

Do Individual Investors Trade Differently in Different Markets?

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Abstract

We investigate the hypothesis that the same investors trade differently in different financial markets. We use a proprietary data base with the transaction records of 129,461 investors for a 10-year period, and select the investors holding both stocks and warrants in the portfolio. We compare the trading behavior of investors in the stock market and in the warrant market, controlling for investors' sociodemographic characteristics (age, occupation, education, etc.) and for investors' behavioral biases (overconfidence, the disposition effect and pursuit of the pleasure of gambling).

Even though investors are the same in both markets, our results clearly show that the determinants of the trading activity in stocks and in warrants are not all the same, implying that the same investors trade stocks differently than warrants. More precisely, overconfident investors have a higher warrant trading activity and a lower domestic stock trading activity, and investors pursuing gambling pleasure or prone to the disposition effect trade warrants more (but do not trade stocks more).

Keywords: Behavioral finance; Individual investor; Stocks; Warrants

JEL Classification: G02; G11; G12; G41

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1. Introduction

In this paper we investigate the hypothesis that investors trade differently in different financial markets. More precisely, we compare the trading activity of a group of investors holding both stocks and warrants in their portfolio. We are particularly interested in studying whether investors with certain financial behavioral biases trade differently in different financial markets (i.e., the stock market and the warrant market).

Investors do not always behave rationally when making investment decisions and display many behavior biases that influence their investment decision-making processes. Because of these biases, investors can make suboptimal investment decisions that may seriously harm their wealth. Some biases stem from a variety of factors and not only from one type of heuristic simplification. Overconfidence is probably the most widely studied behavioral bias of this type. Defined as the tendency to overestimate one's knowledge, abilities or the precision of the information we possess, as well as one's capacity to estimate future events or to control them, overconfidence seems likely to be a key factor in financial decision-making. The tendency for individual investors to overestimate their ability to trade (the *better than average* effect) has been well-documented and seems to be a regular trait of the individual investor profile (Daniel and Hirshleifer 2015). However, because overconfidence is not directly observable in the financial markets it is frequently apprehended by its consequences, such as the individual investor tendency to overtrade. Barber and Odean (2000) analyzed how active trading affects the overall performance of investors and concluded that the more actively investors trade the more they lose.

Another well-documented individual investor bias is the tendency to sell winners too soon and to keep losers too long. Behavioral finance explains this disposition effect by loss aversion, or by the fact that individuals dislike admitting that past purchases were mistakes (Chang et al, 2016), or by the fact that people's ability to learn from news depends on whether the news confirms these individuals' prior investment decisions (Kuhnen and Miu 2017). This individual investor bias has been documented for American investors (Odean 1998), for Finland (Grinblatt and Keloharju 2001), and for China (Feng and Seasholes 2005).

The pursuit of gambling pleasure is another key factor in financial decision-making. Investors with a stronger propensity to gamble exhibit a strong preference for riskier assets (lottery-like stocks, Kumar 2009a) and for assets which present lottery like pay-offs (such as turbos and warrants, with low probability of a very high gain, Célérier and Vallée 2013), and trade more frequently (Hoffmann and Shefrin 2011, Grinblatt and Keloharju 2009). Dorn and Sengmueller (2009) conclude that 98% of German discount brokerage investors report that they “enjoy investing”, and that 45% “enjoy taking risky positions”. Investors who report enjoying investing or gambling hold more concentrated portfolios and turn over their portfolio at twice the rate of their peers (Dorn and Sengmueller 2009).

The above-mentioned financial biases are personal characteristics that affect the participation and the trading behavior of investors. The hypothesis discussed here is that the investor’s decision to participate in a specific financial market and to trade a specific financial asset is also influenced by the specificity of that market and the singularity of the financial products. In other words, we test the hypothesis that the same investor behaves differently in different contexts, the context being defined by the market and the financial instrument characteristics.

The impact of framing on individual decision-making has been recognized since the first works of Kahneman and Tversky (1979) and Tversky and Kahneman (1982) on prospect theory. People respond to a particular choice in different ways, depending on how the choice is presented. For instance, risk behavior is dependent on context. We tend to avoid risk when the choice is presented in a positive frame and seek risk when the choice is presented in a negative frame. People tend to display risk-aversion in the domain of gains and are risk seekers in the domain of losses.

While the importance of framing in the context of portfolio choice has been predicted in the behavioral finance literature (e.g., Barberis et al. 2006), few empirical works beyond laboratory experiments affirm the importance of framing on individual financial investment decisions. Goetzman and Kumar (2008) study portfolio diversification decisions and whether some investors under-diversify because they examine the risks of individual stocks too narrowly. Closer to our work, Blackburn et al. (2014) study a sample of individual trading accounts in growth fund shares and in value fund shares, and conclude that investor’s attitude towards risk depends on the characteristics of the securities being traded.

We add to the literature regarding individual investor behavior, studying the extent to which the context (represented by the specific characteristics of two types of financial assets - stocks and warrants -, namely the complexity of the asset) has an influence on the trading behavior of individual investors. From a theoretical standpoint, if one assumes that investors are boundedly rational, then asset complexity is relevant insofar as it bounds the ability of investors to accurately value assets (Carlin et al. 2013) and may drive how assets are traded. Additionally, more information is not a solution for it may lead to information overload, and thus it does not necessarily help investors make well-informed investment decisions (Brunnermeier and Oehmke 2009). Arora et al. (2011) show that the computational complexity of derivative instruments may amplify adverse selection between buyers and sellers. Moreover, investors are more likely to use heuristics and rules of thumb when they face more difficult problems, and these lead to decisions which are often associated with stronger behavioral biases. For example, overconfidence tends to be stronger when people make decisions in relatively more difficult environments (Griffin and Tversky 1992). Kumar (2009b) finds that individual investors exhibit stronger disposition and overconfidence biases when stocks are more difficult to value, which goes hand-in-hand with the conclusions of the theoretical behavioral finance models of Daniel et al. (1998, 2001). We extend this reasoning to a particular derivative instrument, and test whether the impact of individual investor biases is stronger when he trades warrants, which are more complex financial instruments and in general are more difficult to value than stocks.

To test this proposition, we use a proprietary data base with the transaction records of 129,461 investors for the period from January 1997 to September 2006, and select the investors holding both stock and warrants in their portfolio. We compare the trading behavior of those investors in both markets, controlling for investors' sociodemographic characteristics (age, occupation, education, etc.) and for investors' behavioral biases (overconfidence, the disposition effect and the pursuit of gambling pleasure).

The Portuguese warrant market has been considered one that had the largest growth in the early years of this millennium. This contributes to making the Portuguese market a strong candidate to conduct an investigation on the characterization of the investors' trading behavior in warrants, a complex financial product, in contrast to the trading behavior in stocks, a more traditional and easier to understand financial product.

Our results clearly show that investors behave differently in different financial markets. First, the analysis of the factors that leads investors to participate in the market for warrants shows that the sociodemographic determinants are different from those leading them to participate in the stock market. Secondly, the analysis of the trading behavior of the same group of investors in the warrant market and in the stock market shows that those investors behave differently in different markets. More precisely, overconfident investors have a higher warrant trading activity and a lower domestic stock trading activity, and investors searching for the pleasure of gambling or prone to the disposition effect trade warrants more (but do not trade stocks more). These results are robust in considering investors' financial literacy, the investors' past performance in the stock market, the time span during which the investor is active in the market and the inclusion of a series of control variables regarding investors' financial profile (time deposits, mortgages and consumer loans). Our results are original, since, as far as we know, this is the first study to address individual investor's dissimilar trading behavior in different financial instruments.

The study is structured as follows: The next section provides a brief description of the Portuguese market and describes the database used. In section 3 a probit model is used to allow distinguishing the characteristics of warrant investors among the characteristics of other investors and evaluate the influence of some behavioral biases on the decision to participate in this market. The fourth section compares the investors' trading activity in the market for warrants and in the stock market. In the last section some final conclusions are drawn.

2. The database

2.1. The Portuguese market

Detachable warrants came into Portuguese legislation in 1988.¹ Under this regulation, bonds may have detachable warrants, and the bondholder has a warrant that confers on him the right to acquire shares at a price under predetermined conditions. This warrant is

¹ Decree-Law N^o 229 B/88 (July 4th). The first issue of detachable warrants in Portugal was led by the Banco Comercial de Macau, in 1990.

detached from the bond and can be freely traded on the stock market regardless of the bond it was detached from.

The legal framework of covered warrants was established in 1999.² Covered warrants are financial instruments that confer on the holder the right to a specific underlying asset. The warrant can confer the right to buy, sell or to subscribe to the underlying asset, or to receive a cash difference between the price of the underlying asset at the exercise date and the exercise price of the warrant. This right can be exercised on the maturity date or before that date, at a specific exercise price determined under the conditions of issue. The main features of covered warrants are the inherent right to buy or sell the underlying asset (which may be shares, bonds, stock indices, interest or exchange rates, among others), the exercise price (price at which one has the right to buy or sell the underlying asset), parity (number of warrants equal to one unit of the underlying asset), time of exercise (in the American type the holder can exercise this right at any time, from acquisition to maturity date; in the European type the owner can only exercise this right at maturity), the activation of the exercise (the exercise at maturity date can be automatic or not; if it is not automatic, the holder has to declare his intentions of exercising his right and if he does not do so his rights expire without being exercised) and the type of settlement (physical, if the right holder receives, subscribes to or delivers the underlying asset by paying the exercise price; financial, if exercising the right gives rise to payment by the issuer of the warrant in the amount corresponding to the difference, if positive, between i) the market price of the underlying asset at the exercise date and the exercise price, multiplied by parity, in the case of call warrants; ii) the exercise price and the market price of the underlying asset at exercise date, multiplied by parity, in the case of put warrants).

There are multiple factors influencing the value of a warrant. Among them is the price of the underlying asset and its volatility, the exercise price, parity, time to maturity, the interest rate for the period of maturity and dividends. It is not surprising, therefore, that covered warrants are a much more complex financial instrument than stocks and bonds, and it is to be expected that warrant investors would have a better knowledge of financial matters than other investors do. Moreover, it is expected that an investor in this financial

² Decree-Law Nº 172/99 (May 20th) and Regulation CMVM Nº 19/99 (November 10th). The first issue of covered warrants (Net B@nco PSI-20) was led by Banco Santander, in September 2000.

instrument is more risk tolerant or is even a risk seeker, given that uncertainty about the future trend of the price of the underlying asset and price volatility, together with substantial financial leverage, clearly increase the risks of this type of investment.

The Portuguese market for warrants witnessed substantial growth in the early years of this millennium, and investors traded very actively. According to the annual reports of the CMVM (the Portuguese Securities Commission), between 2000 and 2009 the average annual value of transactions in warrants in the secondary market was around 1,210 million euros, representing 2.1% of the annual average value traded in the secondary market in the same period (excluding public debt negotiation). Moreover, between 2005 and 2009 the share of orders received (by financial intermediaries registered with the CMVM for the business of taking orders on behalf of others) on warrants from resident non-institutional investors accounted for about 77% of total orders received on warrants, which means that the importance of individual investors in this market segment is very relevant.³

2.2. The data

The main database used in this study is proprietary and contains information from one of the top three financial intermediaries in Portugal. The information relates to the accounts of individual investors that were active in late September 2006 and includes sociodemographic data (marital status, birth date, gender, education, occupation and residence) on the first account holder and on time deposits, consumer loans and mortgages associated with the account holders. In addition, information on all transactions in financial instruments linked to these accounts was obtained for the period from the 2nd of January 1997 to the 16th of September 2006. This information includes the date of the transaction, the transaction type (purchase or sale), the ISIN code and description of the financial instrument, the quantity traded and the instrument price.

In the period of about ten years covered by the database, 3,620 investors traded warrants and 491,540 investors traded stocks. This means that for every 136 equity investors only one investor traded warrants, which means that the market of this derivative

³ See Mendes (2012).

financial instrument is composed of a very tiny percentage of the Portuguese population.⁴ This may reflect the privatization programs carried out by successive governments (which was somehow associated with the term 'popular capitalism') which led many Portuguese families to invest in the stock of firms being privatized during this period, as well as the greater complexity of warrants (in comparison with stocks) that discouraged investment in this financial instrument.

It is not surprising, therefore, that in the period covered by the database the total number of stock trades (3,813,845) is much greater than the warrant trades (210,958), or that the average number per investor is 58.3/7.8 trades in warrants/stocks.⁵ Indeed, many investors had their first contact with the stock market following the privatization of state-owned firms, but acquired the shares in a purely buy-and-hold strategy or sold them later without having invested in new stocks. On the contrary, the greater complexity of warrants may have led some investors to specialize in this financial instrument and consequently to be much more active, buying and selling on market expectations that they had regarding the future prices of the underlying assets.

The activity of Portuguese investors in warrants is illustrated in our sample by the size of the average trade (11,121 and 6,555 for trades in warrants and stocks, respectively)⁶ and the value of the average trade (3,884 euros and 1,860 euros, respectively, for trades in warrants and stocks). The average number of warrants/stocks traded by investors is 9.4/3.2 and the maximum is 258/96, again confirming the higher activity of warrant investors.⁷

A second database is also used in this study. It is a survey which was publicly released in May 2005 on the CMVM website.⁸ More than fifteen thousand individuals were contacted and the identified investors in securities (1,559) were interviewed. Each

⁴ The percentage of warrant investors is far lower than reported in Hong Kong. According to SFC (2006), 12.6% of individual investors (those who are over 18 years-old and invest in at least one of the following assets: stocks, mutual funds, bonds, derivatives, structured products and others) had made transactions in warrants.

⁵ In the database used by Schmitz and Weber (2012) the average investor made 55 transactions in warrants. However, the time period covered is only 51 months, shorter than what is used in this study.

⁶ The fact that warrants have a higher leverage than stocks also contributes to the higher average quantity per trade.

⁷ This may also result from the fact that warrants are more tailor-made financial instruments than stocks.

⁸ This is a survey conducted by the CMVM between 2nd October 2000 and 22nd December 2000, aimed at identifying the characteristics of individual investors. The direct interview technique and a structured questionnaire were used. The survey identifies an investor in securities as one holding one or more of the following assets: stocks, bonds, mutual funds, participation certificates and derivatives.

questionnaire included sociodemographic questions, questions related to the nature and type of the assets held by the investor and investor experience, but there were no questions related to the size of the portfolio, nor the amounts invested in each type of asset. It also included questions related to investor's trading behaviour (frequency of transactions, sources of information used, etc.) and on the investor's knowledge about financial markets and products. This database was used to compute proxies for the *better than average*, *gambling* and *risk-lover* variables (see next section).

3. The Decision to Participate in the Warrant Market

This section presents the results of a multivariate analysis. A *probit* model is used to allow distinguishing the characteristics of warrant investors among the characteristics of other investors. For this purpose, only investors who trade stocks were selected from our database, residents abroad were excluded. We had a total of 129,461 stock investors; 1,729 also traded warrants during the period covered by the database.

The base model we use to evaluate the sociodemographic characteristics of the warrant investor vis-à-vis the stock investor is the following:

$$\text{Warrants} = f(\text{age, gender, marital status, residence, occupation, education})$$

where⁹

Warrants: equal to 1 if the investor trades warrants during the period;

Age: age of investor. Defined as (2006 minus year of birth of the account holder);

Gender: equal to 1 if male;

Marital status: equal to 1 if married;

Residence: place of residence; equal to 1 if residing in Lisbon or Porto;

Occupation: four categories are considered: *highly skilled*, if the investor has a highly skilled job; *skilled*, if the investor has a skilled job; *independent*, if the investor is a professional

⁹ The database does not include any variable directly linked to wealth or income of the investor, which prevents the consideration of these aspects in the analysis.

liberal (i.e., the investor has a job but does not have a formal labor contract with the company; *inactive*, if retired, unemployed or student.

Education: years of schooling. Three categories are considered: *low*, if 4 or less years of education; *intermediate*, if more than 4 but 12 or less years of education; *high*, if a technical or higher course was completed.

As stated earlier, the literature considers that higher risk appetite is associated with younger investors without family responsibilities in marriage, that more qualified professions (generally associated with higher income) permit taking higher risks, and that women have less appetite for risk (Barber and Odean 2001, Goetzmann and Kumar 2008). Investor behavior depends on age (DaSilva and Giannikos 2004), occupation (Christiansen et al. 2008) or the environment in which the investor lives (Goetzmann and Kumar 2008). On the other hand, seemingly irrational behavior diminishes substantially with investor wealth (Calvet et al. 2009) or with investor sophistication. Higher levels of education (i.e., more years of schooling) have also been positively associated with greater sophistication, and the higher the individual knowledge the more efficient and rational the financial behavior will be, such as planning and saving for retirement (Lusardi and Mitchell 2008), investing in the stock market (Christelis et al. 2010) or diversifying portfolio (Abreu and Mendes 2010). In short, the investor's characteristics may have an impact on their financial activity.

We attempt to control for investors' income by controlling for their job (the closest proxy for income insofar as neither the survey nor the trading database have information on income or wealth). To that end, dummy variables are used to identify inactive investors; *inactive*, investors with a highly skilled job; *highly skilled*, those with a skilled or low skilled job; *skilled*, and investors who are professional liberals; *independent* workers. Investor's place of residence is also included as an independent variable, since investors who live in the larger metropolitan areas are usually more educated, are more likely to be wealthier and employed in the financial sector and consequently to have access to better quality information. Thus, we distinguish investors who reside in Lisbon and Porto, *Lisbon+Porto*, the two largest Portuguese cities, from investors who reside elsewhere, *other*.

The model is estimated by maximum likelihood.¹⁰ These results are shown in Table 1. In column [1] we only include the variables related to the sociodemographic characteristics of investors. The results indicate that, conditioned to equity investors, young single men who reside in the largest cities (Lisbon and Porto) and with lower academic qualifications have a higher probability of being investors in warrants. Regarding occupations, investors with highly skilled and skilled jobs are less likely to invest in and trade warrants; this is because our omitted employment category is dominated by retirees, which is likely to include an important share of wealthy investors.

Model [2] differs from the previous one in that it includes variables related to behavioral biases and their impact on the decision to participate in the warrant market. Overconfidence can lead investors to participate in and trade financial instruments they are not exactly familiar with. In addition, overconfident investors tend to think they are above average regarding their investment skills (Taylor and Brown 1988) and consequently may invest more in more complex financial instruments. Overconfident investors have been associated with excessive risk taking (Dorn and Huberman 2005; Nasic and Weber 2010), and this means that they are more prone to take on risk for which there is no apparent reward. We follow the Goetzmann and Kumar (2008) and Bailey et al.'s (2008) approach, also used in Abreu et al. (2011) and Abreu and Mendes (2018), and define an investor as overconfident if her/his trading activity is in the top quartile of the distribution in investors' trading activity and his/her performance is in the bottom quartile of the distribution in investors' performance. The underlying idea is that overconfident investors trade too much and consequently get lower returns on their investments (Odean 1999, Barber and Odean 2000). We find that overconfident investors are more prone to participate in the warrant market, thus to invest in and trade warrants.

¹⁰ Regarding the educational level and occupation, the basic categories are, respectively, four (or fewer) years of education and inactive investors.

Table 1 – The decision to participate in the warrant market (*Probit* model)

	[1]	[2]	[3]	[4]	[5]	[6]
Age	-0.010 *** <i>-2.68</i>	-0.019 *** <i>-4.24</i>		-0.018 *** <i>-3.96</i>	-0.018 *** <i>-3.68</i>	-0.018 *** <i>-3.80</i>
Age squared	0.0000 <i>0.99</i>	0.0001 *** <i>2.91</i>		0.0001 ** <i>2.50</i>	0.0001 ** <i>2.34</i>	0.0001 ** <i>2.25</i>
Male	0.390 *** <i>15.66</i>	0.145 *** <i>4.79</i>		0.153 *** <i>5.02</i>	0.149 *** <i>4.86</i>	0.133 *** <i>4.17</i>
Married	-0.046 ** <i>-2.01</i>	0.007 <i>0.25</i>		0.004 <i>0.15</i>	0.003 <i>0.11</i>	0.013 <i>0.48</i>
Lisbon+Porto	0.045 ** <i>2.31</i>	0.014 <i>0.59</i>		0.011 <i>0.46</i>	-0.009 <i>-0.29</i>	0.010 <i>0.38</i>
Highly skilled	-0.069 ** <i>-1.97</i>	-0.062 <i>-1.52</i>		-0.062 <i>-1.51</i>	-0.060 <i>-1.60</i>	-0.088 ** <i>-2.08</i>
Independent workers	-0.003 <i>-0.10</i>	-0.033 <i>-0.81</i>		-0.039 <i>-0.95</i>	-0.058 <i>-1.46</i>	-0.059 <i>-1.37</i>
Skilled+low skilled	-0.096 *** <i>-2.77</i>	-0.067 * <i>-1.66</i>		-0.150 *** <i>-3.61</i>	-0.155 *** <i>-3.77</i>	-0.162 *** <i>-3.72</i>
High education	-0.326 *** <i>-7.09</i>	-0.155 *** <i>-2.87</i>		-0.117 ** <i>-2.16</i>	-0.132 ** <i>-2.40</i>	-0.082 <i>-1.44</i>
Intermediate educ.	-0.202 *** <i>-7.23</i>	-0.111 *** <i>-3.49</i>		-0.078 ** <i>-2.42</i>	-0.071 ** <i>-2.23</i>	-0.059 * <i>-1.79</i>
Overconfidence		0.165 *** <i>4.64</i>	0.173 *** <i>5.16</i>	0.126 *** <i>2.99</i>		0.104 ** <i>2.44</i>
Better than average					-0.053 <i>-1.41</i>	
Disposition		0.531 *** <i>17.14</i>	0.539 *** <i>17.71</i>	0.528 *** <i>16.86</i>	0.532 *** <i>16.84</i>	0.526 *** <i>16.69</i>
Gambling		0.121 *** <i>3.21</i>	0.273 *** <i>9.12</i>	0.088 ** <i>2.27</i>	0.075 * <i>1.81</i>	0.071 * <i>1.78</i>
Risk-lover		0.039 <i>0.95</i>	0.192 *** <i>5.35</i>	0.045 <i>1.08</i>	0.036 <i>0.81</i>	0.049 <i>1.12</i>
Literacy				0.317 *** <i>8.12</i>	0.317 *** <i>7.35</i>	0.315 *** <i>7.90</i>
Low return				0.044 <i>1.39</i>	0.091 *** <i>3.45</i>	0.048 <i>1.44</i>
Deposit				0.015 <i>0.58</i>	0.015 <i>0.58</i>	0.010 <i>0.38</i>
Mortgage				-0.193 *** <i>-5.74</i>	-0.197 *** <i>-5.82</i>	-0.201 *** <i>-5.81</i>
Loan				0.074 * <i>1.94</i>	0.074 * <i>1.85</i>	0.095 ** <i>2.35</i>
Nº obs with Y=1	1 729	1 729	1 729	1 729	1 729	1 702
Nº observations	129 461	129 461	129 461	129 449	129 449	52 766
LR stat.	605	4 301	4 196	4 401	4 393	1 736
Prob.	0.000	0.000	0.000	0.000	0.000	0.000

Obs: (i) *z-stats in italics*; (ii) *, ** and *** denote statistical significance at 10%, 5% and 1% respectively; (iii) the models include a constant as well.

Defined as the tendency to sell winning stocks too early while riding losing stocks too long, the disposition effect has an impact on the trading behavior of individual investors. This is a case of reference point dependent behavior: investors behave differently when they are in the gain and in the loss zone. The disposition effect has been identified in retail and in professional investors, and in stock (Odean 1998, Grinblatt and Keloharju 2001, Dhar

and Zhu 2006, for example) and mutual fund investors (Bailey et al. 2011). From an experiment, Ofir and Wiener (2016) conclude that investors tend to be affected by the disposition effect and favor structured product investments. We consider that disposition-prone investors may also adjust their behavior with their investment in warrants, a complex financial instrument. Thus, if an investor exhibits a disposition effect in her/his stock trading activity then this behavioral bias may also have an impact on the decision to participate in the warrant market.

We use the *disposition* variable as the proxy; it is a binary variable, equal to one if the investor exhibits disposition behavior in the stock trading activity, and zero otherwise. We use Goetzmann and Massa's (2008) methodology. Firstly, each transaction in stocks is classified as "trade at loss" or "trade at gain".¹¹ Then, for each stock in the portfolio, a time series of the trades at loss and at gain is constructed. For example, when the investor sells a stock, the difference between the sell price and the price at which the previous purchase of that stock occurred is computed. If the difference is negative (sale price lower than the buy price), the sale is recorded at loss, and positive differences are recorded as sale at gain. Buys are treated similarly; in these cases the price that occurred in the previous trade of the same stock (regardless of it being a sale or a purchase) is used as the reference price. Given that disposition investors tend to sell winning stocks (that is, sell at gain) and buy losing stocks (that is, buy at loss), for each stock we compute the ratio between buys at loss plus sells at gain minus sells at loss minus buys at gain, standardized by the sum of buy at loss, buy at gain, sell at loss and sell at gain. Finally, we add up the difference for all stocks in the portfolio: if the ratio is positive, then the investor exhibits disposition effect; if not positive, the investor does not exhibit disposition effect. Thus, *disposition* = 1 if the computed ratio is positive, and zero otherwise. We conclude from column [2] that disposition prone investors are more likely to buy and trade warrants.

On the other hand, some investors seem to view trading in the stock market as an opportunity to gamble. For instance, Barber et al. (2009) document that the introduction of the government-sponsored lottery in Taiwan did reduce the stock market turnover by about a quarter, apparently showing that part of the individual investors' excessive trading is motivated by the desire to gamble. Gambling may thus justify investors' irrationality when

¹¹ We assume that the last shares bought are the first ones to be sold to identify sales at loss.

participating in the warrant market. In fact, retail investors may decide not to be informed about product complexity and thus choose randomly with the help of commission-based incentivized distributors (Bernard et al. 2011, Campbell 2006). One way to account for this behavioral bias is to consider that investors who do not get any information about financial markets and instruments are gamblers and make random decisions. The *gambling* binary variable is the proxy used; it is equal to one if the investor does not use any source to get information about financial markets and instruments.¹² We find that the gambling attitude leads more investors to buy and trade warrants, and this is evidence of a behavioural bias in this market.

Finally, there are investors who claim to be risk-lovers. When asked “*What are the reasons that led to a concrete investment decision in financial markets*” they state that the main reason why they invest (or have invested) is because they love risk. Controlling for this investor treat¹³, we conclude that the risk-loving attitude does not have an impact on investors’ participation in the warrant market. However, this result could be driven by collinearity. In fact, a strand of the literature considers that women are more risk averse than men in financial decision making (Schubert et al 1999, Croson and Gneezy 2009).¹⁴ If this is the case, then some collinearity may exist between the *male* and the *risk-lover* variables. Results from column [3] (regression with the behavioral variables only) somewhat confirm this possibility, as the *risk-lover* variable becomes statistically significant (and positive). We thus conclude that there are signs that the risk-loving attitude of individual investors leads them towards investment in warrants.

In Models [4] and [5] we add a few additional controls: the investor’s level of financial literacy, whether there are savings accounts, consumer loans and mortgages, and the investor’s past performance in the investment in stocks. The *literacy* variable distinguishes investors who may have greater knowledge of financial matters because of their academic education (economists) or occupation (business managers and bank staff); it is a binary variable equal to 1 if the account holder is an economist, business manager or bank officer, and identifies those investors who are more likely to be financially educated because of

¹² In the Annex we describe how this variable is calculated.

¹³ In the Annex we describe how we calculate the *risk-lover* binary variable.

¹⁴ However, Nelson (2015) has a different view and claims that “The results are considerably more mixed and overlapping than might be expected”.

their closer 'proximity' with financial issues. Agarwal and Mazumder (2013), for example, explicitly link cognitive abilities to financial mistakes, and Agarwal et al. (2010) claim that consumers make financial mistakes because they lack sufficient knowledge about financial concepts and instruments to make informed financial decisions. Also, Hilgert et al. (2003) find that those who have more financial knowledge are more likely to engage in recommended financial practices.

As regards savings accounts (*deposit*), consumer loans (*loan*) and mortgages (*mortgage*), these are likely to influence the wealth of the investor and her financial behavior. These are binary variables, equal to 1 if the investor has a savings account, consumer loan or a mortgage.¹⁵ The hypothesis that the performance achieved by investors in the stock market influences the investment in warrants is also tested. The underlying idea is that this performance can help identify the ability of the investor in making informed investment decisions and therefore leads these investors to 'test' their skills with other types of financial instruments. Alternatively, it can be argued that investors with the worst performance invest more readily in warrants, which are more leveraged than stocks, in order to recover losses suffered. Thus, dummy variables are defined (one for each quartile of performance) that cover the spectrum of distribution of performance of equity investments. Lacking information on the composition of the investment portfolio of each investor, the methodology of Seru et al. (2010) is followed and we measure the performance of investors by the 30-day average return of stocks purchased. Accordingly, *low return* is a binary variable, equal to 1 if the investor had a return on the investment in stocks in the lowest quartile of returns.

These controls allow us to conclude that investors with greater knowledge of financial matters are more likely to participate in the warrant market. Moreover, investors with a mortgage have a lower probability of investing in warrants, but those with a consumer loan are more likely to invest in warrants. As for savings deposits, its estimated coefficient is positive but not statistically significant. On the other hand, lower returns from the investment in stocks are associated with higher odds of investing in warrants, which suggests that

¹⁵ We do not have information on the amount of the savings deposit, or consumer loan or mortgage.

the investment in warrants may be speculative in nature or even a second-best solution in an attempt to obtain better returns on investments in financial markets.

More importantly, all the estimated coefficients of the behavioral variables in model [4] retain their positive sign, and all but one (the *risk-lover*) are statistically significant at the usual levels of significance. Alternatively, if we use the *better than average* concept (instead of overconfidence) and assume that *better than average* investors are those who believe that they know more than they do, this being measured by the difference, if positive, between self-reported financial knowledge and actual financial knowledge,¹⁶ we find (model [5]) that the *better than average* effect does not have an impact on the participation decision.

Finally, model [6] allows us to check the robustness of our results. In this case, we restrict the sample a bit further, and omit what we call ‘curious’ investors, that is, investors with only one trade in stocks or in warrants. With the exception of two variables (*highly skilled* and *high education*), the other independent variables remain statistically significant and they all have the same sign as in model [4].

All in all, we conclude that investors with the studied behavioral biases (overconfident, disposition-prone, disposed to gambling and risk loving) are more likely to invest in warrants.

4. The Trading Activity of Investors

Once conditioned to the decision to participate in the warrant market, the investor may trade rather frequently. Liquidity does not seem to be a distinguishing factor of the stock and the warrant markets in Portugal (Mendes 2012). In this section we study whether the same investors have a different trading activity when they trade different instruments (stocks and warrants). In particular, we study the impact of investors’ behavioural biases on their trading activity in both types of financial instruments. Prior research has studied investor financial behaviour but, to the best of our knowledge, the behaviour of the same investors in different markets (trading different financial instruments) has not been studied

¹⁶ See the Annex for a more complete description of the *better than average* variable.

previously. In our sample we have 1,572 investors who trade stocks and warrants, and we focus our attention on these investors.

Our dependent variable is the number of warrant (or stock) trades an investor makes during the sample period. The corresponding negative binomial count model is estimated by maximum likelihood, and the independent variables are those from the previous section. The results are shown in Table 2 (Huber-White standard errors).

Table 2 – The trading activity (count model)

	Warrant Trades	Warrant Trades	Domestic Stock Trades	Domestic Stock Trades	Domestic and Foreign Stock Trades	Domestic and Foreign Stock Trades
	[7]	[8]	[9]	[10]	[11]	[12]
Age	0.156 *** <i>9.96</i>	0.133 *** <i>7.67</i>	0.141 *** <i>13.52</i>	0.128 *** <i>10.41</i>	0.140 *** <i>13.28</i>	0.127 *** <i>10.27</i>
Age squared	-0.0011 *** <i>-9.58</i>	-0.0013 *** <i>-7.45</i>	-0.0012 *** <i>-10.51</i>	-0.0010 *** <i>-7.99</i>	-0.0012 *** <i>-10.37</i>	-0.0010 *** <i>-7.92</i>
Male	0.183 ** <i>2.04</i>	0.154 <i>1.47</i>	0.191 ** <i>2.33</i>	0.138 <i>1.52</i>	0.184 ** <i>2.23</i>	0.135 <i>1.49</i>
Married	-0.224 *** <i>-3.14</i>	-0.160 * <i>-1.93</i>	0.038 <i>0.57</i>	0.103 <i>1.37</i>	0.088 <i>1.34</i>	0.152 ** <i>2.08</i>
Lisbon+Porto	0.132 ** <i>2.30</i>	0.132 ** <i>2.06</i>	-0.026 <i>-0.46</i>	0.007 <i>0.12</i>	0.004 <i>0.07</i>	0.033 <i>0.57</i>
Highly skilled	0.078 <i>0.79</i>	0.017 <i>0.14</i>	0.051 <i>0.57</i>	0.054 <i>0.52</i>	0.079 <i>0.86</i>	0.088 <i>0.85</i>
Independent workers	-0.190 ** <i>-2.02</i>	-0.241 ** <i>-2.26</i>	-0.174 * <i>-1.90</i>	-0.160 <i>-1.59</i>	-0.161 * <i>-1.77</i>	-0.152 <i>-1.51</i>
Skilled+low skilled	-0.527 *** <i>-5.35</i>	-0.602 *** <i>-5.33</i>	-0.327 *** <i>-3.50</i>	-0.326 *** <i>-3.07</i>	-0.311 *** <i>-3.28</i>	-0.310 *** <i>-2.88</i>
High education	-0.243 <i>-1.49</i>	-0.281 <i>-1.60</i>	-0.344 * <i>-1.84</i>	-0.285 <i>-1.44</i>	-0.395 ** <i>-2.12</i>	-0.336 * <i>-1.71</i>
Intermediate educ.	0.133 ** <i>1.97</i>	0.116 <i>1.63</i>	-0.128 * <i>-1.76</i>	-0.134 * <i>-1.70</i>	-0.122 * <i>-1.71</i>	-0.137 * <i>-1.75</i>
Overconfidence		0.163 * <i>1.65</i>		-0.166 ** <i>-2.18</i>		-0.102 <i>-1.35</i>
Disposition		0.351 *** <i>3.41</i>		-0.107 <i>-1.41</i>		-0.100 <i>-1.34</i>
Gambling		0.157 * <i>1.65</i>		0.126 <i>1.36</i>		0.130 <i>1.44</i>
Risk-lover		-0.034 <i>-0.34</i>		-0.143 * <i>-1.66</i>		-0.141 <i>-1.62</i>
Nº observations	1 572	1 572	1 572	1 572	1 572	1 572
LR stat.	255	677	375	708	382	722
Prob.	0.000	0.000	0.000	0.000	0.000	0.000

Obs: (i) z-stats in italics; (ii) *, ** and *** denote statistical significance at 10%, 5% and 1% respectively; (iii) the models include a constant as well.

Models [7], [9] and [11] allow one to conclude that although investors are the same in both markets, the sociodemographic determinants of the trading activity in stocks and in

warrants are not all the same, implying that the same investors trade (domestic and foreign) stocks differently than warrants. For example, married investors trade warrants less actively, but do not trade stocks less actively. Similarly, investors living in the largest metropolitan areas have higher warrant trading activity but have similar stock trading activity than investors not living in the largest metropolitan areas. Furthermore, we also reveal some disturbing results related to academic education: investors with 4 to 12 years of education trade more warrants than highly educated investors, but more academic education lowers the stock trading activity of investors. As Abreu and Mendes (2010) put it, “the general level of education is also fundamental for obtaining a correct perception of financial information and available opportunities, as well as being crucial in the decision-making process” (p. 517), and we expected the level of academic education to have a similar impact on the trading activity of stocks and warrants.

The difference between the investors’ characteristics that make them trade more in each market is even clearer when behavioral variables are included (models [8], [10] and [12]). In fact, the impact of the behavioral biases is different when investors trade stocks than when they trade warrants. This fundamental finding enables us to conclude that investors behave differently in each financial market according to their behavioral bias characteristics: overconfident investors have a higher warrant trading activity and a lower domestic stock trading activity, investors pursuing gambling pleasure or prone to the disposition effect trade warrants more (but do not trade stocks more). Finally, the risk-loving attitude decreases the number of domestic stock trades, but does not affect the warrant trading activity. Thus, although there are signs that the trading activity in warrants is driven by rational motives (notice the sign and statistical significance of the coefficient of occupation variable, for example), we conclude that the behavioral biases have a stronger impact on the trading activity in more complex financial instruments.

5. Robustness Issues

We conduct a series of robustness tests. First, we include the controls used in section 3 (Table 3, models [13], [15] and [17]). Next, we control for the time span during which the investor was active in the market (*period of activity*), and consider that the investors’ trading activity starts when the investor makes their first trade, and assume they remain active until

the last day of the sample. Differently from Abreu (2018), rather than computing the average number of trades the investor makes, we use this new variable as an additional regressor as it adds flexibility to our model (Table 3, models [14], [16] and [18]).¹⁷

Table 3 – Additional Results

	Warrant Trades	Warrant Trades	Domestic Stock Trades	Domestic Stock Trades	Domestic and Foreign Stock Trades	Domestic and Foreign Stock Trades
	[13]	[14]	[15]	[16]	[17]	[18]
Overconfidence	0,217 * <i>1,91</i>	0,231 ** <i>2,00</i>	0,136 <i>1,29</i>	0,142 <i>1,34</i>	0,184 * <i>1,84</i>	0,185 * <i>1,89</i>
Disposition	0,389 *** <i>3,84</i>	0,434 *** <i>4,10</i>	-0,033 <i>-0,35</i>	-0,245 ** <i>-2,52</i>	-0,023 <i>-0,25</i>	-0,200 ** <i>-2,17</i>
Gambling	0,197 ** <i>2,08</i>	0,238 ** <i>2,41</i>	0,122 <i>1,26</i>	0,135 <i>1,30</i>	0,132 <i>1,42</i>	0,140 <i>1,44</i>
Risk-lover	-0,005 <i>-0,04</i>	0,015 <i>0,14</i>	-0,122 <i>-1,34</i>	-0,139 <i>-1,36</i>	-0,118 <i>-1,32</i>	-0,127 <i>-1,27</i>
Literacy	0,442 *** <i>3,80</i>	0,496 *** <i>4,22</i>	-0,154 <i>-1,35</i>	-0,292 ** <i>-2,51</i>	-0,162 <i>-1,45</i>	-0,283 ** <i>-2,52</i>
Low return	-0,207 ** <i>-2,55</i>	-0,204 ** <i>-2,54</i>	-0,549 *** <i>-5,77</i>	-0,542 *** <i>-5,56</i>	-0,552 *** <i>-6,24</i>	-0,550 *** <i>-6,18</i>
Deposit	-0,340 *** <i>-4,50</i>	-0,303 *** <i>-3,99</i>	-0,113 <i>-1,23</i>	-0,153 <i>-1,64</i>	-0,128 <i>-1,41</i>	-0,164 * <i>-1,80</i>
Mortgage	0,188 * <i>1,93</i>	0,216 ** <i>2,14</i>	-0,141 <i>-1,14</i>	-0,212 * <i>-1,73</i>	-0,137 <i>-1,14</i>	-0,203 * <i>-1,74</i>
Loan	0,610 *** <i>6,29</i>	0,615 *** <i>6,40</i>	0,198 * <i>1,89</i>	0,243 ** <i>2,36</i>	0,243 ** <i>2,42</i>	0,290 *** <i>3,00</i>
Period of Activity		-0,0002 *** <i>-3,67</i>		0,0006 *** <i>12,18</i>		0,0006 *** <i>11,43</i>
N° observations	1 572	1 572	1 572	1 572	1 572	1 572
LR stat.	782	804	776	382	796	997
Prob.	0,000	0,000	0,000	0,000	0,000	0,000

Obs: (i) *z-stats in italics*; (ii) *, ** and *** denote statistical significance

at 10%, 5% and 1% respectively; (iii) the models include a constant and the sociodemographic variables as well.

Our estimated models gain explanatory power: some (or all) of these additional controls are significant at the usual significance levels. The impact of the low return, deposit and loan variables is similar for all the estimated models in terms of the respective coefficient sign (but not in terms of the statistical relevance), and investors seem to use consumer loans to leverage their stock and warrant trading activity. Some other investors' characteristics affect the trading of warrants and the trading of stocks differently. For instance, financial literacy is associated with higher warrant trading activity and with lower

¹⁷ We omit the sociodemographic variables in the interest of space. Huber-White standard errors.

stock trading activity. Similarly, whilst having a mortgage is positively associated with warrant trading activity, it is also negatively associated with stock trading activity. In addition, the longer the investor's period of activity the lower her warrant trading activity and the higher level of stock trading.

More importantly, however, these additional controls confirm dissimilar investor behavior when trading different financial instruments. In fact, disposition-prone investors trade warrants more and trade stocks less, and investors with a gambling attitude also trade warrants more actively. Also, overconfident investors trade both warrants and foreign stocks more actively than they trade domestic stocks.

Some additional robustness exercises are performed. In the first exercise, we use the *better than average* proxy, rather than the overconfidence variable. In the second, we use a time (year) variable¹⁸ (instead of the period of activity variable) to control for the state of the market at the time of the investor's first trade. Furthermore, we assume that investors with certificates and structured retail products (SRP) in the portfolio are more likely to be advice driven because both certificates and SRP are very frequently marketed by banks to their clients (Abreu and Mendes 2018). Finally, tax awareness might condition our results insofar as it impacts individual investor trading activity (Barber and Odean 2004). Thus, we assume that investors with a particular type of mutual funds in the portfolio (i.e., mutual funds which allow tax savings, such as retirement mutual funds) are tax savvy. Results of these robustness exercises are essentially unchanged and are not reported.¹⁹

6. Concluding remarks

In this paper, we investigate the hypothesis that investors behave differently in different financial markets. More specifically, we compare the financial activity of investors holding both warrants and stocks in their portfolio. We are particularly interested in studying if investors with particularly important financial behavioral biases behave differently in different markets.

¹⁸ Year of the first trade of the investor.

¹⁹ Results are available from the authors upon request.

We begin by characterizing the profile of warrant investors. Results show that single, male investors with lower academic qualifications are more likely to participate in the warrant market. Moreover, we find that investors with a consumer loan and those with lower returns from previous investments are more likely to invest in warrants. On the other hand, investors with a mortgage exhibit a lower probability of investing in warrants. More importantly, investors with studied behavioral biases (overconfident, disposition-prone, gambling attitude and risk loving investors) are more likely to invest in warrants.

Secondly, we study the investors' trading behavior in the warrant market and in the stock market. Even though investors are the same in both markets, our results clearly show that the sociodemographic determinants of trading activity in stocks and in warrants are not all the same, this evidence indicates that the same investors trade (domestic and foreign) stocks differently than warrants. More precisely, overconfident investors have a higher warrant trading activity and a lower domestic stock trading activity, investors searching for the pleasure of gambling or prone to the disposition effect trade warrants more (but do not trade stocks more). These results are original, since, as far as we know, this is the first study to address investor's behavior in the market of different financial instruments.

Our results are robust to the consideration of investors' financial literacy and past performance in the stock market, to the inclusion of a series of control variables regarding investors' financial profile (time deposits, mortgages and consumer loans) and the consideration of the time span during which the investor was active in the market.

We also find that there are a significant number of active investors with low educational levels, less qualified occupations or of an older age, which means that the investment in this complex financial instrument might not be the most appropriate. In this context, and combined with the behavioral biases that can lead to unsound decision making, financial intermediaries have a fundamental role to ascertain (for all potential investors in warrants and not just for the average investor) whether this financial instrument is indeed appropriate to their knowledge and risk profile. Furthermore, the Markets in Financial Instruments Directive (MiFID) requires it.

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Annex

We use the CMVM survey to construct proxies for the *better than average*, *gambling* and *risk-lover* variables. We define *better than average* based on the question: “How do you rate, on a 1 (very low) to 7 (very high) scale, your own knowledge of financial assets and markets?” (Self-evaluation). Answers to this question are compared with a financial knowledge variable, which comes out of the survey as well. If the difference between self-reported and actual knowledge is positive and greater than 0.9 then *better than average* = 1.

Similar procedures are used to construct the *gambling* and *risk-lover* variables. From the survey, we assume that the investors who do not use any source of information to become informed on financial markets and products are investors with a gambling attitude, and that those of investors who claim to have a risk-loving attitude are risk-lovers. These two variables are, therefore, binary variables.

Next, we follow Graham et al. (2009) and construct an empirical model for the *better than average*, *gambling* and *risk-lover* variables.²⁰ This probit model assumes that each variable is determined by investor characteristics (gender, marital status, education, age, place of residence and occupation). Results are in table A1 (we drop all the variables which do not load significantly on the empirical model).

We then use the estimated coefficients in each regression and individual characteristics of investors to construct predicted variables for each investor in the trading database. Finally, we assume that the percentage of *better than average*, *gambling* and *risk-lover* investors in the trading database is equal to the percentage of *better than average*, *gambling* and *risk-lover* investors in the survey. Thus, *better than average* = 1, *gambling* = 1 and *risk-lover* = 1 for the investors with the higher score in the estimated empirical model.

²⁰ Graham et al. (2009) use ordered logit regressions to construct their ‘competence’ variable, and logit regressions to construct the ‘optimism toward the US market’ variable. Differently from them, we use a probit model but convert the predicted values into binary variables, thus diminishing the likelihood of collinearity between the predicted variables and the investor characteristics.

Table A1: Empirical probit models for the *better than average, gambling and risk-lover* variables

	Better than average	Gambling	Risk-Lover
Male	-0.154 * <i>-1.89</i>		
Lisbon	-0.234 ** <i>-2.44</i>		
Porto	-0.310 ** <i>-2.43</i>		
Highly skilled	0.183 ** <i>1.98</i>		
Lisbon		-0.350 ** <i>-2.08</i>	
Male		0.258 * <i>1.91</i>	
Age		-0.010 ** <i>-2.29</i>	
Gender			0.348 *** <i>2.92</i>
Age			-0.031 *** <i>-6.94</i>
Lisbon			0.508 *** <i>4.30</i>
Islands			0.577 ** <i>2.02</i>
High Education			0.467 *** <i>4.55</i>
LR stat.	19	15	107
Prob.	0.000	0.001	0.000

Obs: (i) *z-stats in italics*; (ii) *, ** and *** denote statistical significance at 10%, 5% and 1% respectively; (iii) the models include a constant as well; (iv) Huber-White standard errors.