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Stocks repurchase and sophistication of individual investors

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Abstract

In this article, we stress the impact of sophistication on stocks repurchase behavior by individual investors. By analyzing a large database of 8'072'016 trades by 84'500 individual French investors from 1999 to 2006, we evidence at aggregated and individual level that investors prefer to repurchase stocks they previously sold for a gain and stocks that have lost value since being sold. These patterns of repurchase emphasize the role played by anticipated and experienced regret in trading decisions. Based on direct measures of sophistication (trading of foreign assets, derivative assets and bonds) and an indirect one (wealth), we demonstrate that less sophisticated investors are more prone to these biases in repurchase behavior. Besides, we show that portfolio performance of investors are not directly related to these repurchase preferences.

Keywords: Stock Repurchase, Individual Investor, Trading Behavior.

JEL Classification : G 11

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Introduction

In accordance with standard finance models, investment decisions should be based on rational expectations of future stock prices. Consequently, purchase and repurchase decisions should be independent of the past performance of stocks, of the remembering associated to their sale, or of behavioral biases. However, cognitive capacities are limited, and investors cannot manage all information simultaneously. When building and rebalancing their portfolio, they naturally simplify the decision-making process, by reducing the set of possibilities they are facing. About purchase behavior, investors are more prone to buy stocks that grab their attention, through financial news, abnormal volume or extreme performance (Barber and Odean, 2008). Others attention grabbing events have been studied, such as stock hitting upper price limits (Seasholes and Wu, 2007) dividend announcements (Graham and Kumar, 2004) and earnings announcements (Lee, 1992). The attention-based buying behavior is confirmed in each case. Besides, they are more likely to invest in the familiar while ignoring the principles of portfolio theory (Huberman, 2001; Grinblatt and Keloharju, 2001) and due to the extrapolation bias, they tend to prefer past winning stocks (De Bondt, 1993).

More recently, Strahilevitz *et al*. (2011) established two patterns of repurchase selection on a U.S database. They found that investors prefer to: (1) repurchase stocks they previously sold for a gain and (2) repurchase stocks that have lost value since being sold. Strahilevitz *et al*. (2011) test several rational explanations for these behaviors. First, they prove that repurchase patterns are not motivated by superior skills or information, since investors do not benefit from these trades. Secondly, they show that the repurchases biases are not guided by skills the investors might believe to have. Then, they establish that repurchase behaviors are not tax-motivated. Lastly they demonstrate that investors do not believe in mean reversion of stock returns. The conclusions drawn from an experimental investigation on repurchase selection (Weber and Welfens, 2011) corroborates these additional results. Strahilevitz *et al*. (2011) give an emotion driven hypothesis, arguing that these patterns of repurchase are mainly motivated by investor's desire to avoid regret. This assumption, in line with the investors limited rationality hypothesis, underlines the influence of emotions in investors choices.

In this paper, we examine the degree to which investor's sophistication can explain the existing heterogeneity in trading behavior. More precisely, we question the ability of sophisticated investors to control and decrease the role played by psychological factors in their financial decisions.

Previous studies, concerning for instance the disposition effect, proved that investors' sophistication, measured with individuals income and occupational status (Dhar and Zhu, 2006), or wealth, family size and education (Calvet *et al*., 2009), decreases the degree of the bias. Feng and Seasholes (2005) corroborate this result, identifying skilled investors with the diversification level and the number of investors' trading rights[3]. Grinblatt, Keloharju and Linnainmaa (2011) show that high IQ investors as well are less likely to be inclined to the disposition effect. They also prove the existence of a link between intelligence and superior market timing, stock-picking skills, and trade execution. Yet, Chen *et al*.(2007) give evidence that experienced, middle-aged, active, wealthy, and urban investors exhibit greater disposition effect, overconfidence and representativeness bias. Along the same lines Goetzmatn et Kumar (2001) evidence that high cognitive capacities investors trade more, have portfolio more concentrated and are more prone to overconfidence. The evidence is mixed when considering professional investors, who should be more sophisticated by definition. In an experimental study, Kaustia, Alho and Puttonnen (2008) demonstrate that financial market professionals show a much smaller anchoring effect in their long term stock return expectation than do university students. Grinblatt & Keloharju (2000) find that foreign institutional investors are less prone to home bias. On the other hand, Coval & Shumway (2005) find that US market makers are highly loss averse, and Frazzini (2006) shows that US mutual funds exhibit the disposition effect to a similar degree as individual investors. In short, though the sophistication of investors influence their behavior, the direction of this impact is not clear-cut.

In this work, we test the patterns of repurchase on a large French database and extend Strahilevitz *et al*.'s work, bringing new evidence relative to the impact of investor sophistication on repurchase behavior. Originally, we consider investors to be sophisticated if they trade foreign assets, derivative assets and bonds. It is noteworthy to specify that direct measure of sophistication are rarely used, in favor of demographics and socio economics variables correlated with financial literacy. Besides, we proxy the investor's sophistication with the average portfolio value. Following Dhar and Zhu (2006), we suggest that high-income individual investors are more likely to solicit financial advisors such as financial and tax planners. Moreover, wealthier individuals also have more stocks and it's more worthwhile for them to seek such

[3] They hypothesize that sophisticated investors are inclined to receive more rights because they use more methods to trade. Indeed, in Popular Republic of China, investors apply for the "right" to trade with each method (through their branch office, via telephone, via internet, etc.) and must receive authorization to place orders.

services. Thereby, even if they are not themselves sophisticated, they resort to professional who have the benefit of a sound experience on financial markets. They also have more opportunities to enjoy an access to financial education. We postulate that sophisticated investors are likely to exhibit greater skills in gathering and interpreting information. Additionally we believe that sophistication is correlated with a better understanding of stock investments. Actually, financial expertise should increase the propensity of trades backed on rational incentives.

Results prove that sophisticated investors, identified with indirect and direct and never used measures, are less prone to the repurchase biases.

Our work offers several contributions. First, by analyzing more than nine million trades, this work is the largest study of the repurchase behavior in a European context. Second, the biases are analyzed both at the aggregate and the individual level. The latter is not developed by Strahilevitz *et al*. (2011) who aggregate all observations across investors in their tests. Individual results enable to take the existing heterogeneity in behaviors into consideration. Third, we stress the impact of sophistication on the level of the individual repurchase biases. Finally, we examine how portfolio returns are related to repurchase biases. In fact, if repurchase biases are unrelated to performance, investors have little incentive to control it.

This paper is organized as follows: In a first section we describe our data and our methodology. Section 2 is dedicated to the presentation of our results relative to repurchase biases. In the third section we examine the portfolio performance of investors. Concluding remarks are presented in section 4.

1. Data and methodology

a) Data

The main data is provided by a large French brokerage house. We obtained trading records of 85’400 investors over the period 1999-2006 that is 4'232’512 buy trades and 3’839’504 sell trades. We retained only trades of stocks and kept 2491 stocks for which we were able to build an historical daily price with data from Bloomberg and Eurofidai[4]. To study repurchase characteristics of investors, we must focus on the 34’129 who repurchased at least once. Note that the 51’271 removed investors realized only 1’186’740 transactions on the total number calculated. This quantity is so weak that we can deduce that they are nearly inactive. Not only

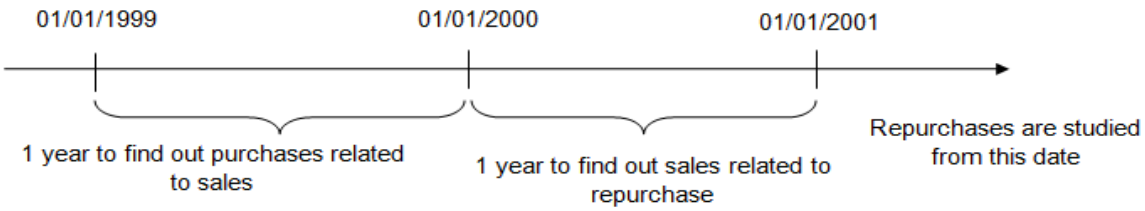
[4] http://www.eurofidai.org

they do not repurchase and accordingly, cannot be included in our work, but their trades count for only 14.7% of total transactions. We present descriptive statistics of our data in table 1.

Concerning trading behavior, on average, investors in our final sample have more trades (mean = 202 and median = 85) than the entire sample investors do (mean = 94 and median = 23). By construction, the average delay between 2 consecutive trades is negatively linked to number of trades. Therefore, it is lower in our sample (38 days) than in the entire date (52 days). Investors in our sample also trade higher cumulated amounts (mean = 818'327 EUR and median = 196'901 EUR) than those of the entire data (mean = 370'532 EUR and median = 39'001 EUR). In the same vein, the average number of years investors own active account, is higher in our sample (mean = 4.45 years and median = 7 years compared to mean= 3.91 years and median = 4 years in the entire sample). We consider that accounts are active when investors realize at least one transaction per year. The average number of days between consecutive trades is Finally, demographics show that in both the entire dataset and in our final sample most traders are men.

We begin our transaction study on 01-01-2001. To understand this choice, imagine that a purchase of stock "A" occurs on this start date. To test if the purchase is actually a repurchase, we must go back in time to find out the last sale of this asset. Therefore, we need a lag to study past trades. We arbitrary set this period to one year. With this limit, we suppose that each sell trade of stock "A" that occurred before this year is not in investor's mind any more. Consequently, we make the hypothesis that the agent do not remember she already held this stock in the past, and the trade realized on the 01-01-2001 is considered as a simple purchase and not as a repurchase. This lag is different from one investor to another, and even for a particular investor, it must differ contingent on the history related to trades. Note that, even imperfect, this limit is necessary to compute our tests. Now imagine that the last sale of stock "A" has been realized by the investor on the 01-01-2000. To study repurchase characteristics, we need one additional year (from January 2000 to January 1999, beginning date of our database) to find out purchases related to this sale. The figure 1 clarifies this point:

Figure 1: Time axis



b) Repurchase behavior and regret

Regret is a common emotion the occurrence of which is experienced by each and everyone as an unpleasant feeling, mainly because it is perceived as a signal that the decision taken was the wrong one. Since it is associated to a disagreeable emotion, agents learn from experience to avoid its occurrence, by converting their preferences and adopting unconscious strategies (Coricelli *et al.*, 2005). Knowing that people are more inclined to regret a choice when it represents a change compared to the initial situation (Inman and Zeelenberg, 2002; Kahnmenan and Miller, 1986), we hypothesize that repurchase decision may be driven by the investor's desire to avoid negative emotions. This is the so-called "status quo effect" which relates to the human natural tendency to maintain current decisions (Samuelson and Zeckhauser, 1988). Furthermore, rewards associated to new choices always seem inferior compared to disadvantages linked to the abandonment of the current decision (Kahneman, Knetsch and Thaler, 1991). Besides, status quo is more likely to be preferred when available alternatives are large, such as in a context of portfolio management.

To estimate the degree of repurchases, we compute the repurchase rate RR at the aggregate and individual level as the ratio of repurchases over all purchases, whatever they are repurchases or real purchases:

$$RR = \frac{total\ number\ of\ stocks\ repurchased}{total\ number\ of\ stocks\ purchased}$$

$$RR_i = \frac{number\ of\ stocks\ repurchased\ by\ investor\ i}{number\ of\ stocks\ purchased\ by\ investor\ i}$$

Notice that the analysis at an individual level allows considering the dependence it may exist between successive trades of a particular investor. Indeed, each decision may be correlated to another, for example when an investor chooses to repurchase the same stock at different times.

In the next subsections, we focus of on the illustration of the repurchase biases.

Test 1: Impact of experienced regret. Stocks previously sold for a gain versus stocks previously sold for a loss

Two kind of regret can be defined, each of them impacting repurchase behavior. The first one, induced by counterfactual thinking, is known as "experienced regret", because it is felt after decisions. Roeses (1997) defines counterfactual thinking as mental representations of alternatives of the past. Literally, counterfactual means "contrary to the facts", therefore it concerns an event that could have happened, but did not occur. Agents compare the outcome resulting from their choice with "what they would have if they selected the option they rejected". If the comparison is disadvantageous, the regret is triggered. To illustrate this, consider the case of not having bought a stock when the price was lower. This decision is likely to provoke retrospective thoughts such as "And what if I bought it before?". Experienced regret influence repurchase decisions when an investor has sold a particular stock inducing a loss. Her memories associated to this sale are so disagreeable that she definitely wants to erase them from her mind. She thus behaves as if this investment option was not existing anymore and as a consequence, the share is no longer traded by this investor (Arkes, Kung, et Huzel 2002).

While they try to escape to regret, investors are likely to engage in trades that yield positive emotions such as pride. Thereby, our first hypothesis is that investors are more prone to repurchase stocks previously sold for a gain rather than stocks previously sold for a loss. Note that, according to the efficient market hypothesis, past performance is not a relevant measure to manage a portfolio. Consequently, such preference is not expected.

We follow Strahilevitz *et al*. (2011) by computing the number of previous winning / loosing stock repurchased divided by the number of opportunities to do so. It allows to control that the repurchase behavior observed is really linked to a previous profit / loss. Actually, in a bullish (bearish) market there are more occasions for investors to realize gains (losses), therefore simply counting the number of repurchases could bias the results.

We determine if the previous sale constituted a realized gain or a realized loss, based on the reference price of the stock. Intuitively, the more correct reference price is the weighted average

purchase price for the stock. However, in reality investors may remember only the latest price they paid to purchase the stock, or the lowest/highest one[5]. In this work, we consider the last price as reference price .

We first compute individual repurchase rate of prior winners $PWRR_i$ and individual repurchase rate of prior losers $PLRR_i$[6]:

$$PWRR_i = \frac{number\ of\ prior\ winners\ repurchased\ by\ investor\ i}{number\ of\ opportunities\ to\ repurchase\ prior\ winners\ for\ investor\ i}$$

$$PLRR_i = \frac{number\ of\ prior\ losers\ repurchased\ by\ investor\ i}{number\ of\ opportunities\ to\ repurchase\ prior\ losers\ for\ investor\ i}$$

After computing the difference $D1$ between these two rates for each investor ($D1_i = PWRR_i - PLRR_i$), we can find out the average $\overline{D1}$ across investors. Note that this average is calculated only across investors who had at least one opportunity to repurchase a stock previously sold for a gain and one opportunity to repurchase a stock previously sold for a loss between 1999 and 2006.

At the individual level, the null hypothesis is $H0_1: \overline{D1} = 0$ [7]:

[5] This peak-and-end pattern has been established by Kahneman *et al.*, 1993; Frederickson and Kahneman, 1993; Varey and Kahneman, 1992. Other reference points are suggested in the literature: Kaustia (2004) observed that when stock prices reach extreme value relatively to previous month, turnover increase significantly. Shefrin and Statman (1985) explain that the reference point is the initial purchase price, as it is the benchmark below which investors are reluctant to realize losses. Weber and Camerer (1998) and Grinblatt and Keloharju (2000) found that investor update their reference point with new prices when purchase price is too "old". Arkes *et al.* (2008) proved that investors adapt their reference point depending on their gains and losses.

[6] To compute $PWRR_i$, $PLRR_i$ for each investor, we observe each purchase and check if the stock purchased on that day had been sold by the same investor during the previous year. First, note that it's not enough to find out one sale to consider the purchase as a repurchase. We control that the stock has not been already repurchased after the sale. If so, the purchase is an additional purchase and is not taken into account in our study. Then, for each day on which the investor repurchased, we compute the number of winning and losing sales during the previous year. These are repurchase opportunities for this investor, including stocks actually repurchased and those which could have been repurchased that day. Lastly, we aggregate winning and losing repurchases and repurchase opportunities of each type over time.

[7] The t-statistic used to test the significance of individual results is: $t = \frac{\overline{D1}}{\sigma_{D1}/\sqrt{n}}$, with $\sigma_{D1} = \sqrt{\frac{\sum_{i=1}^{n}[(D1_i)-\overline{D1}]^2}{n-1}}$.

All quantities previously calculated at the individual level (number of prior winners/losers repurchased, number of opportunities to repurchase previous winners/losers) are then aggregated across investors to compute $PWRR$ and $PLRR$ as if we considered only one representative investor:

$$PWRR = \frac{total\ number\ of\ prior\ winners\ repurchased}{total\ number\ of\ opportunities\ to\ repurchase\ prior\ winners}$$

$$PLRR = \frac{total\ number\ of\ prior\ losers\ repurchased}{total\ number\ of\ opportunities\ to\ repurchase\ prior\ losers}$$

At the aggregate level, the null hypothesis is the following [8]:

$H0_2: PWRR - PLRR = 0$

Test 2: Impact of anticipated regret. Stock up since being sold versus stock down since being sold

The second kind of regret is known as "anticipated regret"[9] because it is a feeling which is expected. As an example, it raises when foreseeing a purchase at a higher price compared to a previous opportunity we missed (Tykocinsky and Pittmann, 1998). Prefactual thoughts, such as "And what if I find cheaper again?", appear before decisions, and influence choices (Mc Connell *et al.*, 2000). In a context of stock repurchase, the investor compares the price at which she previously sold the asset with the current price. If the latter is higher, a repurchase in this case would emphasize the fact that the investor could have done better, if she had waited to sell. The anticipation of a more intense regret, caused by the idea that she would pay more to repurchase

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[8] The t-statistic used to test significance of aggregated results is: $t = \frac{(PWRR-PLRR)}{\sigma_{(PWRR-PLRR)}}$, with

$$\sigma_{(PWRR-PLRR)} = \sqrt{p(1-p)\frac{1}{\#\ of\ opportunities\ to\ repurchase\ previous\ winners} + \frac{1}{\#\ of\ opportunities\ to\ repurchase\ previous\ losers}}$$

and p is equal to $\frac{\#\ of\ \ previous\ winners\ repurchase + \#\ of\ previous\ losers\ \ repurchase}{\#\ of\ opportunities\ to\ repurchase\ previous\ winners + \#\ of\ opportunities\ to\ repurchase\ previous\ losers}$

[9] Anticipated regret has been modeled in regret theory (Loomes and Sugden, 1982), which proposes an alternative theory to classical model. In regret theory, expected utility depends on satisfaction about agent's own choice, and on the utility of outcomes she could have obtained.

the asset than the sum she received with the sale, will drive her to ignore this investment opportunity (Tykocinski et Pittman, 1998). We postulate that investors prefer to repurchase stocks that have gone down in price since the sale rather than stocks that have gone up.

To test our assumption, we compute individual repurchase rate of stocks down since the sale $SDRR_i$ and repurchase rate of stocks up since the sale $SURR_i$:

$$SDRR_i = \frac{number\ of\ stocks\ down\ since\ the\ sale\ repurchased\ by\ investor\ i}{number\ of\ opportunities\ to\ repurchase\ stocks\ down\ since\ the\ sale\ for\ investor\ i}$$

$$SURR_i = \frac{number\ of\ stocks\ up\ since\ the\ sale\ repurchased\ by\ investor\ i}{number\ of\ opportunities\ to\ repurchase\ stocks\ up\ since\ the\ sale\ for\ investor\ i}$$

We then compute an average $\overline{D2}$ of the differences between these two rates ($D2_i = SDRR_i - SURR_i$), to test $H0_3: \overline{D2} = 0$.

Note that $\overline{D2}$ is computed across investors for whom we observed at least one opportunity to repurchase a stock down and a stock up in price sold during the previous year.

All quantities previously calculated at the individual level (number of stocks down/up in price repurchased, number of opportunities to repurchase stocks down/up in price since the sale) are then aggregated across investors to compute $SDRR$ and $SURR$ as if we considered only one representative investor.

$$SDRR = \frac{total\ number\ of\ stocks\ down\ since\ the\ sale\ repurchased}{total\ number\ of\ opportunities\ to\ repurchase\ stocks\ down\ since\ the\ sale}$$

$$SURR = \frac{total\ number\ of\ stocks\ up\ since\ the\ sale\ repurchased}{total\ number\ of\ opportunities\ to\ repurchase\ stocks\ up\ since\ the\ sale}$$

At the aggregate level, the test is the following:

$H0_4: SDRR - SURR = 0$

Asides from the fact that we don't check whether the last sale end in a gain or in a loss, the methodology is the same than the one detailed previously. However, each day a repurchase is

realized, we compare the current price of the stock repurchased with the sale price to determine if the stocks are up or down in price since the sale. Current prices of repurchase opportunities are also controlled, to sort up and down opportunities.

c) Measures of sophistication

Although researchers agree on the hypothesis that investor sophistication clearly modifies behavior (Feng and Seasholes, 2005; Dhar and Zhu, 2006; Frazzini, 2006), it is not entirely clear whether it promotes more or less rationality. Using direct and indirect proxies for sophistication, we thus question the existence of a link between repurchase biases and sophistication.

In this work, we first consider investors to be sophisticated if they trade foreign assets, warrants and bonds. We hypothesize that investors trading foreign assets and bonds are sophisticated because they are more likely to be conscious of diversification benefits. Furthermore, trading derivative assets requires familiarity with option-like payoffs, which may hint to enhanced financial sophistication. Therefore, we sort our population according to these three sophistication variables.

Second, we use average portfolio value (PV) as a proxy for wealth of investors. Notice that individual portfolio value PV_i is computed as the average portfolio value of investor, across quarters, between 1999 and 2006. We make the assumption that wealthiest investors may also afford the costly information given by professional advisors. Thereby, and in accordance with previous studies based on demographic variables, we believe that wealth is correlated with investors sophistication. For each investor, we compute the average portfolio value across quarters between 1999 and 2006. Notice that the average portfolio value is 34'418 Euros, with a minimum of 101 Euros and a maximum of 14'244'000 Euros. As the portfolio value is not a binary variable, we divide the sample in quartiles. We then create four groups relatively to these three values[10].

To go a step further, we create groups according to the "depth" of investor's sophistication. To do so, we establish a grading system. An investor who does not satisfy any sophistication condition gets a score of 0 points. If an investor fulfill only one criteria, she gets one point. Thus, an investor who trades warrants, bonds and foreign stocks is rewarded with three points. Furthermore, we included the "non binary" variable, to add one point to wealthiest traders.

[10] Investors i who have $PV_i \leq 4345$ belong to the first subsample. If $4345 \leq PV_i \leq 11723$, investors belong to the second subsample. If $11723 \leq PV_i \leq 30372$ investors belong to the third subsample. Lastly, investors who have a $PV_i > 30372$ are in the fourth subsample.

Investors win one additional points if their average portfolio value (PV) is above the median value (11'723 Euros) computed across all investors. Therefore, to compute the sophistication score of investors, we transform this non binary variable into a binary one ($Binary\ PV$). We summarize these variables in table 2. The column 2 in table 2B indicate that sophistication variables are not independent at the higher level of significance. In column 3, we give Cramer coefficients which measure the degree of association between two sets of variables. Although sophistication variables are not independent, Cramer's degrees of association are quite low. The highest Cramer's coefficient is 18%, for the association between $Binary\ PV$ and $Foreign\ assets\ trading$. We conclude that our sophistication variables do not overlap.

Thus, sophisticated investors fall into five categories depending on their sophistication score (SS). Notice that all variables are equally weighted since each of them allow investors to gain one point. Consequently, two investors can be sorted in the same subsamples, without fulfilling exactly the same criteria. Finally, 14.6% of investors do not satisfy any sophistication conditions, 34.1% (resp. 35.9%, 12.9% and 2.4%) fulfill one (resp. two, three and four criteria). Since few investors in the sample satisfy all the sophistication conditions, we decide to merge the third and the fourth group.

We perform univariate analyses for the 4 variables, by computing individual results $\overline{D1}$ [11] and $\overline{D2}$ for each of the 14 subsets of investors (the three first sophistication variable $Warrants\ trading$, $Bonds\ trading$ and $Foreign\ Assets\ trading$ are binary, PV is divided in quartile, and SS corresponds to investors score). Next, we test the following hypothesis [12]:

$H0_5$: $\overline{D1}_{X=0} = \overline{D1}_{X=1}$ with $X = Warrants\ trading, Bonds\ trading, Foreign\ asset\ trading$

$H0_6$: $\overline{D2}_{X=0} = \overline{D2}_{X=1}$

$H0_7$: $\overline{D1}_{Y_j} = \overline{D1}_{Y_{j-1}}$ with $Y = PV, SS$ and $j = 0,1,2,3$ [13]

$H0_8$: $\overline{D2}_{Y_j} = \overline{D2}_{Y_{j-1}}$

[11] We choose to compute test using the last price as a reference point.

[12] t-stat is $t = \frac{\overline{D1}_{X=0} - \overline{D1}_{X=1}}{\sqrt{\left({S_1}^2/_{n1} + {S_2}^2/_{n2}\right)}}$, with ${S_1}^2 = \sqrt{\frac{\sum_{i=1}^{n}\left[D1_{i_{X=0}} - \overline{D1}_{X=0}\right]^2}{n-1}}$ and ${S_2}^2 = \sqrt{\frac{\sum_{i=1}^{n}\left[D1_{i_{X=1}} - \overline{D1}_{X=1}\right]^2}{n-1}}$

[13] The index j can take the value of 0 only when $Y = SS$.

Notice that individual results are computed only for investors who had at least one opportunity of each kind.

We complete the study of the impact of investor's sophistication on the decrease of the bias with a focus on two new datasets restricted to investors who exhibit a preference for the repurchase of stocks previously sold for a gain (resp. the repurchase of stocks down since the sale). Therefore we build a dummy variable, taking a value of 1 if $D1_i = PWRR_i - PLRR_i$ (resp. $D2_i = SDRR_i - SURR_i$) was strictly positive. We then model the following linear relationships on the subset of positive $D1_i$ investors:

$$D1_i = a + b_1\, Warrants_i + b_2\, Bonds_i + b_3\, Foreign\ stocks_i + b_4 ln\,(PV_i) + e_i$$

where e_i is the residual and $b_1, b_2, b_3\ and\ b_4$ are the regression coefficients for the explanatory variables. Explanatory variables were defined in the preceding paragraphs. A log transformation of PV is used due to the asymmetric distributions.

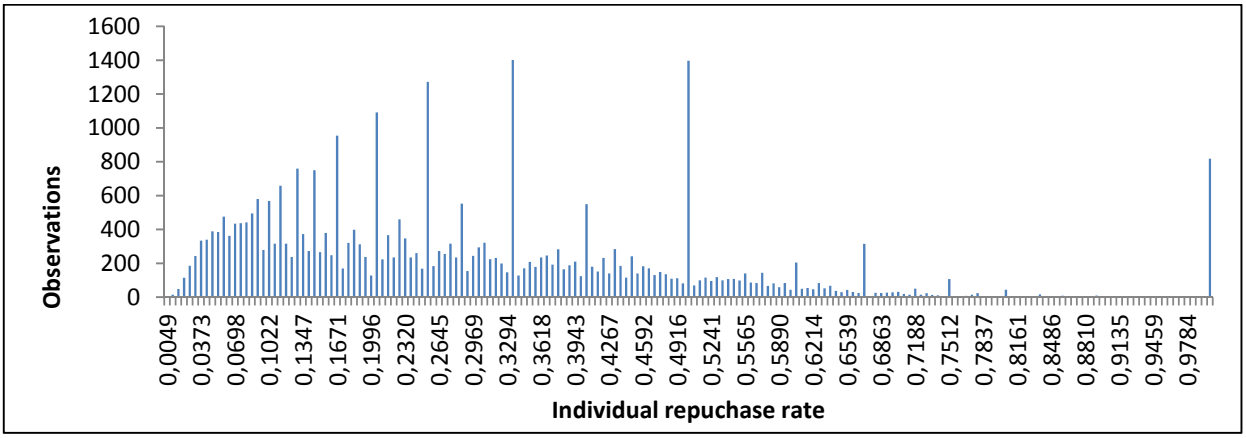
We compute a similar regression for positive $D2_i$ investors.

2. Results

At aggregate level, in the set of all purchases, 32.1% are repurchases. Therefore, a third of purchases are actually repurchases.

We found that the mean $\overline{RR}$ of individual repurchase rates RR_i is equal to 29%, with a median of 25%. Note that the difference between the aggregate and the individual result is linked to the computations (sum of ratios versus ratio of sums). The distribution of individual repurchase rate across our sample of investors is presented in figure 2.

Figure 2: Distribution of the individual repurchase rate of the 34'129 investors



We observe several ratios ($RR_i = 0.5, RR_i = 0.25, RR_i = 1, \dots$) for which the proportions of investor are clearly higher than others frequencies. Notice that in each of these particular case, at least half of the observations correspond to investors who repurchase only once in the period and are specially inactive. More precisely, for $RR_i = 1$ this proportion of investors who repurchase once (and thus purchase once) adds up to 73%. Actually, the average amount of purchases for this category of investors is equal to 11, compared to an average of 91 purchases for investors who repurchased more than once in the period.

We perform an individual repurchase rate analysis for the four subsamples $SS0, SS1, SS2, and\ SS3$. Therefore, we try to answer to the following question: What is the role played by sophistication in the repurchase propensity of individual investors? Interestingly (see table 3), the repurchase rates are the largest for non sophisticated investors ($SS0$), followed by the subsample $SS1$ and $SS2$. Yet, there is a slight increase in RR as we move from the subset $SS2$ to $SS3$. We suggest that this trend is linked to the number of stocks in portfolio. Actually, investors who are deeply underdiversified have a greater propensity to repurchase, since their set of investment possibilities is limited to a couple of stocks. On the other hand, imagine an investor who follow an index market. As she hold many stocks, it's highly probable that a purchase is actually a repurchase. We estimate the diversification level of investors based on the average number of stocks in their portfolio (Div). Consistent with our assumption, investor in the sample $SS0$ hold concentrated portfolio (2.64 different stocks on average), whereas investors in the sample $SS3$ hold well diversified portfolios (12 stocks on average). The most diversified investor in $SS0$ hold 18 stocks, whereas the one in sample $SS3$ hold 125 stocks. Notice that the correlation coefficient between the sophistication score and the average diversification Div is 44.9%.

a) Repurchase biases, anticipated and experienced regret

Test 1: Impact of experienced regret. Stocks previously sold for a gain versus stocks previously sold for a loss

Table 4A reports the aggregated repurchase rate of prior winners and the aggregated repurchase rate of prior losers. $PWRR - PLRR$ is positive, and this result is highly significant ($t = 61.2$). Table 4B show that $\overline{D1} = 0.0362,\ t = 21$. The large difference between individual results and aggregate results is linked to the computation of $PWRR$ and $PLRR$ for which the opportunities are cumulated over time. In this case, the difference between a sum of ratios and a

ratio of sums can be large. Moreover, the difference between $PWRR_i$ and $PLRR_i$ is positive for 62.6% of investors ($t = 42.7$) [14].

Thereby, our results allow us to reject $H0_1$ and $H0_2$: At both the aggregate and the individual level, investors are more prone to repurchase stocks previously sold for a gain rather than stocks previously sold for a loss. It is worth noting that results lead to the same conclusion when the reference price is weighted average purchase price, or the lowest purchase price of the stock. However, when the reference price is the highest price that the investor paid to purchase the stock, the preference for stocks previously sold for a gain is not confirmed. Indeed, most of the sales following the purchase end in a loss (66.17% compared to 29.71% when the reference price is the weighted average purchase price). Repurchases of previous losers increase and opportunities to repurchase previous losers do so. Mechanically, the proportion of previous losers repurchased is higher than the proportion of previous winners repurchased.

Test 2: Impact of anticipated regret. Stock up since being sold versus stock down since being sold.

Table 5A gives results of the aggregate repurchase rate of stocks down (up) since the sale, where $SDRR - SURR = 0.02641$ $(t = 289.3)$. At the individual level (table 5B), $\overline{D2} = 0.08607$ $(t = 53.2)$. We can notice that the preference for repurchase of stocks down since the sale is confirmed for 70.80% of our investors $(t = 79.4)$.

These results allow us to reject the hypotheses $H0_3$ and $H0_4$: At both the aggregate and the individual level, investors are more prone to repurchase stocks that have lost value since the prior sale rather than stocks that have gained value since the prior sale.

b) Sophistication and repurchase biases

The distribution of individual differences $D1_i$ and $D2_i$ are given in figures 3A and 3B.

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[14] To test if the frequency $f_n = \frac{\sum X_i}{n}$ of investors who prefer to repurchase previous winners is significant, we realize a binomial test:

$H0$: $\sum X_i \sim B(n,p), p = 0.5$

$H1$: $\sum X_i \sim B(n,p), p > 0.5$

The t-statistic is $t = \frac{f_n}{\sqrt{\frac{f_n(1-f_n)}{n}}}$

Figure 3A: Distribution of individual difference $D1_i = PWRR_i - PLRR_i$ across investors

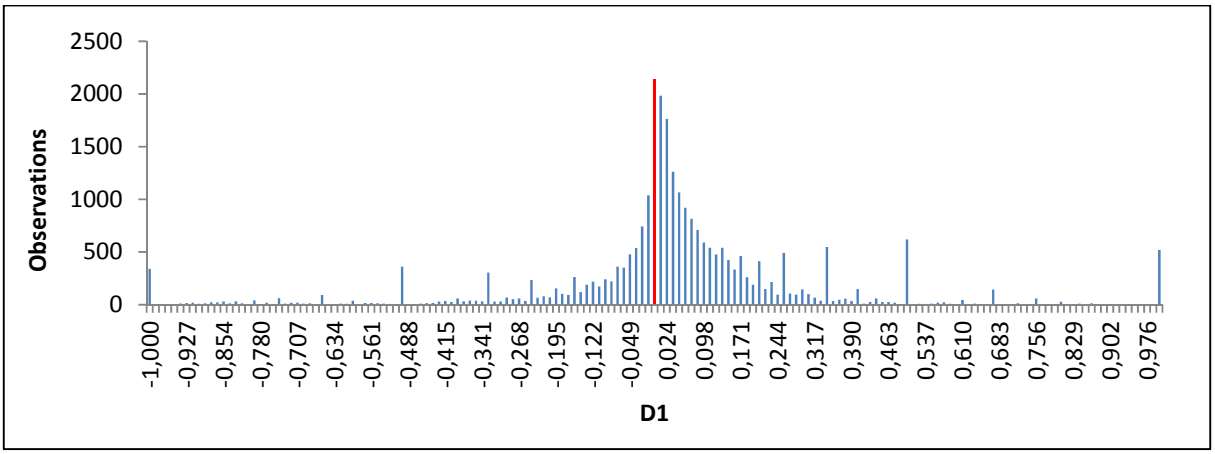
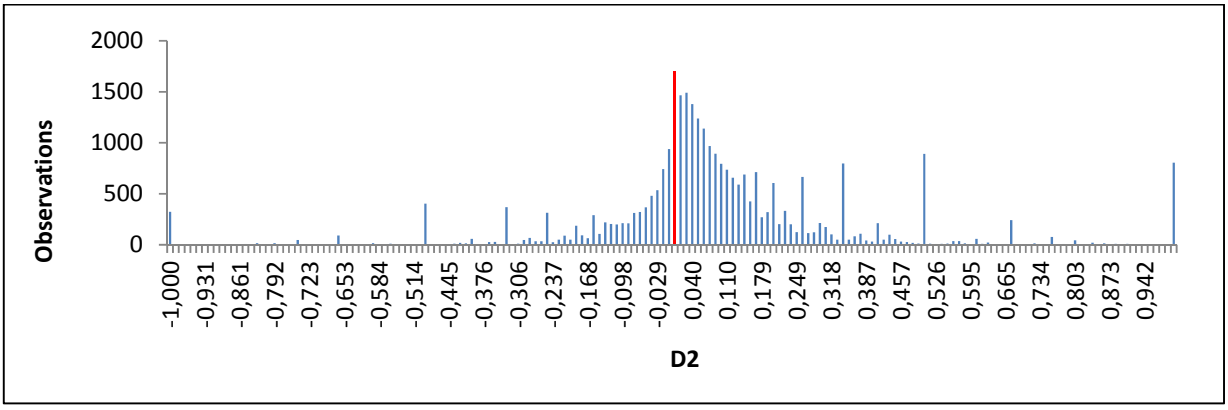


Figure 3B: Distribution of individual difference $D2_i = SDRR_i - SURR_i$ across investors



Even if the differences are positive on average and in both cases, we observe a large cross-sectional heterogeneity. We try to explain this heterogeneity, based on investor's characteristics. We first study the results of tests realized on the subsets built based on binary variables $Warrants\ trading$, $Bonds\ trading$ and $Foreign\ Asset\ trading$ (Table 6).

In each case, results show a positive difference between the repurchase rate of prior winners and the repurchase rate of prior losers. The preference for repurchasing stocks down in price since the sale is also confirmed. Therefore, investors are, on average, prone to repurchase biases, whatever their category (sophisticated or not). We then examine whether the bias is deeper for less sophisticated investors, by calculating the differences between $\overline{D1}$ computed on sophisticated investors and $\overline{D1}$ computed on non sophisticated ones. Results show that the difference in means is positive and significant for each variable, which reveals stronger biases

for investors who don't trade warrants, bonds, or foreign stocks. We thus reject the hypotheses $H0_5$ and $H0_6$.

Before testing $H0_7$ and $H0_8$ relatives to non binary variables PV and SS, we perform a variance analysis on each of them.[15]. In each case, we can reject the null hypothesis that means are equals across subsets. Therefore we validate the relevance of our following work.

Next, we study the impact of a demographic variable, using portfolio value as a proxy for wealth of investors. Results are presented in table 7. We Observe that $\overline{D1}_{PV4} < \overline{D1}_{PV3} < \overline{D1}_{PV2} < \overline{D1}_{PV1}$ and $\overline{D2}_{PV4} < \overline{D2}_{PV3} < \overline{D2}_{PV2} < \overline{D2}_{PV1}$, and results are all significant. This corroborates our hypothesis that wealthiest investors, identified by their large portfolio values, engage in more rational repurchases.

Lastly, we analyze the results of the four sophistication score subsamples (table 8). The conclusion is similar to the previous one, since biases are increasing with the sophistication score decreasing: $\overline{D1}_{SS3} < \overline{D1}_{SS2} < \overline{D1}_{SS1} < \overline{D1}_{SS0}$ and $\overline{D2}_{SS3} < \overline{D2}_{SS2} < \overline{D2}_{SS1} < \overline{D2}_{SS0}$. Thus, among sophisticated investors, those who satisfy a larger number of our sophistication conditions are less prone to repurchase biases.

According to these observations, we can reject the hypotheses $H0_7$ and $H0_8$ .Indeed, computations on each subset prove that behavioral biases are not equally intense across investors. More precisely, repurchase preferences are weakened for more sophisticated investors.

We achieve the study of the role of investor's sophistication on the decrease of the biases with a focus on two new datasets restricted to investors who exhibit a preference for the repurchase of stocks previously sold for a gain (resp. the repurchase of stocks down since the sale).
Regression results (reported in Table 9) show that $Warrants,\ foreign\ stocks$ and $ln(PV)$ variables have a significant and negative impact on both repurchase biases. Yet, $Bonds$ has a positive and insignificant impact in each case. This cross-sectional analysis corroborates strongly our previous results apart for the $Bonds$ variable.

[15] We test the following hypotheses (the tests are similar for $\overline{D2}$):

$H0: \overline{D1}_{PV4} = \overline{D1}_{PV3} = \overline{D1}_{PV2} = \overline{D1}_{PV1}$

$H0: \overline{D1}_{SS3} = \overline{D1}_{SS2} = \overline{D1}_{SS1} = \overline{D1}_{SS0}$

It is worth mentioning that we realize the same regressions on investors who have $D1_i < 0$ (resp. $D2_i < 0$). $Warrants, foreign\ stocks$ and $ln(PV)$ variables have a significant and positive impact on both. Yet, $Bonds$ has a negative impact. Therefore, whatever the sign $D1$ and $D2$ (in other words, whatever the investors repurchase preferences), sophistication helps to converge to a rational behavior according to which $D1_i = 0$ and $D2_i = 0$.

3. Repurchase biases and portfolio performance

One might wonder whether the repurchase biases affect portfolio performance of investors. To answer to this question, we choose to partition investors based on the sign of their repurchase biases. On one hand we focus on the investors who exhibit a preference for the repurchase of stocks previously sold for a gain ($D1_i > 0$). In our data 62.6% of investors exhibit a preference for the repurchase of stocks previously sold for a gain ($D1_i > 0$) and 70.8% of investors exhibit a preference for the repurchase of stocks down since the sale ($D2_i > 0$). We term these investors "positive bias investors". On the other hand we examine investors who do not exhibit these patterns of preferences ($D1_i = 0$; $D2_i = 0$). Only 2.03% (resp. 1.47%) of investors exhibit a null $D1_i$ (resp. $D2_i$) and are "non biased" by definition. Finally, we distinguish investors who exhibit an opposite behavior($D1_i < 0$). We term these investors "negative bias investors"[16]. Notice that the average of positive $D1_i$ ($D2_i$) is 0.1646 (0.1914) whereas the average of negative $D1_i$ ($D2_i$) is -0.1887 (-0.1783).

Next, we realize an estimation of monthly returns of individual investors from January 2001 to December 2006. A mean return across investors is then calculated each month, to create a time series of 72 monthly returns[17]. In a first case, we compute the monthly return time series with an equal weight of individual investors to compute an average result. In a second case, we weight each investor with her monthly portfolio value (based on daily portfolio values in the considered month) to compute an aggregate result.

[16] Our terms "positive bias investors", "negative bias investors" and "non biased investors" always refer to repurchase behavior and do not make any assumption relative to others behavioral biases documented in finance.

[17] To be considered in the calculation of the monthly average, an investor must have his account open during the entire month. Actually, some investors open an account within the 2001-2006 period, some others close their account before the end of the period. On average, 26'532 over 34'129 investors per month have their account open, with a minimum of 23'224 in December 2006 and a maximum of 29'186 in April 2003. 53.6% investors have their account open during the entire period of our dataset, while the average length of presence is 56 months (4.5 year).

To estimate the portfolio performance of investors we employ the framework of the Capital Asset Pricing Model and estimate Jensen's alpha by regressing the monthly excess return earned by individual investors on the market excess return. The value weighted market index is given by the Eurofidai general index (calculated with the methodology of the Center for Research in Security Prices (CRSP)). This index is based on around 700 stocks over the period under consideration. We evaluate the gross monthly return earned by individual investors on average (in aggregate), and estimate the following monthly time-series regression:

$$Rp_t - rf_t = \alpha_p + \beta_p\ (Rm_t - rf_t) + \epsilon_t$$

where Rp_t is the average (aggregate) monthly return of investors, Rm_t is the monthly return on a market index, β_p is the market beta, rf_t is the monthly risk free rate and corresponds to the 1-month Euribor (notice that between 2001 and 2006, the monthly average of the risk free rate is 0.24%, that is 2.92% annualized) and ϵ_t is the regression error term.
In a second step, we employ an intercept test using the three-factor model developed by Fama and French (1993):

$$Rp_t - rf_t = \alpha_p + \beta_p\ (Rm_t - rf_t) + z_p SMB_t + h_p HML_t + \epsilon_t$$

where SMB_t is the monthly return on a value-weighted portfolio of small stocks minus the monthly return on a value-weighted portfolio of big stocks and HML_t is the monthly return on a value-weighted portfolio of high book-to-market stocks minus the monthly return on a value-weighted portfolio of low book-to-market stocks. h_p and z_p are coefficients on factors size and Book to Market. SMB_t and HML_t factors are provided by Eurofidai and calculated according to the Fama-French (1993) methodology.

We present the portfolio performance of the subsets based on $D1_i$ and $D2_i$ signs in table 10. Panel A (resp. B) presents the regression intercepts relative to the subsets based on $D1_i$ (resp. $D2_i$) values. The first column contains results obtained results relative to "positive bias investors" whereas the second column concerns "negative bias investors". The third column is devoted to results relative to investors who do not exhibit the repurchase biases. We observe first that all intercepts are significantly negatives, which reveals the poor performances of individual investors, no matter if they are affected or not by repurchase biases.

However, we should emphasize the dominance of the alphas for "non biased investors". Actually, both the CAPM and the Fama-French intercepts are significantly higher for these investors than

"positive bias investors". Notice that this result is not significant in the case of the average investor for $D1_i$. Therefore, investors who are unaffected in their repurchase decisions by past price patterns, overperform investors who back their repurchase trades on emotional incentives. Yet, this subset contains less than a handful of investors. Investors are mainly sorted either in the positive bias subset, either in the negative bias subset. To infer how the documented patterns of repurchase affect portfolio performance, it is more appropriate to compare the results obtained on these subsamples.

The comparison between the alphas relative to positive and negative bias investors is much less clear. In fact, the sign of the differences between intercepts varies across the tests and is non significant is almost all cases. Consequently, we should conclude that positive and negative bias affect similarly performances. In other word, the preference for the repurchase of stocks previously sold for a gain and/or the repurchase of stocks down in price since the sale has no particular impact on portfolio returns.

4. Discussion - Conclusion

Analyzing repurchase behavior of 34'129 investors between 2001 and 2006, we find that a third of the realized purchases are actually repurchases. We hypothesize that maintaining the status quo is a strategy to minimize the occurrence of regret. This rate could also mean that investors trade the same subset of a couple of stocks, revealing a preferred habitat. Another possible explanation, linked to cognitive limitations of agents, can be found in the tendency of investors to trade stocks that catch their attention. Precisely, stocks previously sold are attention-grabbing stocks since they are still present in investor's mind. News about the latter are likely to remind former trades. Therefore, agents naturally pay more attention to stocks they already held at least once. We also underline the link between the repurchase rate and the number of stocks in portfolio.

We then highlight two patterns of repurchase behavior. Firstly, investors are more prone to repurchase stocks they previously sold for a gain than stocks they previously sold for a loss. This preference for stocks previously sold for a gain can be explained by the tendency of investor to make trade that intensifies positive emotions, and reduce pains. When an investor realizes a loss she prefers to forget this trade and to ignore the asset associated to a negative feeling. At the same time, while she tries to avoid regret, she is more prone to repurchase stocks previously sold for a gain, motivated by the pride she felt with this trade. Secondly, investors are more prone to repurchase stocks that have lost value since the prior sale rather than stocks that

have gained value since the prior sale. This corroborates previous studies on repurchase bias which show that investors' attention is likely to be caught by change in stock price they previously sold. If the observed price has gone down since the sale, the investor is prone to feel proud, because she took a timely decision. Thus this particular asset will be associated with a pleasant feeling, and is more likely to be repurchased. Indeed, buying this stock at a lower price compared to the price sale will emphasize investor's satisfaction. On the contrary, if the price has risen up, the consideration of this stock as an investment opportunity is unpleasant since the current price reminds the investor that she could have done better, by selling later. Therefore, the investor anticipates that the repurchase will yield regret, and (unconsciously) chooses to ignore this stock. Next, based on our original clustering, we show that more sophisticated investors, though being prone to the repurchase biases, are less biased than other investors. We conclude that sophisticated investors are endowed with financial skills which help them to weaken their behavioral bias. Wealthiest investors as well are less likely to be inclined to the repurchase biases. This may be explained by an easier access to financial education and information or professional advices.

Finally, we prove that investors who do not back their repurchase decisions on past price patterns overperform those who have a preference for the repurchase of sold previously sold for a gain and those who have a preference for the repurchase of stocks down in price since the sale. It is worth mentioning that this result is a necessary condition for the repurchase behaviors to be biases. Actually, if returns are unrelated to repurchase behavior, investors do not have interest in adopting a more rational way to repurchase. Yet, nearly 98% of investors exhibit "non rational" preferences in their repurchases. We demonstrate that portfolio returns are identical for this main part of the population, whatever the direction of the repurchase biases. Therefore we can infer that, though investors would gain if they rule preferences, the patterns of repurchase we examine in particular do not affect their performance.

Table 1: Descriptive statistics of our entire dataset and of our sample of investors who repurchased at least once

The left column of this table presents statistics on the whole dataset, i.e. 84'500 investors over the period 1999-2006, and on the sample of investors who repurchased at least once. The right column presents statistics on the same period on the 34'129 investors studied in this paper, who repurchased at least once. Panel 2 gives information about trading behavior per investor; "Nb of trades/ assets" refers to the number of trades/assets computed over 1999-2006. "Nb. of years of activity over 1999-2006" is the number of year investors own active accounts: active account are those with at least one transaction over one year. "Delay between 2 trades" is the average number of business days between 2 consecutive trades. "Trade amount" is the total amount (EUR) traded by investors over 1999-2006. Medians are reported in parentheses.

	Entire dataset	**Investors who repurchased at least once**
Panel 1: Sample size		
Number of investors	85 400	34 129
Number of trades	8072016	6885276
Panel 2: Trading behavior per investor		
Average number of trades	94 (23)	202 (85)
Average number of assets traded	35 704 (1380)	85 275 (10 500)
Average number of years of activity	3.91 (4)	4.45 (7)
Average delay between 2 trades	52.35 (26.64)	38 (28)
Average cumulated trade amount for the period (euros)	370 532 (39 001)	818 327 (196 901)
-Buy	185 793 (19 529)	411 227 (101 135)
-Sell	184 738 (18 801)	407 099 (95 192)
Panel 3: Investors demographics		
% of men	78,26%	81,80%

Table 2A and 2B: Investors sophistication – binary variables

Table 2A: Description of the variables

This table presents a description of the selected binary variables to sort investors. The frequencies among investors who repurchased at least once are reported.

Variables	Description	Frequency in sample
Warrants trading	= 1 if the investor traded warrants during the 1999-2006 period, 0 elsewhere	20.8%
Bonds trading	= 1 if the investor traded bonds during the 1999-2006 period, 0 elsewhere	13.5%
Foreign assets trading	= 1 if the investor traded foreign stocks during the 1999-2006 period, 0 elsewhere	75.7%
Binary PV	= 1 if the average portfolio value of investors during the 1999-2006 period is higher than the median value (11'723 Euros) computed across investors, 0 elsewhere.	50%

Table 2B: Measures of association between variables

This table contains measures of association (Pearson Chi2 and Cramer coefficients) between sophistication variables for the 34'129 investors in the selected sample. ***, ** and * indicate that the results are significant respectively at the 1%, 5% and 10% level.

	Pearson Chi2	Cramer
Warrants trading & Foreign assets trading	610***	14.26%
Warrants trading & Bonds trading	541***	13.42%
Foreign assets trading & Bonds trading	323***	10.38%
Binary PV & Foreign assets trading	873***	18.03%
Binary PV & Warrants trading	125***	6.85%
Binary PV & Bonds trading	688***	16%

Table 3: Repurchase rate in the sample and in sophistication score subsets

This table reports statistics of the individual repurchase rates computed on the sample of investors who repurchased at least once, and on the sophistication score subsets. The subsample $SS0$ contains investor who do not satisfy any sophistication conditions among $Foreign\ assets\ trading$, $Warrants\ trading$, $Bonds\ trading$ and $PV > 11723$. The subsample $SS1$ (resp. 2 and 3) contains investors who fulfill 1 (resp. 2, 3 and 4) of these criteria.

The repurchase rate is computed as the ratio of repurchases over all purchases.

	Sample	$SS0$	$SS1$	$SS2$	$SS3$
Mean	29%	35.1%	29.3%	26.8%	27.4%
Maximum	100%	100%	100%	100%	100%
Minimum	0.5%	2%	1%	0.5%	0.7%
Percentiles:					
0.25	13.2%	16.7%	13%	12%	12.9%
0.5	25%	28.6%	25%	23.3%	24.8%
0.75	40%	50%	40%	28.3%	38.7%

Tables 4A and 4B: Preference for stocks previously sold for a gain versus stocks previously sold for a loss

Table 4A: Aggregate results

This table presents a comparison between the aggregate Repurchase Rate of Prior Winners ($PWRR$) and the aggregate Repurchase Rate of Prior Losers ($PLRR$) between 2001 and 2006. $PWRR$ is the ratio of number of winners repurchased over number of opportunities to repurchase winners. $PLRR$ is computed in a similar way. T-test is in the last row.

	34 129 Investors
Winners repurchased Opportunities to repurchase winners	534 807 12 366 035
$\boldsymbol{PWRR}$	0.04325
Losers repurchased Opportunities to repurchase losers	236 348 6 336 547
$\boldsymbol{PLRR}$	0.0373
$\boldsymbol{PWRR - PLRR}$	0.00595
t-test	61.2

Tableau 4B: Individual results

This table shows the mean $\overline{D1} = \frac{1}{26964}(\sum_{i=1}^{26964} D1_i)$, with $D1_i = PWRR_i - PLRR_i$

$PWRR$ ($PLRR$) is the Repurchase Rate of Previous Winners (Losers). Among our initial population, only investors who had at least one opportunity to repurchase a previous winning stock and a previous losing stock are considered. T-test is in the last row.

	26 964 Investors
$\boldsymbol{\overline{D1}}$	0.0362
t-test	21
Proportion of investor for whom $\boldsymbol{PWRR_i > PLRR_i}$	62.6%
t-test	42.7

Tables 5A and 5B: Preference for Stock up since being sold versus stock down since being sold

Table 5A: Aggregate results

This table presents a comparison between the aggregate Rate of Stocks Down since the sale Repurchased ($SDRR$) and the aggregate Rate of Stocks Up since the sale Repurchased ($SURR$) between 2001 and 2006. $SURR$ is the ratio of stocks up since the sale repurchased over opportunities to repurchase stocks up since the sale. $SURR$ is computed in a similar way. T-test is in the last row.

	34 129 Investors
Stocks down repurchased Opportunity to repurchase stocks down	474 242 8 451 614
$\boldsymbol{SDRR}$	0.05611
Stocks up repurchased Opportunity to repurchase stocks up	321 914 10 837 871
$\boldsymbol{SURR}$	0.02970
$\boldsymbol{SDRR - SURR}$	0.02641
t-test	289.3

Table 5B: Individual results

This table shows $\overline{D2} = \frac{1}{30185}(\sum_{i=1}^{30185} D2_i)$, with $D2_i = SDRR_i - SURR_i$

$SDRR$ ($SURR$) is the Repurchase Rate of Stocks Down (Up) in price since the sale. Among our initial population, only investors who had at least one opportunity to repurchase a stock up in price and a stock down since the sale are considered. T-test is in the last row.

	30 185 Investors
$\boldsymbol{\overline{D2}}$	0.08607
t-test	53.2
Proportion of investor for whom $\boldsymbol{SDRR_i > SURR_i}$	70.8%
t-test	79.4

Table 6: Test results for sophistication subsamples

This table presents the results of repurchase behavior tests realized on sophistication subsample $Warrants\ trading = 1, Warrants\ trading = 0;\ Bonds\ trading = 1, Bonds\ trading = 0;\ Foreign\ assets\ trading = 1;\ Foreign\ assets\ trading\ = 0$.

We first report the differences between means $\overline{D1} = \frac{1}{n}(\sum_{i=1}^{n} D1_i)$, with $D1_i = PWRR_i - PLRR_i$.

$PWRR$ ($PLRR$) is the Repurchase Rate of Previous Winners (Losers).

Then, we report the differences between means $\overline{D2} = \frac{1}{n}(\sum_{i=1}^{n} D2_i)$, with $D2_i = SDRR_i - SURR_i$.

$SDRR$ ($SURR$) is the Repurchase Rate of Stocks Down (Up) in price since the sale.

In each case, a comparison of means between the subsets is reported. T-stat controls for the significance of our results.

		Warrants		***Bonds***		***Foreign assets***	
		1	0	1	0	1	0
Test 1	$\overline{D1}$	0.0256	0.0395	0.0121	0.0386	0.0301	0.0623
	t test	9.2	18.9	2.7	20.9	18	11.1
	$\overline{D1_0} - \overline{D1_1}$	0.0138		0.0264		0.0322	
	t-test	4		5.4		5.5	
Test 2	$\overline{D2}$	0.0601	0.0934	0.0694	0.0876	0.0747	0.1295
	t test	22.6	48.3	16.9	50.7	47.4	26.3
	$\overline{D2_0} - \overline{D2_1}$	0.0333		0.0182		0.0548	
	t-test	10.1		4.1		10.6	

Table 7: Test results for portfolio value subsamples

This table presents the results of tests 1 and 2 realized on portfolio value (PV) subsamples. Individual portfolio value is computed as the average portfolio value of investor, across quarters between 1999 and 2006. The four subsets are created based on quartile values computed on the sample.

We first report the differences between means $\overline{D1} = \frac{1}{n}(\sum_{i=1}^{n} D1_i)$, with $D1_i = PWRR_i - PLRR_i$.

$PWRR$ $(PLRR$) is the Repurchase Rate of Previous Winners (Losers).

Then, we report the differences between means $\overline{D2} = \frac{1}{n}(\sum_{i=1}^{n} D2_i)$, with $D2_i = SDRR_i - SURR_i$.

$SDRR$ $(SURR$) is the Repurchase Rate of Stocks Down (Up) in price since the sale.

In each case, a comparison of means between the subsets is reported. T-stat controls for the significance of our results.

		$\boldsymbol{PV1}$	$\boldsymbol{PV2}$	$\boldsymbol{PV3}$	$\boldsymbol{PV4}$
Test 1	$\overline{\boldsymbol{D1}}$	0.0769	0.0447	0.0267	0.0069
	t-test	15.1	12.6	8.7	3.2
Test 23	$\overline{\boldsymbol{D2}}$	0.1059	0.0916	0.0842	0.0672
	t-test	22	27	30.5	34.6

		$\boldsymbol{PV1/PV2}$	$\boldsymbol{PV2/PV3}$	$\boldsymbol{PV3/PV4}$
Test 1	$\overline{\boldsymbol{D1}}_{\boldsymbol{PV\,j}} - \overline{\boldsymbol{D1}}_{\boldsymbol{PV\,j+1}}$	0.0322	0.0180	0.0198
	t-test	5.2	3.8	5.3
Test 2	$\overline{\boldsymbol{D2}}_{\boldsymbol{PV\,j}} - \overline{\boldsymbol{D2}}_{\boldsymbol{PV\,j+1}}$	0.0143	0.0073	0.0170
	t-test	4.4	1.7	5

Table 8: Test results for sophistication scores subsamples

This table presents the results of tests 1 and 2 realized on sophistication score (SS) subsets. The subsample $SS0$ contains investor who do not satisfy any sophistication condition among $Foreign\ assets\ trading$, $Warrants\ trading$, $Bonds\ trading$ and $PV > 11723$. The subsample $SS1$ (resp. 2 and 3) contains investors who fulfill 1 (resp. 2, 3 and 4) of these criteria.

We first report the differences between means $\overline{D1} = \frac{1}{n}(\sum_{i=1}^{n} D1_i)$, with $D1_i = PWRR_i - PLRR_i$.

$PWRR$ ($PLRR$) is the Repurchase Rate of Previous Winners (Losers).

Then, we report the differences between means $\overline{D2} = \frac{1}{n}(\sum_{i=1}^{n} D2_i)$, with $D2_i = SDRR_i - SURR_i$.

$SDRR$ ($SURR$) is the Repurchase Rate of Stocks Down (Up) in price since the sale.

In each case, a comparison of means between the subsets is reported. T-stat controls for the significance of our results.

		$SS0$	$SS1$	$SS2$	$SS3$
Test 1	$\overline{D1}$	0.0965	0.0647	0.0331	0.0219
	t-test	9.2	15	15	10.8
Test 23	$\overline{D2}$	0.1380	0.0966	0.0746	0.0554
	t-test	8.5	21.52	36.3	33.18

		$SS0/SS1$	$SS1/SS2$	$SS2/SS3$
Test 1	$\overline{D1}_{SS\,j} - \overline{D1}_{SS\,j+1}$	0.0319	0.0316	0.0112
	t-test	3.5	7.7	3.25
Test 2	$\overline{D2}_{SS\,j} - \overline{D2}_{SS\,j+1}$	0.0413	0.0220	0.193
	t-test	5.2	5.8	6.3

Table 9: Test determinants of the level of the individual repurchase biases

This table contains results for the linear regression of the repurchase biases. Student *t* appear in parenthesis. ***, **, *indicate that results are significant at the 1%, 5% and 10% level.

	Positive $D1i$ investors	**Positive $D2i$ investors**
$intercept$	0.6918*** (66.29)	0.6964*** (70.02)
$Warrants$	-0.0348*** (-9.61)	-0.0535*** (-15.34)
$Bonds$	0.0042 (0.76)	0.0005 (0.10)
$Foreign\ stocks$	-0.1111*** (-27.76)	-0.1067*** (-28.91)
$\ln(PV)$	-0.0453*** (-40.66)	-0.0427**** (-40.43)
R^2	16.60	14.78
$Observations$	16827	21302

Table 10: Portfolio performance of subsets formed on $D1_i$ and $D2_i$ signs

This table reports estimations intercept for the datasets of investors who exhibit positive negative and null repurchase biases. Panel A presents the regression intercepts relative to the samples based on $D1_i$ values and Panel B presents the alphas relative to the samples based on $D2_i$ values. CAPM intercept is the estimated intercept from a time-series regression of the investors excess return on the market excess return. Fama–French intercept is the estimated intercept from time-series regressions of investors excess return on the market excess return, a zero-investment book-to-market portfolio (HML), and a zero-investment size portfolio (SMB). *t*-values are presented in parentheses.

	Positive	**Negative**	**Null**	**Pos.-Neg.**	**Pos.-Null**
Panel A: $D1_i$					
Mean $D1_i$	0.1646	-0.1783	0	0.3429 112	0.1646 99
Intercept estimations for the average investor					
CAPM **t-test**	-0.0083 -2.3	-0.0085 -2.3	-0.0078 -2.3	0.0002 0.4	-0.0004 -0.8
Fama-French **t-test**	-0.0084 -2.2	-0.0083 -2.1	-0.0074 -1.9	-0.0001 -0.2	-0.0010 -1.5
Intercept estimations for the aggregate investor					
CAPM **t-test**	-0.0090 -2.8	-0.0086 -2.5	-0.0042 -1.8	- 0.0005 -0.9	-0.0049 -8.9
Fama-French **t-test**	-0.0091 -2.6	-0.0086 -2.3	-0.0042 -1.7	-0.0005 -0.8	-0.0049 -8.5
Panel B: $D2_i$					
Mean $D2_i$ **t-test**	0.1914	-0.1887	0	0.3802 124	0.1914 123
Intercept estimations for the average investor					
CAPM **t-test**	-0.0081 -2.3	-0.0077 -2.2	-0.0052 -1.3	-0.0005 0.8	-0.0029 -5
Fama-French **t-test**	-0.0077 -2	-0.0084 -2.2	-0.0065 -1.5	0.0007 1.1	-0.0012 -1.9
Intercept estimations for the aggregate investor					
CAPM **t-test**	-0.0090 -2.7	-0.0066 -2.2	-0.0053 -1.8	-0.0025 -4.4	-0.0037 -6.7
Fama-French **t-test**	-0.0088 -2.5	-0.0077 -2.4	-0.0047 -1.4	-0.001 -1.7	-0.0041 -7

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