Investors' Unrealized Gains and Losses, and the Low-volatility Anomaly

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Abstract: In this paper, we examine the relationship between unrealized gains and losses held by investors and the low-volatility anomaly in the Japanese stock market. When we measured unrealized gains and losses based on capital gain overhang (CGO), we found that there were more stocks with unrealized losses than the return distribution of individual stocks indicated. The relationship between stock price volatility and future stock returns was negative for stocks with unrealized losses but positive for stocks with unrealized gains. These results can be interpreted as the influence of psychological biases derived from prospect theory.

1. Introduction

There have been various discussions on the relationship between risk and return in the stock market. As the capital asset pricing model (CAPM) by Sharpe (1964) and Lintner (1965) showed a positive relationship between market beta and expected return, the standard view in finance theory is that return is obtained as the compensation for risk.

On the other hand, recent empirical studies have pointed out the existence of the so-called low-volatility anomaly, in which stocks with low stock price volatility have relatively higher future returns. Ang et al. (2006) report that stocks with higher stock price volatility, measured based on daily returns over the past month, have significantly lower future returns. Since the global financial crisis, investor interest in avoiding the risk of stock price volatility has increased, and stock investment for the purpose of risk control has become widespread in practice. Consequently, interest in the low-volatility anomaly has increased both academically and practically.

However, there is no clear consensus as to why a low-volatility anomaly exists in the stock market. From a behavioral finance perspective, the interpretation of investor mispricing and limits to arbitrage is presented. For example, Baker, Bradley, and Wurgler (2011) point out that insufficient arbitrage is exerted on low-risk stocks due to investor avoidance of return deviations from the investment benchmark. On the other hand, there are previous studies that interpret the low-volatility anomaly in relation to other risks. For example, Schneider, Wagner, and Zechner (2020) point out that the low-volatility anomaly is explained by the co-skewness with the stock market.

In this context, Wang, Yan, and Yu (2017) attempt to interpret the risk-return relationship in the stock market based on the prospect theory of Kahneman and Tversky (1979). They examined the risk-return relationship in the US stock market by considering unrealized gains and losses of individual stocks and reported that the risk-return relationship was positive for stocks with unrealized gains, while the risk-return relationship was negative for stocks with unrealized losses.

Prospect theory suggests that humans tend to prefer risk during loss phases relative to a reference point and avoid risk during profit phases. If investors consider the purchase price as a reference point, they will prefer to take risks in stocks with unrealized losses in order to recover their losses, while they will avoid risks in stocks with unrealized gains in order to avoid losing profits. If investors prefer to take risks in the stocks with unrealized losses, they will not only continue to hold risky stocks without cutting their losses, but they may also buy more of them when prices fall. Thus, an increase in demand for risky stocks leads to a rise in stock prices and a decline in expected returns in the market equilibrium. Conversely, a decrease in demand for risky stocks in the stocks with unrealized gains will lead to a decline in stock prices and an increase in expected returns. Thus, the market equilibrium price may be affected by the presence of investors affected by psychological bias derived from prospect theory. This point has been analyzed theoretically in previous studies such as Grinblatt and Han (2005) and Barberis and Huang (2008).

What about the Japanese stock market? Japan's economic structure underwent significant changes during the period of high economic growth in the postwar period, the bubble period, and the period of economic stagnation following the bursting of the bubble economy, and there have been periods of long-term stagnation in the stock market. In such a market environment, the unrealized gains and losses of individual stocks held by investors and their reactions may differ from those of the US stock market.

Therefore, this paper examines the following in the Japanese stock market. First, we examine the relationship between unrealized gains and losses on individual stocks and investor trading. If investors tend to sell stocks with unrealized gains early while continuing to hold stocks with unrealized losses, there will be a relatively large number of stocks with unrealized losses in the stock market. Second, we will examine the relationship between the unrealized gains and losses of individual stocks, and the low-volatility anomaly. If investors are influenced by the psychological bias derived from prospect theory, they will prefer risk for stocks with unrealized losses and avoid risk for stocks with unrealized gains, and a negative relationship between risk and return for stocks with unrealized losses and a positive relationship between risk and return for stocks with unrealized gains will be observed.

2. Data

(1) Data

The market data used for the analysis in this paper is based on data for Japanese listed stocks provided by Financial Data Solutions. This data includes data from January 1977 to December 2020. Considering the calculation period of the indices used in the analysis, the analysis period was set from February 1982 to December 2020. All individual stocks included in the data for this period are included in the analysis[1]. Financial data for individual stocks was obtained from QUICK Astra Manager.

(2) Unrealized gains and losses on individual stocks

[1] Foreign sections, TOKYO PRO Market, ETFs/ETNs, country funds, foreign stocks, preferred securities, REITs, infrastructure funds, and special investment corporations are excluded from the analysis.

In this paper, we use capital gain overhang (CGO) by Grinblatt and Han (2005) as an estimate of unrealized gains and losses on individual stocks. Although it is most desirable to use actual transaction data to measure the unrealized gains and losses held by investors on individual stocks, this is difficult from the standpoint of data acquisition. This model makes it possible to estimate the unrealized gains and losses held by investors on average based on the stock price and turnover of individual stocks.

In this section, we show how to calculate CGO based on the model. First, based on the following model using weekly data, we estimate a reference price that represents the average purchase price of an investor for an individual stock.

$$RP_t = \frac{1}{k}\sum_{n=1}^{T}\left(V_{t-n}\prod_{\tau=1}^{n-1}(1 - V_{t-n+\tau})\right)P_{t-n}$$

In the equation, P_t is the stock price of an individual stock in week t, V_t is the turnover of the individual stock in week t, T is the number of weeks in the past five years, 260, and k is a constant for the sum of the stock price weights to be 1. The turnover is determined by dividing the weekly volume by the number of shares outstanding, with an upper limit of 100%. Stocks for which data was available for at least 100 weeks in the past five years were included in the analysis.

The reference price RP_t is defined as a weighted average of past stock prices P_{t-n}, and the weight of the stock price P_{t-n} can be thought of as the percentage of shares purchased at the stock price in week t-n that remain unsold. The higher the turnover at a given point in time, the more shares are considered to have been acquired at the stock price at that time, and thus the percentage reflected in the reference price is also relatively larger. In addition, the further back in time, the less likely it is that shares acquired at the then-current price will remain unsold, so the percentage reflected in the reference price will be relatively small.

The CGO for week t, which represents the unrealized gains and losses of individual stocks, is then calculated based on the following formula, which compares the reference price and the most recent stock price.

$$CGO_t = \frac{P_{t-1} - RP_t}{P_{t-1}}$$

The CGO for the last week of each month is defined as the monthly CGO. To mitigate the impact of stock price fluctuations caused by temporary bid-ask spread widening and other factors, a one-week lag was applied to the most recent stock price. If all investors acquired the stock at the most recent stock price, the CGO would be zero because the stock price and the reference price coincide. If CGO is 0.5, it means that the most recent stock price is valued at twice the reference price, which is the average investor's purchase price, and is interpreted as there being unrealized gains among the holders. On the other hand, if the CGO is -0.5, it means that the most recent stock price is valued at 2/3 of the reference price, which is interpreted as there being unrealized losses. If an investor acquired a stock at these reference prices, the return from selling at the most recent stock price would be 100% and approximately -33% for the former and latter, respectively.

3. Distribution of Unrealized Gains and Losses on Individual Stocks

In this section, we first review the cross-sectional distribution of unrealized returns of individual stocks in the Japanese stock market. There have been many previous studies on the cross-sectional distribution of individual stock returns. Bessembinder (2018) showed that there is strong positive skewness in the cross-sectional distribution of returns for individual stocks in the US stock market, and that more than half of the stocks had negative returns if the investment was continued from the time of listing. Then, they show that the positive excess returns obtained by investing in the stock market are obtained by very high excess returns realized from a small number of stocks offsetting the negative excess returns of a large number of stocks. Honda (2020) reports that a similar trend is observed in the Japanese stock market.

Then, do we observe the same positive skewness in the cross-sectional distribution of unrealized gains and losses of individual stocks? Even if there were individual stocks that realized large positive returns, it does not necessarily mean that investors actually earned such returns. For example, if investors repeatedly sell at a profit stocks that have risen in price, they will not actually earn the high returns that they would have earned if they had continued to hold some of the best stocks over the long term. Therefore, in order to infer the state of unrealized gains and losses held by the average investor, we consider the CGO as unrealized gains and losses of individual stocks and confirm its cross-sectional distribution.

Figure 1 shows the time series of each percentile value in the cross-sectional distribution of CGO for individual stocks in the Japanese stock market. It shows that a lot of stocks in the Japanese stock market suffered losses during the early 1990s when the bubble economy burst, the Asian currency crisis of the late 1990s, and the global financial crisis of 2008. Although the median value has been fluctuating between positive and negative values around zero, it remained negative in many phases of economic stagnation after the collapse of the bubble economy. The dispersion of CGO widened considerably depending on the market environment, indicating that large disparities emerged among individual stocks.

In Table 1, the CGO and cumulative returns of individual stocks calculated based on weekly data for the past 260 weeks are pooled on a monthly basis, and the basic statistics and density curves of the distributions of the two are compared. The stocks analyzed here were those for which data was available for the past 260 weeks. The skewness of the distribution of cumulative returns for individual stocks was 9.59, while the skewness of the distribution of CGO was 0.59. The positive skewness in the distribution of CGO was relatively small, and the composition of high CGO for some stocks pushing up the mean was not confirmed. In the comparison of density curves, the long right tail observed in the distribution of cumulative returns is not observed in the CGO. In addition, a comparison of the percentage of positive values shows that 55.42% of the cumulative returns are positive, while 36.91% are positive for the CGO. Although the distribution of actual realized returns shows a positive skewness with a long right tail, the distribution of unrealized gains and losses measured by CGO suggests that investors' unrealized gains are not large and that there are more stocks with unrealized losses than the distribution of cumulative returns indicates.

These results indicate that there are more investors with unrealized losses in the Japanese stock market than the return distribution of individual stocks indicates, and analysis focusing on the unrealized gains and losses of individual stocks may provide new insights.

4. Disposition Effect in the Japanese Stock Market

In the previous section, when evaluating the unrealized gains and losses of individual stocks based on CGO, it was confirmed that there are not as many stocks with unrealized gains as the individual stock realized return data indicates, but that there are many stocks with unrealized losses as well. This may be due to the fact that investors tend to sell stocks with unrealized gains early in their trading and continue to hold stocks with unrealized losses. This tendency is known as the disposition effect by Shefrin and Statman (1985), which points to the influence of investors' psychological bias based on prospect theory.

Therefore, in this section, we will examine whether CGO of individual stocks makes a difference in subsequent trading behavior. Specifically, we test the hypothesis that investors actively trade stocks with unrealized gains compared to those with unrealized losses.

Lakonishok and Smidt (1986) examined the relationship between stock price changes and turnover in the US stock market and noted that stocks with higher stock prices have higher subsequent turnover. They considered that the background of such trading is influenced by investors' psychological bias. In this paper, we examine the relationship between CGO, which represents unrealized gains and losses on individual stocks, and subsequent turnover based on the same method.

First, in analyzing the turnover of individual stocks, we will control for the level of turnover in the stock market. Specifically, the following regression analysis is applied based on monthly turnover data for each stock for the past three years.

$$VT_{i,t} = a_i + b_i VTM_t + \varepsilon_{i,t}$$

where $VT_{i,t}$ is the turnover of stock i at time t, VTM_t is stock market turnover at time t, and $\varepsilon_{i,t}$ is the error term for stock i at time t. Stock market turnover is the average of the turnover of all stocks at time t. Based on the following equation using the coefficients a_i and b_i estimated by the above regression analysis, we calculate $AVT_{i,t}$, the abnormal volume of trade for the following month. Stocks for which monthly returns for the past three years were available were included in the analysis.

$$AVT_{i,t} = VT_{i,t} - (a_i + b_i VTM_t)$$

If a positive relationship is confirmed between the CGO of individual stocks and the subsequent abnormal turnover, it means that trading in stocks with unrealized gains increases and trading in stocks with unrealized losses is relatively low, suggesting that a disposition effect may exist in the Japanese stock market. Therefore, we will examine the relationship between the positive and negative CGO at the end of the month and the abnormal turnover in the following month based on the following regression analysis.

$$AVT_{i,t} = \alpha + \beta DCGO_{i,t-1} + \varepsilon_{i,t}$$

where $AVT_{i,t}$ is the abnormal turnover of stock i at time t and $DCGO_{i,t-1}$ is a dummy variable that takes 1 when the CGO of stock i is positive and 0 when the CGO is negative at time t-1.

Table 2 summarizes the results of the regression analysis. The monthly abnormal turnover for stocks with positive CGO was 1.69% (α+β), while the abnormal turnover rate for stocks with negative CGO was -0.46% (α). The t-values of the coefficients indicate that the difference in abnormal trading turnover rates due to positive and negative CGO is statistically significant. Using 6.35%, the average stock market turnover for the analyzed period, as a reference, the trading turnover of stocks with positive CGO (8.04%) is about 37% higher than that of stocks with negative CGO (5.89%), suggesting that the economic impact is also significant. The monthly results confirm that the trend of higher abnormal trading turnover for stocks with positive CGO relative to those with negative CGO is stable, even when the seasonality of trading is taken into account.

The results of this section show that stocks with high CGO, which represents the average unrealized gains and losses investors hold on individual stocks, tend to be actively traded compared to stocks with low CGO. The result in the previous section that there are more stocks with unrealized losses in the cross-sectional distribution of unrealized gains and losses of individual stocks can be attributed in part to investor trading tendencies. One possible explanation for the observed trading tendencies in the Japanese stock market could be the effect of the disposition effect, as discussed by Lakonishok and Smidt (1986).

5. Unrealized Gains and Losses for Individual Stocks, and Low-volatility Anomaly

The previous analysis suggests that investors tend to trade stocks with unrealized gains more aggressively than those with unrealized losses, which is one of the reasons why positive skewness is not observed in the cross-section distribution of CGO. In this section, we focus on the unrealized gains and losses of individual stocks and examine the relationship with the low-volatility anomaly.

If investors are influenced by the psychological bias derived from prospect theory, and the reference point is defined as the purchase price of a stock, they will prefer risk in the stocks with unrealized losses and avoid risk in the stocks with unrealized gains. This increases demand for riskier stocks in stocks with unrealized losses, causing prices to rise and expected returns to fall. Conversely, for stocks with unrealized gains, demand for high-risk stocks decreases, causing the stock price to fall and expected returns to rise. In other words, a low-risk, high-return relationship is expected to be observed for stocks with unrealized losses, while a high-risk, high-return relationship is expected to be observed for stocks with unrealized gains. In this paper, we define risk for investors as stock price volatility, which is the standard deviation of returns.

In the Japanese stock market, previous studies such as Yamada and Uesaki (2009) and Yamada and Nagawatari (2010) have reported that stocks with low stock price volatility tend to have higher future returns than those with high stock price volatility, the so-called low-volatility anomaly. On the other hand, based on the hypothesis of this paper, a low-volatility anomaly is observed in the stocks with unrealized losses. In the following analysis, stock price volatility of individual stocks is measured based on the standard deviation of monthly returns over the past five years, and stocks for which data for more than 24 months were available were included in the analysis.

(1) Single-sorted portfolio

Unrealized gains and losses on individual stocks result from past stock price changes. We first review how CGO relates to future returns and other stock characteristics.

To test the hypothesis that investors' risk appetite is affected by the unrealized gains and losses of individual stocks, we construct portfolios by dividing stocks into four groups based on the level of CGO. The level of CGO at the end of the month represents the return that an investor who acquired a stock at the reference price would receive if they sold the stock at the most recent stock price. Stocks with a CGO of -10% or less are designated CGO1, stocks with a CGO greater than -10% and less than 0% CGO2, stocks with a CGO of 0% to 10% CGO3, and stocks with a CGO of 10% or more CGO4. Considering the possibility of errors in the estimation of unrealized gains and losses and the possibility that purchase prices do not exactly match investors' reference points due to the existence of costs such as taxes and transaction fees, we distinguished stocks with large unrealized gains and losses from those with small ones in our analysis. Portfolio weights are market cap-weighted as in Wang, Yan, and Yu (2017).

Table 3 shows the basic statistics and characteristics for each portfolio. The characteristics are the average values for each group at each time point, averaged over the time series. First, we confirm the returns in Panel A. The difference in returns between CGO4, which consists of stocks with unrealized gains, and CGO1, which consists of stocks with unrealized losses, is 0.19%, which is positive but not significant. On the other hand, when we examine the characteristics in Panel B, we find that stocks with lower levels of CGO have lower historical returns and also tend to have higher market beta, smaller market capitalization, and are undervalued. In the risk-adjusted returns based on the Fama-French three-factor model that takes these characteristics into account, a significant return difference of 0.50% was observed between CGO4 and CGO1. The trend of higher future returns for the group of stocks with higher CGO is consistent with the results reported by Grinblatt and Han (2005) and Wang, Yan, and Yu (2017) for the US stock market. The average number of stocks is higher in the group with negative CGO, which is consistent with the results of the cross-section distribution identified in Table 2.

(2) Double-sorted portfolio

Next, we examine the relationship between the unrealized gains and losses of individual stocks and the low-volatility anomaly using double-sorted portfolios. At the end of each month, individual stocks are sorted into four groups based on CGO, and then within each group, quintile portfolios are created based on stock price volatility, for a total of 20 market cap-weighted portfolios.

Table 4 shows the basic statistics. Given the changes in the environment of the Japanese stock market, the results for the subsamples before 2000 and after 2001 are also shown. First, when we review the results for the entire period, we observe a significant trend toward higher returns with lower stock price volatility for CGO1 and CGO2, which are groups of stocks with unrealized losses. The difference in returns between the highest and lowest quartiles of stock price volatility was significant at -0.77% for CGO1 and -1.04% for CGO2. On the other hand, when we confirm the group of stocks with unrealized gains, we observe a tendency for higher returns with higher stock price volatility in CGO4. In particular, the difference in returns between the highest and lowest quartiles of stock price volatility was significant at 0.78% during the latter half of the period when market conditions turned favorable, a result that is more consistent with the hypothesis that investors are more risk averse in the stocks with unrealized gains.

On the other hand, when the results for the entire period are checked for CGO3 with small unrealized gains, a trend of higher returns with lower stock price volatility is observed, which is inconsistent with the hypothesis. This may be due to the possibility of estimation errors in unrealized gains based on CGO, or the possibility that investors do not have sufficient unrealized gains due to the existence of costs such as taxes and transaction fees. In the first half of the period, the trend is weaker than that for the group of stocks with unrealized losses, and although not significant, we observe a tendency for stocks with lower stock price volatility to have higher returns even for CGO4 with large unrealized gains. This may be due to the possibility that investors' risk appetite increased during the market environment, including the bubble period, regardless of the unrealized gains and losses on individual stocks.

With some exceptions, the results of these analyses suggest that investors affected by psychological bias due to prospect theory tend to prefer risk during loss phases and avoid risk during profit phases, as Wang, Yan, and Yu (2017) point out, and the low-volatility anomaly may be interpreted as an effect of investors' psychological bias.

(3) Fama-MacBeth regression

Although the results from the quantile portfolio tests generally support the hypothesis, they fail to take into account other characteristics of individual stocks. Since Table 3 confirms that CGO is related to past stock price changes and other characteristics of individual stocks, the results in Table 4 may be influenced by other factors besides the unrealized gains and losses of individual stocks. Therefore, as in Wang, Yan, and Yu (2017), we examine the relationship between unrealized gains and losses, stock price volatility, and future returns of individual stocks through regression analysis based on Fama and MacBeth (1973), which considers other characteristics of individual stocks. The regression analysis here is based on the following equation.

$$\begin{aligned} R_{t+1} = \ & \alpha + \beta_1 \times DCGO_t + \beta_2 \times VOL_t + \beta_3 \times VOL_t \times DCGO_t + \beta_4 \times LOGBM_t \\ & + \beta_5 \times LOGME_t + \beta_6 \times MOM_{t-1,t} + \beta_7 \times MOM_{t-12,t-1} + \beta_8 \\ & \times MOM_{t-36,t-12} + \beta_9 \times TURNOVER_t + \varepsilon \end{aligned}$$

where R_{t+1} is the monthly return of individual stocks at time t+1, $DCGO_t$ is a dummy variable that takes 1 when CGO at time t is positive and 0 when it is negative, VOL_t is the stock price volatility at time t, $LOGBM_t$ is the log book-to-market ratio at time t, $LOGME_t$ is the log market capitalization at time t, $MOM_{t-1,t}$ is the monthly return at time t, $MOM_{t-12,t-1}$ is the stock return from time t-12 to time t-1, $MOM_{t-36,t-12}$ is the stock return from time t-36 to time t-12, $TURNOVER_t$ is the turnover at time t. For each variable except the dummy variable, outlier processing is performed to exclude the upper and lower 1%.

Table 5 shows the time-series averages of the monthly regression coefficients estimated from the above regression model and their t-values. Here, the coefficient of CGO was statistically significant positive, and a positive relationship was observed between unrealized gains and future returns as measured by CGO. This is consistent with the results from the single-sorted portfolios, in which the higher the CGO, the higher the risk-adjusted return. Statistically significant negative values were obtained for the coefficient of stock price volatility for all periods, supporting the existence of a low-volatility anomaly.

On the other hand, the coefficient of the cross term between CGO and stock price volatility is significantly positive for all periods, suggesting a relationship between higher stock price volatility and higher returns for the stocks with positive CGO. This result is more consistent with the hypothesis than the results from the double-sorted portfolios in Table 4 since the Fama-MacBeth regression analysis adjusts for other characteristics of individual stocks, such as book-to-market ratios, market capitalization, and past stock price changes. The Fama-MacBeth regression analysis can be interpreted as a clearer observation of the relationship between unrealized gains and losses, stock price volatility, and future returns for individual stocks compared to the analysis using a double-sorted portfolio sorted only by CGO and stock price volatility.

The results of the Fama-MacBeth regression support the results obtained by the double-sorted portfolios. Since investors tend to prefer risk in stocks with unrealized losses and avoid risk in stocks with unrealized gains, we can conclude that the results are consistent with our hypothesis that a negative relationship between risk and return is observed in stocks with unrealized losses and a positive relationship between risk and return in stocks with unrealized gains.

6. Conclusion

This paper examines the low-volatility anomaly in the Japanese stock market from the standpoint of prospect theory. The analysis confirmed that investors tend to actively trade stocks with unrealized gains compared to those with unrealized losses, and that there are relatively many stocks with unrealized losses in the stock market. In the relationship between investors' unrealized gains and losses and the low-volatility anomaly, we observed that stocks with low stock price volatility tended to have higher future returns when investors held unrealized losses, while stocks with high stock price volatility tended to have higher future returns when investors held unrealized gains. These results could be interpreted as the influence of a psychological bias derived from prospect theory, in which investors prefer risk in losses and avoid risk in gains.

Finally, we discuss the challenges of this paper. First, regarding the estimation of unrealized gains and losses on individual stocks by CGO. CGO estimates average unrealized gains and losses on individual stocks based on historical stock prices and turnover. The existence of estimation errors with an investor's actual unrealized gains and losses and other transaction costs would need to be taken into account in interpreting the results of the analysis. Second, we discuss the investor's reference point. For the analysis in this paper, the purchase price of a stock was defined as the reference point, but there may be investors with different reference points, such as investors who invest with an investment benchmark in mind. Such differences in reference points may lead to differences in investor behavior. Third, there is the influence of the investment entity. Previous studies such as Kaniel, Saar, and Titman (2008) and Dhar and Zhu (2006) point out that individual investors with relatively less experience and knowledge are more susceptible to psychological bias. The investment entities that make up the Japanese stock market and the entities that hold each stock have changed over time, and taking these factors into account may bring a new interpretation to the analysis in this paper.

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Figure1: Time Series of Cross-sectional Distribution of CGO

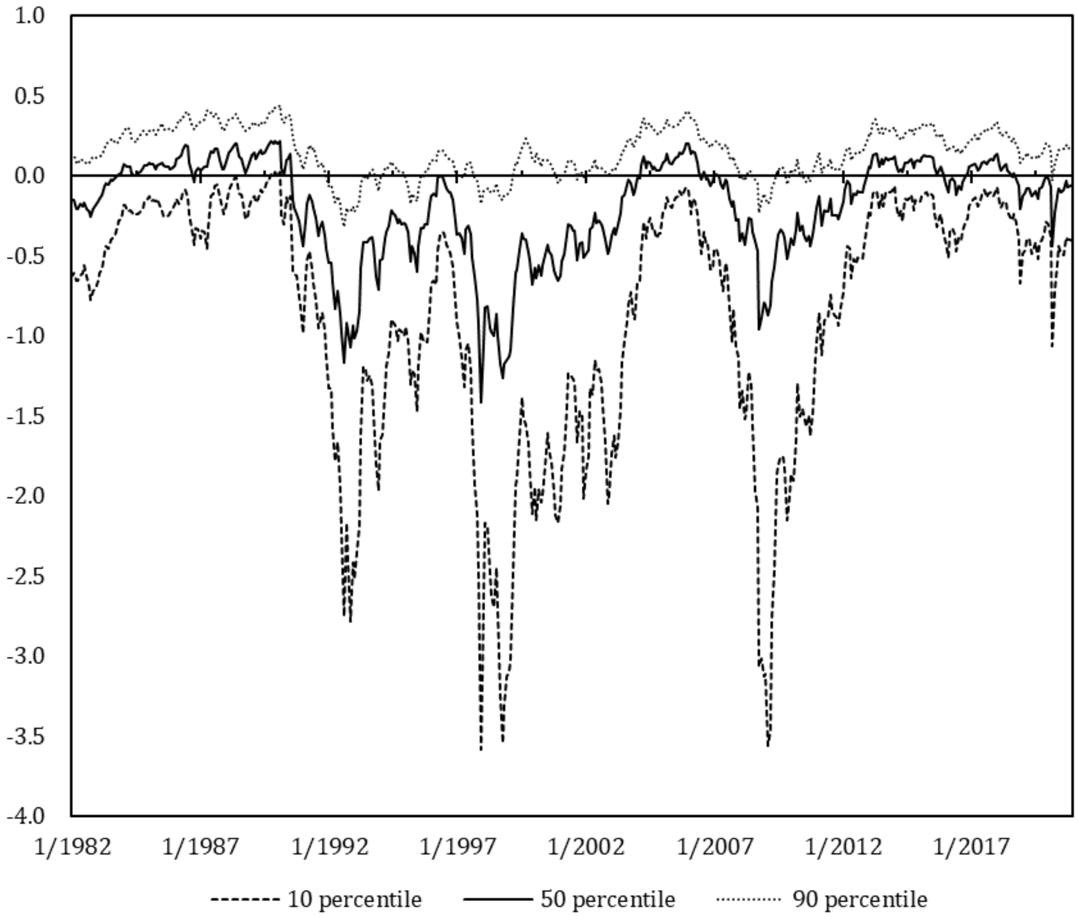
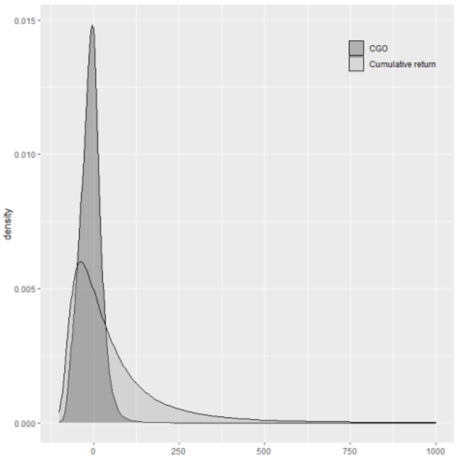


Table 1: Basic Statistics for CGO and Cumulative Returns

	CGO	Cumulative return
Mean	-9.09	60.46
Standard deviation	30.99	192.09
Skewness	0.59	9.59
Kurtosis	2.90	237.54
Max	468.74	11321.41
Median	-8.82	11.52
Min	-99.67	-100.00
> 0%	36.91	55.42



※ CGO converted to the return that an investor who acquired the shares at the reference price would have received if they had sold them at the most recent share price.

Table 2: CGO and Abnormal Turnover

	All	Jan	Feb - Oct	Nov	Dec
Intercept	-0.46 ***	-0.41	-0.44 **	-0.46	-0.75
	(-2.67)	(-0.75)	(-2.31)	(-0.93)	(-1.27)
DCGO	2.15 ***	1.78 ***	2.16 ***	2.31 ***	2.60 ***
	(44.20)	(10.32)	(38.16)	(15.35)	(14.26)
Year dummies	Yes	Yes	Yes	Yes	Yes
R^2	0.002	0.001	0.002	0.002	0.002
Adj. R^2	0.002	0.001	0.002	0.002	0.002
N	1,301,088	106,239	975,695	109,359	109,795

※ This table shows the intercept, regression coefficients, and respective t-values. ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

Table 3: Singe Sorted Portfolio

	Panel A: CGO			Panel B: Characteristics					
	Mean	Standard deviation	FF3-α	CGO	Market beta	Log market cap	Book-to-price	Momentum	N
CGO1	0.06	6.05	-0.42 ***	-0.59	0.90	23.39	1.07	-4.54	1,436
	(0.23)		(-3.37)						
CGO2	0.00	5.19	-0.35 ***	-0.05	0.78	24.22	0.84	11.59	411
	(0.00)		(-3.12)						
CGO3	0.03	4.94	-0.27 ***	0.04	0.76	24.44	0.76	19.76	364
	(0.12)		(-2.71)						
CGO4	0.25	6.05	0.09	0.20	0.76	24.59	0.62	42.78	678
	(1.03)		(0.75)						
CGO4 - CGO1	0.19	4.97	0.50 **	0.80	-0.14	1.20	-0.45	41.71	-758
	(0.82)		(2.41)	(46.06)	(-11.69)	(33.13)	(-22.46)	(29.47)	(-11.40)

※ This table shows the time-series mean of the excess returns for each quintile portfolio, the difference between the excess returns of the highest and lowest quintile portfolios, the standard deviation of the returns, the intercept of the regression analysis based on the Fama-French three-factor model, and each t-value. ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

※ Characteristic are time-series averages of monthly averages in each group. Market beta is the coefficient of the CAPM regression based on monthly returns over the past 60 months (minimum 24 months), momentum is measured based on monthly returns over the past 12 months (excluding the last 1 month).

Table 4: Double Sorted Portfolio

	Panel A: All (02/82 - 12/20)				
	CGO1	CGO2	CGO3	CGO4	CGO4 - CGO1
VOL1	0.32	0.29	0.40 *	0.42 *	
(Low)	[1.38]	[1.51]	[1.96]	[1.91]	
VOL2	0.28	0.19	0.19	0.40	
	[0.94]	[0.81]	[0.78]	[1.58]	
VOL3	0.07	-0.11	-0.11	0.14	
	[0.22]	[-0.40]	[-0.43]	[0.50]	
VOL4	-0.13	-0.26	0.26	0.09	
	[-0.35]	[-0.81]	[0.86]	[0.32]	
VOL5	-0.45	-0.74 **	-0.59	0.77 *	
(High)	[-1.05]	[-2.09]	[-1.61]	[1.92]	
High - Low	-0.77 **	-1.04 ***	-0.99 ***	0.35	1.12 ***
	[-2.32]	[-3.35]	[-3.18]	[1.02]	[3.11]
FF3-α	-0.95 ***	-1.18 ***	-1.16 ***	0.38	1.33 ***
	[-3.34]	[-4.60]	[-4.33]	[1.21]	[3.78]
	Panel B: First half (02/82 - 12/00)				
	CGO1	CGO2	CGO3	CGO4	CGO4 - CGO1
VOL1	0.35	0.26	0.37	0.69 *	
(Low)	[0.97]	[0.81]	[1.08]	[1.95]	
VOL2	0.13	-0.05	0.26	0.46	
	[0.27]	[-0.15]	[0.68]	[1.17]	
VOL3	0.08	-0.43	-0.15	-0.14	
	[0.17]	[-1.05]	[-0.38]	[-0.33]	
VOL4	-0.34	-0.60	0.26	-0.12	
	[-0.63]	[-1.25]	[0.56]	[-0.27]	
VOL5	-0.67	-0.90 *	-1.29 **	0.58	
(High)	[-1.10]	[-1.81]	[-2.46]	[0.88]	
High - Low	-1.02 **	-1.16 ***	-1.66 ***	-0.11	0.90
	[-2.28]	[-2.69]	[-3.58]	[-0.20]	[1.53]
FF3-α	-1.48 ***	-0.97 ***	-1.58 ***	0.39	1.40 **
	[-3.17]	[-2.62]	[-3.71]	[0.75]	[2.47]
	Panel C: Second half (01/01 - 12/20)				
	CGO1	CGO2	CGO3	CGO4	CGO4 - CGO1
VOL1	0.29	0.33	0.43 *	0.16	
(Low)	[0.98]	[1.41]	[1.89]	[0.61]	
VOL2	0.43	0.42	0.12	0.34	
	[1.11]	[1.33]	[0.40]	[1.06]	
VOL3	0.06	0.19	-0.08	0.40	
	[0.13]	[0.50]	[-0.21]	[1.10]	
VOL4	0.07	0.06	0.26	0.30	
	[0.13]	[0.13]	[0.67]	[0.78]	
VOL5	-0.24	-0.60	0.07	0.94 **	
(High)	[-0.40]	[-1.17]	[0.13]	[2.03]	
High - Low	-0.53	-0.92	-0.36	0.78 **	1.32 ***
	[-1.09]	[-2.07]	[-0.87]	[2.04]	[3.15]
FF3-α	-1.10 ***	-1.44 ***	-0.78 **	0.36	1.45 ***
	[-2.70]	[-4.11]	[-2.43]	[1.04]	[3.56]

※ This table shows the time-series average of the excess returns for each quintile portfolio, the difference between the excess returns of the highest and lowest quintile portfolios, the intercept of the regression analysis based on the Fama-French three-factor model, and each t-value. ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

Table 5: Fama-MacBeth Regression

	All		First half		Second half	
	02/82 - 12/20		02/82 - 12/00		01/01 - 12/20	
$DCGO_t$	0.56	***	0.80	***	0.33	***
	[7.53]		[6.00]		[4.94]	
VOL_t	-0.04	***	-0.05	**	-0.02	
	[-2.92]		[-2.43]		[-1.62]	
$VOL_t \times DCGO_t$	0.04	***	0.03	*	0.04	***
	[3.54]		[1.80]		[4.38]	
$LOGBM_t$	0.28	***	0.29	***	0.26	***
	[5.60]		[4.07]		[3.84]	
$LOGME_t$	-0.02		-0.05		0.02	
	[-0.45]		[-0.80]		[0.45]	
$MOM_{t-1,\ t}$	-0.07	***	-0.10	***	-0.03	***
	[-11.85]		[-10.89]		[-5.85]	
$MOM_{t-12,\ t-1}$	0.00		0.00		0.00	
	[-1.29]		[-1.22]		[-0.47]	
$MOM_{t-36,\ t-12}$	0.00	***	0.00	**	0.00	
	[-2.69]		[-2.24]		[-1.50]	
$TURNOVER_t$	0.02		0.05	*	-0.01	
	[1.35]		[1.79]		[-0.97]	

※ This table shows the time-series mean and t-value for each regression coefficient. ***, **, and * indicate statistical significance at 1%, 5%, and 10% levels, respectively.