., Rani, N., Tempest, M., Tobler, P. N., ... Rustichini, A. (2015). Cortisol and testosterone increase financial risk taking and may destabilize markets. *Scientific Reports*, 5, 11206.
13. Cueva, C., Rustichini, A. (2015). Is financial instability male-driven? Gender and cognitive skills in experimental asset markets. *Journal of Economic Behavior and Organization*, 119, 330-344.
14. De Long, J. B., Shleifer, A., Summers, L. H., Valdmann, R. J. (1990). Positive



- feedback investment strategies and destabilizing rational speculation. *The Journal of Finance*, 45(2), 379-395.
15. Dickerson, S. S., Kemeny, M. E. (2004). Acute stressors and cortisol responses: a theoretical integration and synthesis of laboratory research. *Psychological Bulletin*, 130(3). 355-91.
  16. Dreber, A., Hoffman, M. (2007). *Portfolio Selection in Utero*. Stockholm: Mimeo/ Stockholm School of Economics.
  17. Green, C., Jegadeesh, N., Tang, Y. (2009). Gender and job performance: evidence from Wall Street. *Financial Analysts Journal*, 65(6), 65-78.
  18. Greenspan, A. (1996). The Challenge of Central Banking in a Democratic Society. Preuzeto s <https://www.federalreserve.gov/BOARDDOCS/SPEECHES/19961205.htm>
  19. Hu, Y., Wang, D., Pang, K., Xu, G., Guo, J. (2015). The effect of emotion and time pressure on risk decision making. *Journal of Risk Research*, 18(5), 637-650.
  20. Keynes, J. M. (1936). *The general theory of employment interest and money*. London: Macmilland and co.
  21. Mazur, A., Booth, A. (1998). Testosterone and dominance in men. *Behav Brain Sci*, 21(3), 353-363.
  22. Putman, P., Hermans, E. J., Koppeschaar, H., Van Schijndel, A., Van Honk, J. A. (2007). Single administration of cortisol acutely reduces preconscious attention for fear in anxious young men. *Psychoneuroendocrinology* 32(7), 793-702.
  23. Sapienza, P., Zingales, L., Meastripiet, D. (2009). Gender differences in financial risk aversion and and career choices are affected by testosterone. *Proceedings of the National Academy of Sciences*, 106(36), 15268-15273
  24. Shiller, R. J., Akerlof, G. A. (2009). *Animal Spirits: How Human Psychology Drives the Economy, and Why it Matters for Global Capitalism*. Princeton: Princeton University Press.
  25. Van Wingen, G., Mattern, C., Verkes R. J., Buitelaar, J., Fernandez, G. (2010). Testosterone reduces amygdala - orbitofrontal cortex coupling. *Psychoneuroendocrinology*, 35, 105-113.