The Impact of Testosterone on Financial Risk Tolerance

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Abstract: This study aims to examine the relationship between gender and financial risk tolerance. A mixed (qualitative and quantitative) approach was adopted with 100 respondents consisting of 63 Moroccan men and 37 Moroccan women, aged between 18 and 47 years. The analysis of the responses to the questionnaire based on the risk tolerance question of The Survey Of Consumer Finances, demonstrated that men have a higher risk tolerance than women and that there is a relationship between gender and individuals' attitude toward risk. The results of the questionnaire show that 78.37% of the women surveyed have no tolerance for risk and only 21.62% of women are more tolerant of financial risk. While 35 men in our sample are willing to take significant financial risks and only 11 men prefer not to take any. Otherwise, 23.81% of the men surveyed are intolerant of financial risk and 76.19% are more tolerant of financial risk. The regression analysis examined the relationship between testosterone levels in the sample and financial risk tolerance. It was found that there was a positive relationship between the two variables. However, the study reveals that testosterone is not the only factor that could explain excessive risk-taking and thatother variables can also explain financial risk tolerance.

Keywords: Testosterone, Gender, Risk Tolerance

1. Introduction

After the crisis of 2008, a lot of thought went into the collapse of the American bank Lehman Brothers. Several experts could not understand how large banks subject to rigorous regulation and careful monitoring could have taken such high levels of risk. Several explanatory factors were detected. Some accused the homogeneity of the banks' governance bodies, which were often led by a profile with typical characteristics. They are usually white men coming from the same academic background. This explanation of the crisis considers that these similar profiles generate similar reasoning. Otherwise, the similarity of the profiles of the leaders leads to a similarity in the decisions they make and causes mimetic behavior.

It is in this perspective that gender diversity is strongly recommended and especially after the words of the Managing Director of the International Monetary Fund (IMF) Christine Lagarde who seized the opportunity of 10 years after the subprime crisis to announce that "If Lehman Brothers had been called "Lehman Sisters", the situation of banks in 2008 would have been very different (Ferrary, 2019).

This reflection is rooted in the common stereotype that considers women to be more risk-averse than men [1].

2. Conceptual Framework

2.1. Financial Risk Tolerance

According to Cupples et al. (2013), financial risk tolerance is the maximum level of uncertainty that an individual can accept when faced with a financial decision that may bring adverse outcomes [2].

It is defined according to Grable (2016) as a person's intention to achieve a goal that is characterized by uncertainty and that can lead to a potential loss [3].

2.2. Gender and Sex

There is a difference between the term gender and sex. According to the WHO, the term sex refers to the biological and physiological characteristics that make the difference

between men and women. While the term gender represents the societal difference between women and men [4].

2.3. Testosterone

Testosterone is a hormone found in humans and some animals. In men, this hormone is produced by the testicles. In women, this hormone is present in smaller quantities and is produced by the ovaries [5].

3. Literature Review: The Relation Between Testosterone and Financial Decision Making

Several studies have focused on exploring the different factors that can explain financial risk tolerance among individuals. The most common determinants found by researchers are gender, age, marital status, number of dependents, income, wealth, education, and financial knowledge [6].

Gender has also been found to be an important differentiating factor in the classification of risk tolerance, as women have consistently been shown to have a lower preference for risk than men.

Fisher and Yao (2017) conducted a study to examine gender differences in financial risk tolerance. The result of the study showed that women are less risk tolerant than men and this is explained according to the authors by the difference that exists between the individual characteristics of men and women [7].

Since all previous studies have focused on the difference between single women and single men in terms of financial risk tolerance. In their paper, Yao and Hanna (2005) explored the effect of gender and marital status on financial risk tolerance. To do so, they conducted their study among 24037 households between the period of 1983 and 2001 using all SCF cross-sectional surveys. The results of the study showed that financial risk tolerance is highest among single men, followed by married men, then single women, and married women. Their findings were explained by the fact that women are not educated to take financial risks, and they need to pay more attention to this aspect to finance their lives, which are on average longer than men's [8].

Hallahan; Faff and McKenzie (2003) conducted a cross-sectional regression analysis on a total of 3003 individuals to examine the effect of certain demographic factors on risk tolerance. Their results indicate that gender is an important determinant of an individual's risk-taking behavior and that women are less risk-tolerant than men [9].

The same result was demonstrated by Cupples, Rasure and Grable (2013), who attempted to observe whether in the United States, the level of education was responsible for the relationship between gender and financial risk tolerance. Using a sample of 249 people, they proved that there is a negative relationship between financial risk tolerance and being a woman. These results are explained by the researchers through the educational aspect. Indeed, they consider that education promotes certain skills in individuals such as calculation, analysis, evaluation and choice of decisions involving a level of risk.

In a more sophisticated study, Zhong and Xiao (1995) sought to understand the specifics of stock and bond ownership among 3,143 households using data from the Survey of Consumer Finances. The results showed that women were less attracted to investing in stocks or bonds and that male-headed households held more bonds than female-headed households [10].

In the same area of thought, Dwyer et al (2002) attempted to explore the effect of investor gender on risk-taking. Their survey of 2,000 mutual fund investors found that men are likely to take more risks in their investment decisions than women. This result is explained by gender gaps in knowledge about financial markets [11].

In a study conducted in South Africa, Dickason and Ferreira (2018) profiled the South African investor by the level of risk they tolerate based on age and gender. The study was conducted with 600 investors and proved that male investors have a higher level of financial risk tolerance than female investors [12].

In a study of the determinants of risk-taking, Coet and McDermott (1979) found that all-male groups exhibited more risky behavior than all-female groups. These results are explained by stereotypical gender roles [13].

Indeed, studies on the impact of gender on financial risk tolerance have taken on a dimension other than simply measuring financial risk in men and women through quantitative and qualitative approaches. There is now a particular interest in the biological aspect of risk-taking, and in particular in hormones and specifically testosterone [14].

This is the background to the study by Coates and Herbert (2008), who measured the testosterone levels of a group of London-based traders, consisting of 17 men, for 8 days under normal working conditions. They found that on days when testosterone levels were higher than the median level, traders achieved a higher level of profitability than on days when their testosterone levels were below the median. These results demonstrate the role of testosterone in the rationality of the choices a trader can make as well as their risk preferences [15].

In more advanced research, Apicella et al (2008) examine the relationship between prenatal testosterone exposure measured by the 2D:4D ratio, pubertal testosterone exposure represented by facial masculinity, circulating testosterone, and financial risk preferences for a sample of 98 men. They found that risk-taking was positively associated with testosterone and with pubertal hormone exposure. However, prenatal hormone exposure had no significant impact on risk preferences. Otherwise, men with high testosterone levels and a masculine appearance tend to take more financial risks than others.

The authors explain these results by the fact that women prefer rich partners, so men seek to maximize their income to attract women. To do this, they engage in risky financial investments with the possibility of potential gains. Another

explanation advanced by the researchers is that testosterone stimulates competitive behavior in men, and in this way if the financial risk is seen as a competitive aspect, men with high levels of testosterone can take more risks [16].

Based on a Colombian population of 89 men and 34 women, Chicaiza-Becerra, L. A., & Garcia-Molina, M. (2017) experimented with the association of testosterone (represented by the 2D:4D ratio and the rel2 ratio) with financial risk (represented by the choice of a lottery with real payoffs). Results displayed that participants with high testosterone exposure favor high-risk lotteries [17].

For the benefit of a sample composed of investors, Nofsinger, Patterson, and Shank (2018) sought to trace a link between the cortisol hormone, testosterone, and risk-taking.

The study points out that the higher the level of testosterone, the riskier the investors' portfolios. In addition, they find that testosterone levels are likely to increase when the environment becomes competitive, which explains risk-taking in such circumstances [18].

For Stanton et al (2011) and based on 154 participants (78 men and 76 women). The results were different. Indeed, they found that men and women with high testosterone levels tend to favor risky decisions. In this way, the effect of testosterone on risk-taking is similar for men and women, but the effect is more pronounced for women [19].

Sapienza et al (2009) observed the variation in risk-taking in a sample of over 500 MBA students as a function of variation in testosterone. They found that this hormone was positively related to high-risk tolerance in women but not in men. This unexpected result was explained by the specifics of the population studied [20].

Following a different approach and to study the role of testosterone in risk-taking, Zethraeus et al. (2009) randomly administered treatment with estrogen, testosterone, or placebo to 200 postmenopausal women for four weeks. Towards the end of the treatment, the participants collaborated in several experiments assessing economic preferences including risk tolerance. The results showed that there is no significant impact of hormones on the elements studied [21].

4. Methodology

To explore the relationship between testosterone and financial risk-taking, we opted for a mixed approach (qualitative and quantitative) based on a questionnaire. We used the famous risk tolerance question from The Survey Of Consumer Finances, which is widely used by financial experts and researchers. This question allows us to examine the attitude of individuals towards financial risk.

It is phrased as follows:

"Which of the following statements on this page comes closest to the amount of financial risk that you are willing to take when you save or make investments?
1. *take substantial financial risk expecting to earn substantial returns;*
2. *take above average financial risk expecting to earn above average returns;*
3. *take average financial risk expecting to earn aver age returns;*
4. *not willing to take any financial risk." [22].*

Before distributing our questionnaire, we took a testosterone sample from 120 people and selected a sample of 100 people consisting of 63 Moroccan men and 37 Moroccan women, aged between 18 and 47 years and whose testosterone levels vary between 20 and 28 nmol in men and 1 to 2 nmol in women. These constitute the group for the questionnaire.

5. Data Analysis

5.1. Qualitative Study

To determine the impact of testosterone on financial risk tolerance, we performed a cross-tabulation in the form of a contingency table with XLSTAT, from which we obtained the following results:

Table 1. Contingency table.

Gender	Risk Tolerance	Number	Proportion
Women	not willing to take any financial risk	14	0,140
	take substantial financial risk	1	0,010
	take above average financial risk	7	0,070
	take average financial risk	15	0,150
Men	not willing to take any financial risk	11	0,110
	take substantial financial risk	35	0,350
	take above average financial risk	13	0,130
	take average financial risk	4	0,040

Realized with XLSTAT.

The table above shows that only one woman in our sample is willing to take significant financial risks, 14 women prefer not to take risks and 15 can take medium risks. This means that 78.37% of the women surveyed have no risk tolerance and only 21.62% of the women are more tolerant of financial risk. Whereas 35 men in our sample are willing to take significant financial risks and only 11 men prefer not to take any. Otherwise, 23.81% of the men surveyed are intolerant of financial risk and 76.19% are more tolerant of financial risk.

To confirm our results, we conducted a multiple correspondence analysis to study the association between the two variables (level of risk tolerance and gender).
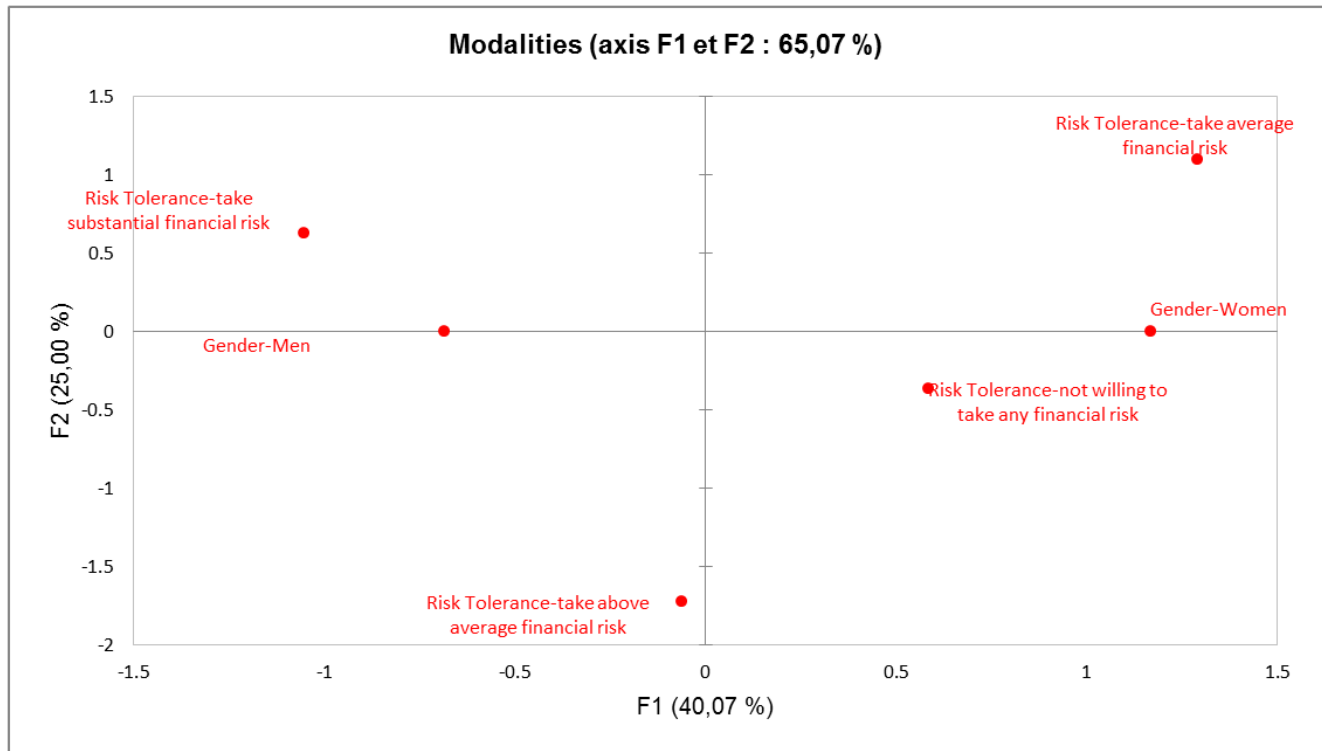
Figure 1. *Multiple Correspondence Analysis.*

The graph above shows that we have two distinct groups, the first category includes the variable "Women" with the two risk tolerance modalities "take average financial risk" and "not willing to take any financial risk". The second category includes the variable "Men" with the modality "take substantial financial risk".

To assess the relationship between the rows and colums of the contingency table, a test of independence between the rows and colums was performed. The following tables display the results associates with the Chi-square test and Fisher's exact test.

Table 2. *Test of independence between rows and colums (Gender/Risk Tolerance).*

Khi² (Observed value)	36,336
Khi² (Critical value)	7,815
DDL	3
p-value	<0,0001
Alpha	0,050

Realized with XLSTAT.

Table 3. *Fisher's exact test.*

p-value (bilateral)	<0,0001
Alpha	0,050

Realized with XLSTAT.

The results show that the p-value (<0.0001) is below the 0.05 significance level. Thus, the null hypothesis that gender and risk tolerance are independent variables is rejected. Therefore, there is a relationship between gender and financial risk tolerance.

5.2. Quantitative Study

At this level, we were able to demonstrate through the qualitative study that there is a relationship between the gender variable and the risk level variable. For further clarification and to determine the nature of this relationship, we conducted a second quantitative study based on a regression analysis, in which we examined the impact of testosterone level on risk tolerance. Thus, the dependent variable is represented by financial risk tolerance and the independent variable is the testosterone level.

To quantify our financial risk tolerance variable, we assigned risk levels according to the following scale:

1) take substantial financial risk: 4;
2) take above average financial risk: 3;
3) take average financial risk: 2;
4) not willing to take any financial risk: 1.

Table 4. *Descriptive statistics.*

Variable	Observations	Min	Max	Mean	Standard deviation
Risk Tolerance	100	1,000	4,000	2,670	1,207
Testosterone levels	100	1,006	27,827	15,743	11,174

The descriptive statistics table displays the mean of the testosterone level of our sample, which is 15.743. This same variable displays a standard deviation of 11.174, a maximum value of 27.827 and a minimum of 1.006.

In terms of the dependent variable, financial risk tolerance has a mean of 2.670 and a standard deviation of 1.207. A maximum value of 4 and a minimum value of 1.

Table 5. Correlation matrix.

	Testosterone levels	Risk Tolerance
Testosterone levels	1	0,512
Risk Tolerance	0,512	1

In terms of correlation, the table above shows that a positive linear relationship exists between testosterone level and risk tolerance. This indicates that as testosterone levels increase, risk tolerance increases.

Table 6. Table Adjustment Coefficients (Risk Tolerance).

Observations	100
Sum of weights	100
DDL	98
R²	0,262
R² adjusted	0,254
MCE	1,085
RMCE	1,042
MAPE	50,254
DW	1,389
Cp	2,000
AIC	10,169
SBC	15,380
PC	0,768

The table of adjustment coefficients shows that 26.2% of the variability in risk tolerance is explained by testosterone level. The rest of the variability is due to effects (other explanatory variables) that are not taken into account in this study.

Table 7. Analysis of Variance (Risk Tolerance).

Source	DDL	Sum of squares	Average of squares	F	Pr > F
Model	1	37,746	37,746	34,778	<0,0001
Error	98	106,364	1,085		
Total corrected	99	144,110			

Computed against the model Y=Average (Y).

The analysis of the variance table above shows that the probability associated with the F, in this case, is less than 0.0001, which means that we take a risk of being wrong of less than 0.01% in concluding that the explanatory variable brings a significant amount of information to the model.

Thus, the model parameters are as follows:

Table 8. Model parameters (Risk Tolerance).

Source	Value	Standard error	T	Pr > |t|	Lower terminal (95%)	Upper terminal (95%)
Constant	1,800	0,181	9,967	<0,0001	1,442	2,158
Testosterone levels	0,055	0,009	5,897	<0,0001	0,037	0,074

This allows us to formulate the model according to the following equation:

Risk Tolerance = 1,80005010244606 + 5,52596963608698E - 02* Testosterone levels

The model indicates that within the range of variation of the testosterone level variable given by the observations, every time testosterone level increases by one unit, risk tolerance increases by 0.055.

6. Conclusions and Discussion

The results of this study show that the effect of testosterone on financial risk tolerance is positive. Therefore, since men have high levels of testosterone, this means that they have a strong preference for risk-taking, unlike women. These results are in agreement with most previous studies. These findings are explained by the nature of the hormone, as testosterone is associated with power, fear reduction, social competition, and dominance behaviors. As a result, men with high levels of testosterone seem to perceive risky behaviors as a form of gaining social status.

However, women take less risk than men and are not attracted to excessive financial risk-taking. This result can be explained not only by the biological aspect but also by the ideas anchored by society that make some women unable to leave their comfort zones in various contexts. This risk aversion on the part of women can also be explained by how some women were educated and which enabled them to avoid any type of risk or danger.

Policymakers should consider women's thoughtful and cautious risk-taking to include them in financial stability research programs. Governments should encourage the involvement of women in decision-making, which can reduce risky behavior in the financial sector and limit the occurrence of many cases of distress and failure.

References

[1]   Croson, R., & Gneezy, U. (2009). Gender differences in preferences. *Journal of Economic literature*, *47* (2), 448-74.

[2] Cupples, S., Rasure, E., & Grable, J. (2013). Educational achievement as a mediator between gender and financial risk tolerance: An exploratory study. Ewha Journal of Social Sciences, 29 (1).

[3] Grable, J. E. (2016). *Financial Risk Tolerance. Handbook of Consumer Finance Research, 19–31.*

[4] https://www.coe.int/fr/web/gender-matters/sex-and-gender

[5] https://webcache.googleusercontent.com/search?q=cache:fvz0nS AMplkJ:https://www.healthline.com/health/what-is-testosterone+&cd=1&hl=fr&ct=clnk&gl=ma&client=firefox-b-d

[6] Gibson, R. J., Michayluk, D., & Van de Venter, G. (2013). Financial risk tolerance: An analysis of unexplored factors. *Financial Services Review*.

[7] Fisher, P. J., & Yao, R. (2017). *Gender differences in financial risk tolerance. Journal of Economic Psychology, 61, 191–202.*

[8] Yao, R., & Hanna, S. D. (2005). The effect of gender and marital status on financial risk tolerance.

[9] Hallahan, T., Faff, R., & McKenzie, M. (2003). *An exploratory investigation of the relation between risk tolerance scores and demographic characteristics. Journal of Multinational Financial Management, 13 (4-5), 483–502.*

[10] Zhong, L. X., & Xiao, J. J. (1995). Determinants of family bond and stock holdings.

[11] Dwyer, P. D., Gilkeson, J. H., & List, J. A. (2002). Gender differences in revealed.

[12] Dickason, Z., & Ferreira, S. J. (2018). The effect of age and gender on financial risk tolerance of South African investors. *Investment Management and Financial Innovations, 15* (2), 1-8.

[13] Coet, L. J., & McDermott, P. J. (1979). *Sex, Instructional Set, and Group Make-up: Organismic and Situational Factors Influencing Risk-Taking. Psychological Reports, 44 (3_suppl), 1283–1294.*

[14] Price, L. F. (2005). The Biology of Risk Taking. *Educational Leadership*, *62* (7), 22-26.

[15] 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.

[16] 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.

[17] Chicaiza-Becerra, L. A., & Garcia-Molina, M. (2017). *Prenatal testosterone predicts financial risk taking: Evidence from Latin America. Personality and Individual Differences, 116, 32–37.*

[18] Nofsinger, J. R., Patterson, F. M., & Shank, C. A. (2018). *Decision-making, financial risk aversion, and behavioral biases: The role of testosterone and stress. Economics & Human Biology, 29, 1–16.*

[19] Stanton, S. J., Liening, S. H., & Schultheiss, O. C. (2011). *Testosterone is positively associated with risk taking in the Iowa Gambling Task. Hormones and Behavior, 59 (2), 252–256.*

[20] Sapienza, P., Zingales, L., & Maestripieri, D. (2009). Gender differences in financial risk aversion and career choices are affected by testosterone. *Proceedings of the National Academy of Sciences*, *106* (36), 15268-15273.

[21] Zethraeus, N., Kocoska-Maras, L., Ellingsen, T., Von Schoultz, B. O., Hirschberg, A. L., & Johannesson, M. (2009). A randomized trial of the effect of estrogen and testosterone on economic behavior. *Proceedings of the National Academy of Sciences*, *106* (16), 6535-6538.

[22] Gilliam, J., Chatterjee, S., & Grable, J. (2010). Measuring the perception of financial risk tolerance: A tale of two measures. *Journal of Financial Counseling and Planning*, *21* (2).