“Effects of ambiguity in market reaction to changes in stock recommendations”

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EFFECTS OF AMBIGUITY IN MARKET REACTION TO CHANGES IN STOCK RECOMMENDATIONS

Abstract

This study uses analyst recommendations and three ambiguity proxies, namely ambiguity in fundamentals, ambiguity in information and market ambiguity, to examine market reaction to recommendation changes in the Taiwanese stock market. The authors find that analysts' recommendation changes have positive effects on subsequent buy-and-hold abnormal returns when market ambiguity is moderate. When ambiguity in fundamentals is low, recommendation changes have a positive influence on smaller firms. The effect of ambiguity in information on stock returns is associated with market ambiguity; market ambiguity is negatively associated with abnormal returns for firms with moderate ambiguity in fundamentals. Investors in a small firm rely more on analyst recommendations.

Keywords ambiguity in fundamentals, ambiguity in information, market ambiguity, recommendation changes

JEL Classification G00, G02, G11

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INTRODUCTION

Investors tend to be ambiguity averse when faced with risk and uncertainty. Keren and Gerritsen (1999) argue that ambiguity aversion is a situation in which decision-makers prefer gambling with a known probability to gambling with uncertainty. The experiment of Bossaerts et al. (2010) shows that people are ambiguity averse (Heath & Tversky, 1991). Ambiguity aversion can explain the responses of investors. For example, the asymmetric response of investors to good and bad news is contributed by ambiguity aversion (Epstein & Schneider, 2008). Williams (2014) finds that investors have a greater response to bad news than to good news as ambiguity increases. Gilboa and Schmeidler (1989) argue that investors choose the worse cases when ambiguity exists. Moreover, ambiguity aversion could explain the equity premium puzzle (Mehra & Prescott, 1985; Rieger & Wang, 2012), mean variance premium[1], portfolio inertia and excess volatility of stock prices (Illeditsch, 2011)[2].

1 The puzzle of mean variance premium is the difference between risk-neutral and objective expectations of market return variance. Miao et al. (2012) find that about 96% of the mean variance premium can be referred to as ambiguity aversion.

2 Illeditch (2011) shows that, due to the effects of risk and ambiguity on optimal portfolio and equilibrium asset prices, the desire of investors to hedge ambiguity will lead to portfolio inertia and excess volatility when investors receive information that is hard to link to fundamentals. Even when there is no transaction costs or other market frictions, investors may not react to price changes when news is surprising. In addition, this paper shows that small shocks to cash flow news, asset betas or market risk premia may have dramatic impacts on stock prices and excess volatility.

Driss (2013) defines two kinds of ambiguity, namely ambiguity in fundamentals (AIF) and ambiguity in information (AII). AIF is a situation in which investors know the fundamental prospect of a firm, but cannot make reasonable decisions, since there is no relevant information. AII is a situation in which investors have difficulty in updating their prior beliefs in dealing with the information, since they have doubts about the uncertain information quality. Driss (2013) finds that investors have a greater response to analyst recommendation changes, as they perceive a higher level of AIF or AII.

Investors are ambiguity averse, as they try to figure out the unfamiliar circumstances they face (Epstein & Schneider, 2008; Liu, Pan, & Wang, 2005). William (2014) finds this directly affects investor reaction to firms' earnings announcements (Drechsler, 2013; Epstein & Schneider, 2008; Hansen & Sargent, 2010; Illeditsch, 2011). Typically, investors receive earnings information and face a set probability distribution of revenues. If the market is ambiguous, they act cautiously and choose the worse information. As a result, they give more weight to the bad news and so respond more to bad news than to good.

Prior research points out that analyst recommendations convey information contexts and that investors could obtain normal or abnormal returns through investing in stocks recommended by analysts (Beneish, 1991; Bauman et al., 1995; Womack, 1996; Barber et al., 2001; Jegadeesh et al., 2004). We use ambiguity in fundamentals (AIF), ambiguity in information (AII) (Driss, 2013) and market ambiguity (the change of VIX) (Williams, 2014) to measure whether different ambiguity proxies affect investors' decisions after analyst recommendations. We find that only in the situation of low AIF, do recommendations have stronger and positive impacts on smaller firms. When market ambiguity is moderate, analyst recommendation changes have a positive effect on buy-and-hold abnormal returns. For low-level market ambiguity, larger, more analyst-recommended and younger firms have higher buy-and-hold abnormal returns. The response of stock prices to AIF is affected by market ambiguity.

The contribution of this paper is to simultaneously explore whether markets respond differently to recommendation changes for various ambiguity proxies – AIF, AII and market ambiguity. The findings will help investors to make investment decisions when considering analyst recommendations.

The remainder of this paper is organized as follows: section 1 presents the sample, variable definitions and research design, section 2 offers the empirical results; and final section summarizes the results and gives a conclusion.

1. RESEARCH DESIGN

1.1. Sample

We obtained all daily data from the Taiwan Economic Journal (TEJ) database and considered analyst recommendations about firms listed on the Taiwan Stock Exchange and the Gre Tai Security Market. The sample period covers from 2007 to 2015.

1.2. Sample formation

Following Chih and Shiao (2005), we rank stock recommendations as follows: strong sell = 1, sell = 2, hold = 3, buy = 4, strong buy = 5. Because recommendation changes are influenced by news regarding individual firms (Bradley et al., 2008), upgrades (downgrades) preceded by another upgrade (downgrade) in the two previous trading days are deleted. We also delete observations without complete data.

After the above ranking and filtering processes, 10.959 observations remain. Panel A of Table 1 shows the frequency matrix of recommendation changes. We find that regardless of the prior recommendation level, the number of current 'strong buy' recommendations is 5.217, or 47.6%of the total observations. The number of current 'hold' recommendations is 3709 or 33.84% of the total observations. Panel B presents the distribution of the recommendation changes. Two-level upgrades constitute the largest percentage of up-

Table 1. Features of recommendation changes

Panel A: Transition frequency matrix of recommendation changes						
Prior recommendation	**Current recommendation**					
	1. Strong sell	**2. Sell**	**3. Hold**	**4. Buy**	**5. Strong buy**	**Total**
1. Strong sell	201 (1.83%)	20 (0.18%)	98 (0.89%)	7 (0.06%)	103 (0.94%)	429 (3.91%)
2. Sell	9 (0.08%)	194 (1.77%)	85 (0.78%)	58 (0.53%)	48 (0.44%)	394 (3.6%)
3. Hold	119 (1.09%)	114 (1.04%)	2113 (19.28%)	239 (2.18%)	1011 (9.23%)	3596 (32.81%)
4. Buy	7 (0.06%)	58 (0.53%)	250 (2.28%)	654 (5.97%)	159 (1.45%)	1128 (10.29%)
5. Strong buy	112 (1.02%)	70 (0.64%)	1163 (10.61%)	171 (1.56%)	3896 (35.55%)	5412 (49.38%)
Total	448 (4.09%)	456 (4.16%)	3709 (33.84%)	1129 (10.3%)	5217 (47.6%)	10959 (100%)

Panel B: Distribution of recommendation changes		
Magnitude	**Frequency**	**Percentage**
+4	112	1.02%
+3	77	0.7%
+2	1340	12.23%
+1	544	4.96%
0	7058	64.4%
–1	503	4.59%
–2	1167	10.65%
–3	55	0.5%
–4	103	0.94%
Total	10.959	100%

Note: This table shows the features of recommendation changes. The sample coves all brokerage firms' recommendations for firms listed in Taiwan Stock Exchange and Gre Tai Security Market during the period 2007–2015. Recommendations are associated with numerical scores on the following scale: 1 = strong sell, 2 = sell, 3 = hold, 4 = buy, and 5 = strong buy. Panel A presents the transition matrix of recommendation changes, ( ) presents the ratio of different recommendations after brokerage firms announced, Panel B presents the frequency distribution of recommendation changes, and the relevant percentage indicates the ratio of upgrade or downgrade among total sample.

grade samples and up to 12.23% of the total observations; two-level downgrades compose the largest percentage of downgrade samples and up to 10.65% of the total sample. In addition, the unchanged recommendations make up 64.4%, which indicates that most analysts keep a steady view of specific firms. Further, from Panel A of Table1, we can see that current 'hold' and current 'strong buy' recommendations make up 19.28% and 35.55%, respectively, of all recommendation changes.

1.3. Buy-and-hold abnormal returns

Following Daniel, Grinblatt, Titman and Wermers (1997) (DGTW), we compute two-day buy-and-hold abnormal returns for recommendation changes issued on a stock *j*.

$$BHAR_j\left(0.1\right)=\prod_{t=0}^{1}\left(1+r_{j,t}\right)- -\prod_{t=0}^{1}\left(1+r_{j,t}^{DGTW}\right), \quad (1)$$

where $r_{j,t}$ is the raw return on stock j at day t,

and $r_{j,t}^{DGTW}$ is the raw return on a benchmark portfolio formulated with a comparable size, book-to-market and momentum as stock j.

1.4. Proxy for ambiguity

We use the ambiguity in fundamentals (AIF), ambiguity in information (AII) (Driss, 2013) and market ambiguity index, the change of VIX (Williams, 2014), to measure how different ambiguity proxies affect investors' decisions. The ambiguity variables are defined as follows.

1.4.1. Ambiguity in fundamentals

Ambiguity in fundamentals (AIF) is a condition in which ambiguity-averse investors have difficulty in formulating prior beliefs about a firm's fundamental values due to lack of knowledge as to relevant information (Dequech, 2000; Caskey, 2009; Driss, 2013). Gillboa and Schmeidler (1989) argue that investors usually choose a worst-case if they are faced with ambiguity. The reason is that investors have little confidence in the ambiguous fundamentals of a firm; therefore, they give less weight to available information and more weight to new information from recommendation changes. As a result, ambiguity-averse investors respond more strongly to recommendation changes issued for high-AIF firm. Moreover, investors use the 52-week high and low prices as the reference points when making decisions (George & Hwang, 2004; Huddart et al., 2009). Hence, we use the following proxy used by Driss (2013) for AIF:

$$N52WL_j = \frac{52WH_j - P_j}{52WL_j}, \qquad (2)$$

where $N52WL_j$ is the stock price's nearness to its 52-week low, P_j is stock *j*'s price at the end of the prior month, and, $52WH_j$ and $52WL_j$ are stock *j*'s 52-week high and low prices, respectively, calculated from the 52-week period at the end of the prior month.

1.4.2. Ambiguity in information

Ambiguity in information (AII) is a situation in which a firm conveys too little or imprecise information for investors to correctly interpret and investors have difficulty in updating their prior beliefs in response to that information. Ambiguity-averse investors are uncertain about the quality of the signal, and, thus, they give less weight to information carried by the signal and more weight to new information from analyst recommendations (Epstein & Schneider, 2008). In general, smaller firms, younger firms or firms with lower analyst coverage release less information to the public and receive little media coverage, thereby providing investors with information environments of lower quality. This study uses the reciprocals of firm size, analyst coverage and firm age as the proxies to measure AII (Hirshleifer, 2001; Jiang et al., 2005; Zhang, 2006; Autore et al., 2009). The variables are defined as follows:

A. Reciprocal of firm size (RME): smaller firms have a lower quality information environment. Since the cost of an information release is fixed, smaller firms may offer less information. Firm size (ME) is measured as the market capitalization at the end of the previous month before recommendations are released.

B. Reciprocal of analyst coverage (RACOV): firms with lower analyst coverage have more information uncertainty. Analyst coverage is defined as the number of analysts following the firm during the year prior to the end of previous month.

C. Reciprocal of firm age (RAGE): compared to long-history firms, younger firms release less information to the public, receive little media coverage and attract less attention, thereby offering lower quality information to the public. This may lead to less influence in investors' decision-making. Firm age is measured as the number of quarters from the firm first time listed to the month prior to the announcement of recommendation change.

1.4.3. Market ambiguity

Following Williams (2014), we use the change of VIX (ΔVIX) to measure market ambiguity. VIX is measured as the *TXO* (Taiwan Index Option) volatility index. A higher (lower) ΔVIX indicates that investors expect more (less) market ambiguity.

1.5. Ambiguity aversion and recommendation changes

In order to measure whether or not the market response is affected by recommendation changes, we run the following regression model:

$$\begin{aligned} BHAR_j(0.1) &= \beta_0 + \beta_1 CHANGE_j + \\ &+ \beta_2 D_1(HAIF_j) + \beta_3 D_2(RME_j) + \\ &+ \beta_4 D_3(RACOV_j) + \beta_5 D_4(RAGE_j) + \\ &+ \beta_6 \Delta VIX + \beta_7 CHANGE \cdot D_1(HAIF_j) + \\ &+ \beta_8 CHANGE \cdot D_2(RME_j) + \\ &+ \beta_9 CHANGE \cdot D_3(RACOV_j) + \\ &+ \beta_{10} CHANGE \cdot D_4(RAGE_j) + \\ &+ \beta_{11} CHANGE \cdot \Delta VIX + \\ &+ \beta_{12} D_5(MAIF_j) + \beta_{13} D_6(MRME_j) + \\ &+ \beta_{14} D_7(MRACOV_j) + \beta_{15} D_8(MRAGE_j) + \\ &+ X_j + \varepsilon_j, \end{aligned} \quad (3)$$

where $BHAR(0.1)$ is the two-day buy-and-hold abnormal return after the recommendation is released; $CHANGE$ is the recommendation changes; $D_1(HAIF)$ is a dummy variable defined as 1, if $N52WH$ is within the top 30% sample, otherwise, it is 0; $D_2(RME)$, $D_3(RACOV)$ and $D_4(RAGE)$ are dummy variables, which are equal to 1 when they are within the top 30% of the reciprocal of firm size, reciprocal of analyst coverage and reciprocal of firm age, respectively, otherwise they are equal to 0; ΔVIX is the change in the volatility index of the Taiwan Stock Index Option; and $D_5(MAIF)$, $D_6(MRME)$, $D_7(MRACOV)$ and $D_8(MRAGE)$[3] are the dummy variables if they are within the middle level of ambiguity. We also add the control variables, which affect recommendation changes. These include book-to-market value (BM), price momentum (MOM), percentage of institutional ownership (IO), analyst experience (AEXP), recommendation deviation from consensus (DC) and magnitude of recommendation change (MAG). The variables are defined in the Appendix. Following Petersen (2009), we estimate the standard errors by allowing correlation between error terms. Furthermore, we also control for the year and industry effects to consider a fixed effects panel regression.

If investors respond to upgrades (downgrades), the subsequent BHARs are positively related to the direction of the recommendation changes, and $\beta_1 > 0$. In addition, β_2, β_3, β_4, β_5 and β_6 indicate the incremental effects of stock returns of high ambiguity compared to those of low ambiguity. If ambiguity is higher, the interaction effects of a recommendation change $(CHANGE)$ between ambiguity in fundamentals (AIF), ambiguity in information (AII) and market ambiguity (ΔVIX) will be more significant. Thus, β_7, β_8, β_9, β_{10} and β_{11} will be greater than zero.

2. EMPIRICAL RESULTS

Table 2 presents the basic statistics. The average change magnitude $(CHANGE)$ is –0.043. The minimum, the maximum and the mean ambiguity in fundamentals $(N52WL)$ are 0, 7.836 and 0.586, respectively. The mean firm size (ME) is 131.083 million. The mean analyst coverage $(ACOV)$ is 140 times since one year before recommendations are announced. The average firm age is 24 years (96.382 quarters). The average momentum (MOM) is 7.898% during the eleven months prior to analysts issuing the revised recommendations.

2.1. Level of ambiguity and analyst recommendations

Table 3 presents the regression results. Column 1 shows that the magnitude of recommendation change is significantly and positively correlated with $BHAR(0.1)$. This indicates that recommendation changes do affect the market reaction before controlling for ambiguity, as well as firm, analyst and recommendation characteristics. Column 2 includes the ambiguity proxy in the regression, and Column 3 further includes other control variables. The results indicate that the coefficient of recommen-

3 $D_5(MAIF)$, $D_6(MRME)$, $D_7(MRACOV)$ and $D_8(MRAGE)$ are dummy variables indicating ambiguity proxies ranked above their 30th and below their 70th percentiles, respectively.

Table 2. Basic statistics

Variable	Unit	N	Mean	Median	Skew	Kurt	Std. dev.	Maximum	Minimum
CHANGE		10959	–0.045	0.000	–0.026	1.753	1.196	4.000	–4.000
Ambiguity proxy									
N52WL		10959	0.586	0.366	2.564	9.606	0.665	7.836	0.000
ME	(millions)	10959	131.083	424.058	4.341	24.474	253.161	264.081	641.825
ACOV		10959	140.207	72.000	2.818	10.683	182.500	1600.000	1.000
AGE	(quarters)	10959	96.382	86.000	0.881	0.102	55.473	268.000	11.000
ΔVIX		10959	26.942	26.310	0.883	0.670	9.243	60.410	12.340
Firm characteristics									
BM		10959	465.162	313.875	2.799	12.963	481.130	5397.560	7.921
MOM	(%)	10959	7.898	0.138	2.300	11.778	48.677	532.594	–139.857
IO	(%)	10959	60.986	64.130	–0.643	–0.196	19.445	97.970	0.620
Analyst characteristics									
AXEP	(quarters)	10959	6.803	6.000	0.676	–0.495	5.704	23.000	0.000
Recommendation characteristics									
DC		10959	–0.049	0.000	–0.270	10.698	2.547	16.000	–16.000
MAG		10959	0.668	0.000	1.256	0.722	0.994	4.000	0.000

Note: This table shows descriptive statistics of all variables. $CHANGE$ is the recommendation changes, $N52WL$ is the proxy for ambiguity in fundamentals, *ME* is the firm size, *ACOV* is the analyst coverage, *AGE* is the firm age, ΔVIX is the change in the *TXO* volatility index, *BM* is the market to book ratio, *MOM* is the price momentum, *IO* is a common stock holding ratio of an institution, *AXEP* is the analyst experience, *DC* is the recommendation deviation from consensus, *MAG* is the magnitude of recommendation changes. The variables are defined in Appendix.

dation change is not significant, but the proxies of ambiguity are related to $BHAR(0.1)$. On average, higher analyst coverage and younger firms have higher $BHAR(0.1)$. However, the interaction terms of recommendation change between ambiguity in fundamentals, ambiguity in information and market ambiguity have no significant coefficients. This implies that ambiguity does not affect the market's immediate response to recommendation changes.

In order to investigate whether the above results still hold when the holding periods are extended, we use different periods of BHAR as the dependent variables. Table 4 and Table 5 show these results. The results in Table 4 include firm ambiguity and market ambiguity. The coefficient of recommendation change is positive for $BHAR(0.125)$. This indicates that upgrading firms have higher buy-and-hold abnormal returns than firms within the same industry and of similar size and BM ratio. The significant and positive $D_1(HAIF_j)$ implies that a higher AIF firm has a lower $BHAR$. In addition, firms with shorter history have higher buy-and-hold abnormal returns, and this effect lasts for two days to six months. This implies that firms with strong ambiguity in information (AII) are affected by analyst recommendations for longer periods.

Table 3. Ambiguity and two-day buy-and-hold abnormal returns

	< 1 >	< 2 >	< 3 >
$INTERCEPT$	0.028 (0.009)	–0.018 (–0.070)	–0.193 (–0.610)
$CHANGE_j$	0.107*** (4.400)	0.099 (1.160)	0.087 (1.040)
Ambiguity proxies			
$D_1\left(HAIF_j\right)$		–0.013 (–0.140)	0.113 (1.210)
$D_2\left(RME_j\right)$		–0.013 (–0.140)	–0.135 (–1.390)
$D_3(RACOV_j)$		–0.113 (–1.160)	–0.266** (–2.100)
$D_4(RAGE_j)$		–0.227* (–1.840)	0.402*** (3.230)
ΔVIX		0.454*** (4.330)	–0.007 (–1.070)
$CHANGE_j \cdot D_1\left(HAIF_j\right)$		–0.005 (–0.840)	–0.024 (–0.380)
$CHANGE_j \cdot D_2\left(RME_j\right)$		–0.017 (–0.280)	0.087 (1.240)
$CHANGE_j \cdot D_3\left(RACOV_j\right)$		0.086 (1.240)	–0.095 (–0.940)
$CHANGE_j \cdot D_4(RAGE_j)$		–0.093 (–0.910)	0.002 (0.030)
$CHANGE_j \cdot \Delta VIX$		0.000 (0.000)	0.000 (0.060)
Ambiguity controls			
$D_5\left(MAIF_j\right)$		–0.080 (–1.000)	–0.009 (–0.110)
$D_6\left(MRME_j\right)$		0.009 (0.100)	0.012 (0.150)
$D_7\left(MRACOV_j\right)$		–0.076 (–0.950)	–0.083 (–1.030)
$D_8\left(MRAGE_j\right)$		0.229*** (3.330)	0.197*** (2.660)
Firm characteristics			
BM			0.000 (0.440)
MOM			0.004*** (6.540)
IO			0.000 (0.050)

Table 3 (cont.). Ambiguity and two-day buy-and-hold abnormal returns

	< 1 >	< 2 >	< 3 >
Analysts characteristics			
$AEXP$			0.006 0.810
Recommendation characteristics			
DC			–0.002 (–0.110)
MAG			–0.026 (–0.760)
Industry-fixed effect	Yes	Yes	Yes
Year-fixed effect	Yes	Yes	Yes
R^2	0.005	0.005	0.012
$\text{Adj}\,R^2$	0.002	0.004	0.007
N	10959	10959	10959

Note: This table sets the *DGTW* as the base investment portfolio, and calculate the 2-day buy-and-hold abnormal return ($BHAR(0.1)$). *CHANGE* is the analyst recommendation change $(CHANGE)$. Ambiguity in fundamentals (*AIF*) is defined as a stock price's nearness to its 52-week low $N52WL$. Ambiguity in information (AII) is defined as the reciprocal of firm size, the reciprocal of analyst coverage, and the reciprocal of firm age. $D_1(HAIF)$, $D_2(RME)$, $D_3(RACOV)$, and $D_4(RAGE)$ are the dummy variables, which are defined as 1, indicating ambiguity proxies ranked above their 30th, respectively. ΔVIX is the change in the volatility index of the Taiwan Stock Index Option. $D_5(MAIF)$, $D_6(MRME)$, $D_7(MRACOV)$, and $D_8(MRAGE)$ are the moderate ambiguity, which are dummy variables indicating ambiguity proxies ranked above their 30th and below their 70th percentiles, respectively. *BM* is book to market ratio, *MOM* is momentum of stock price return, *IO* is institutional ownership ratio, *AXEP* is analyst experience, *DC* is recommendation deviation from consensus, *MAG* is the magnitude of recommendation change. The variables are defined in Appendix. ( ) indicates the t-value. *,**,*** indicates statistical significance at 10%, 5% and 1% level, respectively.

Table 4. Ambiguity and BHARs: controlling for ambiguity

	BHAR(0.1)	BHAR(0.20)	BHAR(0.62)	BHAR(0.125)
$INTERCEPT$	–0.018 (–0.070)	2.626* (1.900)	4.993** (2.040)	0.088 (0.020)
$CHANGE_j$	0.099 (1.160)	0.318 (1.280)	0.577 (1.330)	1.435** (2.100)
Ambiguity proxies				
$D_1\left(HAIF_j\right)$	–0.013 –0.140	–0.823** (–2.230)	–2.223*** (–2.650)	–3.021** (–1.990)
$D_2\left(RME_j\right)$	–0.113 (–1.160)	0.306 (0.750)	1.551 (1.630)	2.258 (1.160)
$D_3\left(RACOV_j\right)$	–0.227* (–1.840)	–0.609 (–1.250)	0.149 (0.150)	–0.107 (–0.060)
$D_4(RAGE_j)$	0.454*** (4.330)	1.405*** (3.020)	2.733*** (2.810)	6.161*** (3.030)
ΔVIX	–0.005 (–0.840)	–0.022 (–1.020)	–0.027 (–0.530)	–0.040 (–0.360)
$CHANGE_j \cdot D_1\left(HAIF_j\right)$	–0.017 (–0.280)	0.175 (0.940)	0.036 (0.110)	0.471 (1.090)
$CHANGE_j \cdot D_2\left(RME_j\right)$	0.086 (1.240)	0.087 (0.520)	0.266 (0.950)	0.020 (0.050)
$CHANGE_j \cdot D_3(RACOV_j)$	–0.093 (–0.910)	–0.392 (–1.460)	0.504 (0.970)	–0.285 (–0.330)

Table 4 (cont). Ambiguity and BHARs: controlling for ambiguity

	BHAR(0.1)	BHAR(0.20)	BHAR(0.62)	BHAR(0.125)
$CHANGE_j \cdot D_4(RAGE_j)$	0.000 (0.000)	0.070 (0.260)	–0.336 (–0.820)	–0.802 (–1.180)
$CHANGE_j \cdot \Delta VIX$	0.000 (–0.040)	–0.008 (–0.810)	–0.019 (–1.220)	–0.047* (–1.830)
Ambiguity controls				
$D_5\left(MAIF_j\right)$	–0.080 (–1.000)	–1.030*** (–3.690)	–2.034*** (–3.270)	–2.509*** (–2.700)
$D_6\left(MRME_j\right)$	0.009 (0.1000)	0.464 (1.280)	1.091 (1.420)	1.311 (0.780)
$D_7\left(MRACOV_j\right)$	–0.076 (–0.950)	–0.522* (–1.700)	–0.540 (–0.850)	–0.343 (–0.280)
$D_8\left(MRAGE_j\right)$	0.229*** (3.330)	1.285*** (3.740)	0.985 (1.330)	2.355 (1.510)
Industry-fixed effect	Yes	Yes	Yes	Yes
Year-fixed effect	Yes	Yes	Yes	Yes
R^2	0.007	0.013	0.017	0.026
Adj R^2	0.004	0.009	0.013	0.022
N	10959	10959	10959	10959

Note: This table examine whether investors make decisions according to analyst recommendations after controlling for firm-level ambiguity and market ambiguity. $BHAR(0,H)$ is the buy-and hold abnormal returns for H = 1, 20, 62, 125 days. Other variables are defined in Table 3. ( ) indicates the t-value. *,**,*** indicate statistical significance at 10%, 5% and 1% level, respectively.

Table 5. Ambiguity and BHARs: controlling for both ambiguity and characteristics

	BHAR(0.1)	BHAR(0.20)	BHAR(0.62)	BHAR(0.125)
$INTERCEPT$	–0.193 (–0.610)	0.870 (0.630)	0.119 (0.040)	–10.167** (–2.010)
$CHANGE_j$	0.087 (1.040)	0.195 (0.820)	0.075 (0.190)	0.534 (0.890)
Ambiguity proxies				
$D_1\left(HAIF_j\right)$	0.113 (1.210)	0.171 (0.490)	0.720 (0.850)	3.117** (2.110)
$D_2\left(RME_j\right)$	–0.135 (–1.390)	0.184 (0.500)	1.287* (1.800)	1.481 (1.020)
$D_3\left(RACOV_j\right)$	–0.266** (–2.100)	–1.048** (–2.370)	–1.170 (–1.450)	–2.677* (–1.940)
$D_4(RAGE_j)$	0.402*** (3.230)	0.727 (1.570)	0.487 (0.530)	2.142 (1.160)
ΔVIX	–0.007 (–1.070)	–0.039* (–1.860)	–0.075 (–1.550)	–0.138 (–1.310)
$CHANGE_j \cdot D_1\left(HAIF_j\right)$	–0.024 (–0.380)	0.116 (0.610)	–0.067 (–0.210)	0.205 (0.510)
$CHANGE_j \cdot D_2\left(RME_j\right)$	0.087 (1.240)	0.110 (0.680)	0.307 (1.140)	0.117 (0.310)

Table 5 (cont). Ambiguity and BHARs: controlling for both ambiguity and characteristics

	BHAR(0.1)	BHAR(0.20)	BHAR(0.62)	BHAR(0.125)
$CHANGE_j \cdot D_3\left(RACOV_j\right)$	–0.095 (–0.940)	–0.385 (–1.440)	0.550 (1.130)	–0.222 (–0.270)
$CHANGE_j \cdot D_3\left(RAGE_j\right)$	0.002 (0.030)	0.079 (0.290)	–0.321 (–0.820)	–0.747 (–1.220)
$CHANGE_j \cdot \Delta VIX$	0.000 (0.060)	–0.003 (–0.360)	–0.004 (–0.270)	–0.018 (0.790)
Ambiguity controls				
$D_5\left(MAIF_j\right)$	–0.009 (–0.110)	–0.436 (–1.700)	–0.296 (–0.510)	1.109 (1.360)
$D_6\left(MRME_j\right)$	0.012 (0.150)	0.512 (1.610)	1.281** (2.160)	1.600 (1.240)
$D_7\left(MRACOV_j\right)$	–0.083 (–1.030)	–0.574** (–2.020)	–0.706 (–1.380)	–0.671 (–0.740)
$D_8\left(MRAGE_j\right)$	0.197*** (2.660)	0.862*** (2.660)	–0.328 (–0.500)	–0.107 (–0.080)
Firm characteristics				
BM	0.000 (0.440)	0.001*** (3.910)	0.004*** (5.230)	0.007*** (5.660)
MOM	0.004*** (6.540)	0.041*** (11.460)	0.121*** (15.130)	0.247*** (23.000)
IO	0.000 (0.050)	0.002 (0.330)	–0.008 (–0.460)	0.006 (0.190)
Analyst characteristics				
$AEXP$	0.006 (0.810)	0.042* (1.750)	0.168*** (3.620)	0.283*** (3.850)
Recommendation characteristics				
DC	–0.002 (–0.110)	0.019 (0.600)	–0.094 (–1.540)	–0.094 (–1.130)
MAG	–0.026 (–0.760)	0.079 (0.930)	0.252 (1.620)	0.303 (1.580)
Industry-fixed effect	Yes	Yes	Yes	Yes
Year-fixed effect	Yes	Yes	Yes	Yes
R^2	0.012	0.060	0.153	0.254
Adj R^2	0.007	0.056	0.150	0.251
N	10,959	10,959	10,959	10,959

Note: This table reports the effects of ambiguity on subsequent buy-and-hold returns over various periods. *BHAR (0, H)* is the buy-and-hold abnormal returns for H = 1, 20, 62, 125 days. Variables are as defined in Table 3 and Table 4. ( ) indicates the t-value. *,**,*** indicates statistical significance at 10%, 5%, and 1% level, respectively.

Furthermore, in Table 5, we include the characteristics of firms, analysts and recommendations as control variables in order to examine the influence of recommendation changes on investors. We find that recommendation changes have no significant effect on investors' responses when considering the effects of ambiguity. Ambiguity in fundamentals $\left(AIF\right)$ is significant and positively related to $BHAR\left(0.125\right)$ at a 5% confidence interval. In addition, firms with more analyst coverage have higher BHARs, an effect which persists for at least one month. Younger firms have higher two-day buy-and-hold abnormal returns. This result implies that, when analyst recommendations are changed, the effects of AII on subsequent stock price changes are mixed.

However, the interaction terms of recommendation change between *AIF, AII* or market ambiguity are not significantly different from zero. This implies that market response to recommendation changes is not affected by ambiguity magnitude for either short or long term. For more robust results, we divide *AIF* and *AII* into high, moderate and low firm subgroups, and further examine whether the market reaction to recommendation change is affected by different levels of ambiguity.

Table 6 presents the results when the ambiguity in fundamentals (AIF) is divided into three groups. The coefficients of reciprocal analyst coverage $\left(D_3\left(RACOV_j\right)\right)$ are marginally significant and negative at the 10% confidence level for high *AIF*, which confirms that firms with higher ambiguity in fundamentals have lower abnormal returns as recommendations are revised upward. The significant and negative coefficient of ΔVIX for moderate AIF indicates that a rise in market ambiguity would lead to a lower return for firms with moderate ambiguity in fundamentals. In addition, the coefficient of $CHANGE_j \cdot D_2\left(RME_j\right)$ is significantly positive only for firms with lower levels of AIF, which implies that investors in a small firm rely more on analyst recommendations; thus, the effect of recommendation changes on stock prices decreases with firm size (a proxy for AIF). However, this doesn't hold for moderate and high AIF. With respect to firm characteristics, price momentum and subsequent $BHARs$ are positively correlated, regardless of the level of ambiguity. This confirms the existence of the momentum effect in the Taiwan Stock Market.

Table 6. The effects of ambiguity in information and market ambiguity on BHARs under different levels of ambiguity in fundamentals

	Low AIF	Moderate AIF	High AIF
$INTERCEPT$	–0.313 (–0.520)	–0.546 (–0.940)	2.593** (2.540)
$CHANGE_j$	0.134 (0.840)	0.037 (0.240)	0.071 (0.540)
Ambiguity proxies			
$D_2\left(RME_j\right)$	–0.285 (–1.290)	–0.108 (–0.650)	0.000 (0.000)
$D_3\left(RACOV_j\right)$	–0.095 (–0.460)	–0.213 (–1.040)	–0.520* (–1.830)
$D_4(RAGE_j)$	0.194 (0.670)	0.219 (1.120)	0.793 (2.900)
ΔVIX	0.001 (0.070)	–0.020** (–2.200)	–0.001 (–0.050)
$CHANGE_j \cdot D_2\left(RME_j\right)$	0.207** (2.300)	0.008 (0.090)	0.100 (0.740)
$CHANGE_j \cdot D_3\left(RACOV_j\right)$	–0.037 (–0.250)	–0.089 (–0.550)	–0.154 (–0.630)
$CHANGE_j \cdot D_4(RAGE_j)$	–0.241 (–1.580)	0.023 (0.170)	0.138 (0.900)
$CHANGE_j \cdot \Delta VIX$	–0.001 (–0.220)	0.003 (0.470)	–0.001 (–0.230)
Ambiguity controls			
$D_6\left(MRME_j\right)$	–0.013 (–0.070)	0.044 (0.300)	–0.001 (–0.010)
$D_7\left(MRACOV_j\right)$	0.052 (0.470)	–0.097 (–0.870)	–0.229 –1.110
$D_8\left(MRAGE_j\right)$	0.026 (0.190)	0.100 (0.850)	0.540*** (2.770)

Table 6 (cont). The effects of ambiguity in information and market ambiguity on BHARs under different levels of ambiguity in fundamentals

	Low AIF	Moderate AIF	High AIF
Firm characteristics			
BM	0.000 (–1.520)	0.000 (1.050)	0.000 (0.250)
MOM	0.006*** (6.450)	0.003*** (2.760)	0.004** (2.440)
IO	–0.005 (–1.270)	–0.003 (–0.770)	0.006 (1.540)
Analyst characteristics			
AXEP	–0.002 (–0.120)	0.024** (1.980)	–0.014 (–0.840)
Recommendation characteristics			
DC	0.002 (0.110)	0.020 (1.010)	–0.031 (–1.080)
MAG	0.012 (0.240)	–0.054 (–0.910)	–0.036 (–0.560)
Industry-fixed effect	Yes	Yes	Yes
Year-fixed effect	Yes	Yes	Yes
R^2	0.026	0.017	0.021
Adj R^2	0.014	0.007	0.008
N	3,515	4,402	3,042

Note: This table presents the results when dividing the ambiguity in fundamentals into three groups. The sample is divided into low-, moderate-, and high-AIF groups according to the 30th and 70th percentiles of $N52WL$. $BHAR(0, 1)$ is the dependent variable. Other variables are defined in Table 3 and 4. ( ) indicates the *t*-value. *,**,*** indicates statistical significance at 10%, 5%, and 1% level, respectively.

Table 7 presents the results when market ambiguity is divided into three groups. Table 7 reveals that recommendation changes and $BHAR(0.1)$ are significantly positively correlated only when the market is moderately ambiguous. Further, during periods of low and high market ambiguity, there is a significant and positive relation between $BHAR$ and AIF. By contrast, $BHAR$ and AIF are negatively correlated in times of moderate market ambiguity. This indicates that AIF has different effects on stock price, depending on market ambiguity.

Moreover, the coefficient of the reciprocal of firm size and $BHAR$ is marginally significant and negative at the 10% level, indicating that smaller firms which are recommended by analysts have lower returns during periods of low market ambiguity. The relation between the reciprocal of analyst coverage and $BHAR$ is also significantly negative at the 10% level in times of low and moderate market ambiguity, but not significant for high market ambiguity. This implies that larger firms and firms with more analyst coverage have higher returns during periods of low and moderate ambiguity. The reciprocal of firm age is positively associated with $BHAR$ for low ambiguity. This implies that firms with a longer history have lower returns during periods of low market ambiguity. However, when controlling for the effect of market ambiguity, the effect of recommendation changes on stock prices is not significantly associated with ambiguity in fundamentals or ambiguity in information. Finally, the finding of price momentum remains unchanged regardless of market ambiguity.

Table 7. The effects of ambiguity in fundamentals and ambiguity in information and on BHARs under different levels of market ambiguity

	Low ΔVIX	Moderate ΔVIX	High ΔVIX
$INTERCEPT$	–0.013 (–0.020)	–0.045 (–0.090)	–0.516 (–0.900)
$CHANGE_j$	0.097 (1.560)	0.101** (2.090)	0.045 (0.690)
Ambiguity proxies			
$D_1\left(HAIF_j\right)$	0.491*** (2.640)	–0.334** (–2.410)	0.419** (2.340)
$D_2\left(RME_j\right)$	–0.352* (–1.700)	–0.269 (–1.300)	0.214 (1.170)
$D_3\left(RACOV_j\right)$	–0.460* (–1.910)	–0.393* (–1.850)	–0.010 (–0.040)
$D_4(RAGE_j)$	0.754*** (3.210)	0.385* (1.850)	0.070 (0.280)
$CHANGE_j \cdot D_1\left(HAIF_j\right)$	–0.032 (–0.260)	–0.031 (–0.310)	0.032 (0.270)
$CHANGE_j \cdot D_2\left(RME_j\right)$	0.096 (0.930)	0.137 (1.640)	0.044 (0.370)
$CHANGE_j \cdot D_3\left(RACOV_j\right)$	–0.148 (–0.820)	–0.012 (–0.060)	–0.108 (–0.610)
$CHANGE_j \cdot D_4(RAGE_j)$	0.019 (0.110)	–0.035 (–0.250)	0.036 (0.240)
Ambiguity controls			
$D_5\left(MAIF_j\right)$	0.119 (0.930)	–0.117 (–0.950)	0.087 (0.620)
$D_6\left(MRME_j\right)$	–0.156 (–0.890)	0.000 (0.000)	0.174 (1.190)
$D_7\left(MRACOV_j\right)$	–0.210 (–1.400)	–0.050 (–0.450)	–0.046 (–0.270)
$D_8\left(MRAGE_j\right)$	0.376*** (2.610)	0.103 (0.840)	0.139 (0.940)
Firm characteristics			
BM	0.000 (–0.510)	0.000 (0.150)	0.000 (0.350)
MOM	0.002** (2.570)	0.006*** (4.460)	0.006*** (3.500)
IO	0.001 (0.220)	–0.001 (–0.260)	–0.001 (–0.240)
Analyst characteristics			
$AXEP$	0.000 –0.010)	0.013 (1.60)	0.000 (0.030)
Recommendation characteristics			
DC	0.008 (0.300)	0.012 (0.560)	–0.028 (–1.010)
MAG	0.001 (0.010)	–0.006 (–0.014)	–0.078 (–1.190)
Industry-fixed effect	Yes	Yes	Yes
Year-fixed effect	Yes	Yes	Yes
R^2	0.020	0.025	0.018
$\text{Adj}\,R^2$	0.007	0.014	0.006
N	3.116	4.316	3.527

Note: This table presents the results when dividing the market ambiguity into three groups. The sample is divided into low-, moderate-, and high- ΔVIX groups according to the 30th and 70th percentiles of ΔVIX . *BHAR* (0, 1) is the dependent variable. Other variables are defined in Tables 3 and 4. ( ) indicates the *t*-value. *,**,*** indicates statistical significance at 10%, 5% and 1% level, respectively.

CONCLUSION

This paper investigates whether the effect of recommendation changes differs with ambiguity. We consider three proxies for ambiguity, namely ambiguity in fundamentals (AIF), ambiguity in information (AII) and the market ambiguity index in this research. We find that recommendation changes have short-term and positive influences on $BHARs$ only in times of moderate market ambiguity. AII has the most influence on subsequent stock returns; firms with more analyst coverage and shorter history have higher $BHARs$. An increase in market ambiguity decreases two-day $BHARs$ for firms with moderate ambiguity in fundamentals. For low-AIF firms, recommended changes have positive influence on smaller firms. Irrespective of market ambiguity and AIF, prior returns have significant and positive effects on the subsequent $BHARs$.

The response of stock prices to AIF is affected by market ambiguity. There is a negative relation between ambiguity in fundamentals and two-day $BHARs$ during periods of moderate market ambiguity. However, this relation becomes positive when the level of market ambiguity is low or high. Only during periods of low moderate market ambiguity do firms with a shorter history have higher abnormal returns.

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APPENDIX

Variable	Description	Calculation
$N52WL$	Stock price's relative nearness to its 52-week low	$N52WL_j = \frac{52WH_j - P_j}{52WL_i}$, where P_j is stock j price at the end of prior month. $52WH_j$ and $52WL_j$ are the 52-week highest and lowest prices, respectively
ME	Market value (unit: millions)	The stock price timesthe outstanding sharesat the end of prior month issued.
BM	Book-to-market ratio	The book value at the end of previous fiscal year divided by market capitalization of common equity at the end of prior month
MOM	Stock return momentum	$MOM_j = \Pi_{q=-11}\left(1+R_{j,q}\right) - \Pi_{q=-11}\left(1+R_{j,q}^{DGTW}\right)$, where $R_{j,q}^{DGTW}$ is the month-q raw return on a benchmark portfolio with comparable size, book-to-market, and momentum characteristics as stock j (Daniel, Grinblatt, Titman, & Wermers, 1997)
IO	Institutional ownership ratio	The common stock shares heldby institutions divided by total outstanding shares at the end of prior month issued
AGE	Firm age (unit: quarters)	The number of quarters from the firm listed to the month prior to the announcement of recommendation change
$ACOV$	Analyst coverage	The number of analysts following the firm during the year prior to the end of the prior month
$AEXP$	Analyst experience	The number of quarters from the first recommendation issued by an analyst to one month before the recommendation is revised
DC	Recommendation deviation from consensus	$DC = \left(\mathrm{Rec}_{\mathrm{current}} - \mathrm{Consensus}\right)^2 - \left(\mathrm{Rec}_{\mathrm{prior}} - \mathrm{Consensus}\right)^2$, where $\mathrm{Rec}_{\mathrm{current}}$ is a current recommendation level; $\mathrm{Rec}_{\mathrm{prior}}$ is a prior recommendation level; $\mathrm{Consensus}$ is the consensus recommendation. According to Jegadeesh et al. (2004), consensus recommendation is calculated as the mean of recommendations issued by different analysts for a specific month
MAG	Magnitude of recommendation change	$MAG = \left\lvert \mathrm{Rec}_{\mathrm{current}} - \mathrm{Rec}_{\mathrm{prior}} \right\rvert$, where $\mathrm{Rec}_{\mathrm{current}}$ is a current recommendation level; $\mathrm{Rec}_{\mathrm{prior}}$ is a prior recommendation level