Satellite-Driven Investor Attention and Stock Return Comovement

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Abstract

Satellite launches distract investors from the stock market. Under limited attentional resources, investors allocate their attention more to market-level shocks than firm-specific shocks, making stock returns to comove more with the market on satellite launch days compared to other days. We provide supportive evidence using U.S. satellite launches and return comovements for U.S. stocks. We also show that investors pay more attention to pioneering, failed, and manned launches, leading to larger increases in return comovement. Moreover, international aerospace competition seems to attract more U.S. investors' attention, especially during the Soviet period and for launches by Russia, China, and India, leading to higher return comovement. Our results are robust to the exclusion of firms in the aerospace industry. Finally, we deliver an important financial implication by designing a trading strategy to exploit the potential satellite-induced mispricing, which yields an annualized abnormal risk-adjusted return of up to 17% within the three-day window around the launch date.

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"Humanity is destined to explore, settle, and expand outward into the universe"
Buzz Aldrin (American former astronaut – a second man to walk on the Moon)

1. Introduction

Back in history in 1969, roughly one fifth of the world's population (i.e., around 600 million people) watched the Apollo 11 mission live via television broadcast, marking a global media sensation. In the United States, "94 percent of people watching television were tuned into the event".[1] In the era of social media live stream, the launch of SpaceX's Falcon Heavy rocket in on February, 06 2018 stood out as the second biggest live stream in YouTube's history with 2.3 million simultaneous views.[2] As of April 2021, the National Aeronautics and Space Administration (NASA)'s YouTube channel had nearly 9 million subscribers and its video view and subscriber numbers have extraordinarily jumped around the time of satellite launches. For example, as shown in Figure 1, the launch of NASA-SpaceX Falcon 9 rocket (Demo-2 mission) in May 2020 was associated with an abrupt increase of nearly 108 million views and 1.3 million new subscribers compared to less than 10 million views and 100 thousand new subscribers a month on average over the previous year.[3] A survey conducted by Pew Research Center in March 2018 revealed that 72% of the interviewed Americans say, "it is essential that the U.S. continue to be a world leader in space exploration".[4] These evidence clearly indicate that satellite launches have widely attracted public attention.

We argue that, in the U.S., the launch of a satellite can be an exogenous event that significantly attract investor attention away from financial markets. Existing theoretical research (e.g., Peng and Xiong, 2006; Veldkamp, 2006; Veldkamp and Wolfers, 2007) forecasts that stock return comovement is driven by investors' inattention. Specifically, when

[1] See, https://www.nytimes.com/2019/07/15/business/media/apollo-11-television-media.html.
[2] See, https://www.theverge.com/2018/2/6/16981730/spacex-falcon-heavy-launch-youtube-live-stream-record.
[3] See, https://socialblade.com/youtube/c/nasa.
[4] See, https://www.pewresearch.org/science/2018/06/06/majority-of-americans-believe-it-is-essential-that-the-u-s-remain-a-global-leader-in-space/.

investors are attracted away from financial markets by exogenous events, they relatively pay less attention to firm specific information than market shocks, leading to higher stock return correlations with the market. Nonetheless, testing the theory's implications is challenging due to an identification of a suitable exogenous shock to investors' attention. In this research area, the only investigated shock to date is the large jackpot lotteries proposed by Huang, Huang, and Lin (2019) for the Taiwan market, and later studied in the Chinese market (see, Zhaunerchyk, Haghighi, and Oliver, 2020; Hu et al., 2021).

Our choice of satellite launches as exogeneous shocks to investor attention is motivated by the following reasons. First, although satellite launches and their outcome (i.e., success or failure) can have a direct impact on firms in the aerospace industry, they are largely independent of the financial markets.[5] Second, space exploration is of nationwide interest in the U.S. It is extremely important for national security. The U.S. government spends an approximate $40 billion a year on civilian and military space programs.[6] In addition, public interest in space industry and its associated technology is growing remarkably in recent years. It is estimated that this industry will be worth between $1.0 – $1.4 trillion by 2040 and nearly $3 trillion by 2050.[7] Based on this information and the facts discussed earlier, we conjecture that satellite launches can draw a great deal of investors' attention on the days when these events occur relative to other days. Given that human mind is naturally subject to limited cognitive capacity and hence resort to selective attention to collect and process information (e.g., Kahneman, 1973), we argue that investors become more attentive to market-wide information than firm-specific information during high attention-attracting periods, which is consistent with the spirit of Peng and Xiong (2006) and Huang, Huang, and Lin (2019)

[5] We address this issue by performing a robustness check with a subsample that excludes firms in the aerospace industry. Our findings remain highly consistent.

[6] https://www.forbes.com/sites/gregautry/2017/07/09/americas-investment-in-space-pays-dividends/?sh=1edbcf22639b.

[7] https://www.morganstanley.com/ideas/investing-in-space; https://www.cnbc.com/2020/10/02/why-the-space-industry-may-triple-to-1point4-trillion-by-2030.html.

frameworks. Therefore, we predict that stock prices reflect more of market shocks than their firm-level shocks on satellite launch days, leading to higher return comovement with the market.

To test our prediction, we use 300 U.S. satellite launch events from 1957 to 2019. We first examine the difference in investor attention between satellite launch days and non-launch days. We find that share turnover and U.S. mutual fund flows decrease significantly on launch days, suggesting that investors reduce their trading and investment activities when a satellite is launched. We also find that both normal and abnormal Google Search Volume Index (SVI) for the word "satellite" sharply increase on launch days, but the SVI for abbreviations of firm names significantly decreases on those days. These results confirm our expectation that investors are distracted from their stock investments while attracted by satellite launches.

Next, we calculate stock return comovements with the market separately for launch days and non-launch days and obtain the difference for each firm. We measure return comovement by the Pearson correlation coefficient between the stock excess return and the market excess return and the adjusted R^2 from the market model (e.g., Barberis, Shleifer, and Wurgler, 2005; Anton and Polk, 2014; Huang, Huang, and Lin, 2019). We find that the difference in mean correlation coefficient between launch and non-launch days is 0.03, representing an economically and statistically significant increase of 11% from the non-launch correlation coefficient. The difference in mean adjusted R^2 is 0.019, also marking a substantial increase of 22% from the average R^2 on non-launch days. The results for medians are similar in both statistical and economic terms.

Since public attention to a satellite launch may start to pick up some days before the official event and subside a couple of days after that, we investigate this spillover effect of investor attention on return comovement. We examine the effects for two and four trading days before and after launch days, which we call "spillover days". We find that the stock return comovement with the market is lower on spillover days compared to launch days, but higher than the return comovement on non-launch days.

Alongside the identification of a unique shock to test the theory of investor inattention in the U.S. market, we further contribute to the literature an important financial implication based on the main findings. More specifically, we design a trading strategy to exploit the potential stock mispricing due to increased (reduced) attention to market-wide (firm-specific) shocks. For each satellite launch event, we estimate the "additional" sensitivity of a stock's returns to satellite launches in the prior year ending on day t – 10 before the event. This additional sensitivity, called the satellite beta, is the value of beta that is on top of the stock beta on non-launch days. We decompose the satellite beta of each stock depending on whether the market price went up or went down on launch days of prior year. We conjecture that for two similar stocks, one being insensitive to satellite launch events, and one comoving more with the market on the event days due to investor inattention, the later tends to be overpriced (underpriced) if the market goes up (down) on those days. As a result, we term the satellite beta as "overpriced" ("underpriced") beta for increasing (decreasing) market condition. We then sort stocks into five portfolios based on their "overpriced" ("underpriced") betas and calculate the portfolio returns for different holding windows around launch events. If our conjecture is supported, we should obtain significant abnormal returns for longing the highest "underpriced" beta portfolios and shorting the highest "overpriced" beta portfolio. Indeed, our empirical results show that this long-short strategy yields an abnormal risk-adjusted return of between 10% and 17% per year within a three-day window around the launch date.

We are also interested in exploring whether the U.S. stock market is strongly distracted by worldwide competitions in the aerospace area. We perform two analyses to test our conjecture. First, we distinct U.S. satellite launches into two periods: pre- and post-Soviet Union dissolution periods. We consistently find that the stock return comovement with the market is significantly higher on launch days than on non-launch days for both pre- and post-Soviet Union dissolution periods. More importantly, the difference in return comovement between launch days and non-launch days is significantly larger in the pre- compared to the post-Soviet Union dissolution periods. The results provide fresh evidence that U.S. investors significantly paid more attention to satellite launches when worldwide competition in the aerospace area peaked during the Cold War. Second, we collect international satellite launches and divide them into three groups: U.S. satellite launches, launches by Russia, China, and India (hereafter, RCI), and those by other countries.[8] We then replicate the main analysis and find interesting results. The stock return comovement with the market is the largest on RCI's launch days, followed by U.S. launch days, then other countries' launch days. As expected, the return comovement is the smallest on U.S. non-launch days (excluding days overlapped with launch days in countries other than the U.S.). The results confirm that satellite launches by powerful foreign countries strongly attract U.S. investors' attention away from their stock investments, leading stock returns to comove more with the market.

As for further analyses, we use the event status and description information to split satellite launch events into: (1) pioneering and normal events, (2) success and fail events, and (3) manned and unmanned events. We find remarkable results. First, we find that the increase in stock return comovement on launch days is significantly larger for pioneering launches than normal launches. Second, stock return comovement with the market increases markedly more for unsuccessful launch events than for successful launches. This is consistent with the findings in psychology discipline (e.g., Taylor, 1991; Rozin and Royzman, 2001), which document a

[8] We group Russia, China, and India together for the following reasons. A Morning Consult poll conducted on 12–15 February 2021 shows that 52% (45%) of the respondents consider China (Russia) a "major threat" to the U.S. leadership in space research, https://morningconsult.com/2021/02/25/space-force-travel-exploration-poll/. Meanwhile, the Indian space program (ISRO – Indian Space Research Organization) is among the most cost-effective program such that comparable missions could be completed at a much lower cost compared to NASA. For example, the Martian orbit of India was launched at a cost of around $74 million, while a similar mission of NASA's Mars probe, Maven, costed $651 million. Besides, the ISRO comes to attention as it is the first space organization succeeding in its first launch attempt.

considerably stronger cognitive effect of negative events on humans compared to positive events. Third, stock returns comove more with the market on the launching days of manned satellites compared to unmanned ones. We also investigate stock return comovements with the corresponding industry and find similar patterns with market comovements. We find that the return correlation between a stock and its industry is higher on satellite launch days than that on non-launch days. Finally, there is a concern that there are firms operating in the aerospace industry and hence, the events may not be totally exogenous to the financial markets. To address this concern, we perform a robustness check by excluding these firms. The results are robust.

Our study contributes to the literature that links rational inattention to phenomena in the financial markets. A pioneering work proposed by Peng and Xiong (2006) introduces a framework of rational inattention to explain puzzling asset pricing phenomena. After that, rational inattention is also used to explain home bias (Nieuwerburgh and Veldkamp, 2009), under-diversification (Nieuwerburgh and Veldkamp, 2010). Existing theoretical research (e.g., Veldkamp, 2006; Veldkamp and Wolfers, 2007) forecasts that exogenous shocks to investors' attention can trigger individual stocks to comove more with the market due to investors are attracted away from the financial markets and pay relatively more attention on learning market-level than firm-specific information. However, empirical research that links investor attention to return comovement is relatively silent due to the challenge of identifying exogenous shocks to investor attention. Exceptions include Huang, Huang, and Lin (2019), Zhaunerchyk, Haghighi, and Oliver (2020), and Hu et al. (2021). While Huang, Huang, and Lin (2019) employed large jackpot lotteries as an exogenous shock to test the theory in Taiwan market, the two later studies exploit the same shock and replicate Huang, Huang, and Lin (2019) in the

Chinese markets. Our study identifies a unique shock, the satellite launch, which is applicable to test the theory in the most important market in the world, the U.S. market.[9]

Our study also contributes to the literature that explains return comovement in financial markets. For example, stock return comovement is driven by culture factors (Eun, Wang and Xiao, 2015), similarity in investors' country origin (Meng and Pantzalis, 2022), impact on fundamental values due to climate disasters (Ma et al., in press), or economic linkage (Chen, Guo, and Tu, 2021). Investors' tendency to categorize stocks into investment groups based on their characteristics also gives rise to return comovement (Barberis and Shleifer, 2003). The extant literature has documented return comovement for stocks included in the same index (e.g., Barberis, Shleifer, and Wurgler, 2005; Greenwood, 2008; Boyer, 2011), with firm headquartered in the same geographic location (Pirinsky and Wang, 2006), covered by the same analysts (Israelsen, 2016), sharing common mutual fund ownership (Anton and Polk, 2014), or having other similar characteristics such as price (e.g., Green and Hwang, 2009), size and book-to-market ratio (Kumar, 2009), dividend payment (Hameed and Xie, 2019), and financial leverage (Do, Nguyen, and Nguyen, 2022). We differentiate our study from previous studies by linking investors' attention to the stock return comovement with the market.

The remainder of the paper is structured as follows. Section 2 describes data selection and descriptive statistics. Section 3 validates the U.S. satellite launches as exogenous shocks to investors' attention. Section 4 discusses empirical results on return comovement with the market triggered by satellite launches. Section 5 investigates the cross-border effect of the international satellite launches on U.S. stock return comovement. Section 6 presents robustness tests and additional analyses. Section 7 concludes the paper.

[9] Peress and Schmidt (2020) use sensational news on television as exogenous shocks to noise traders. They find that on these news days, trading activity and liquidity decrease significantly for stocks with large proportions of noise traders.

2. Data Selection and Descriptive Statistics

Our study employs four main databases, including (1) U.S. satellite launch events, (2) daily stock related data and daily market return, (3) Google Search Volume Index (SVI) for "satellite", and (4) mutual fund related data. We obtain U.S. satellite launch events from Wikipedia in the period from 1957 to 2019.[10] Each satellite launch event includes launch date, launch country, satellite name, launch vehicle, status (i.e., success/fail) and description. We report descriptive statistics on U.S. satellite launch events in Table 1. Our main sample includes 300 U.S. satellite launches. We consider Soviet Union dissolution event in 1991 as a breakpoint year and present the sample distribution by approximately 10-year periods. Table 1 shows that the U.S. has made 170 and 130 satellite launches during pre- and post-Soviet Union dissolution periods, respectively. In additional tests, we split our sample events into subsamples using available information. We first define a launch as a pioneering event if the description contains a term "first" or "pioneering" and otherwise a normal one. There are 105 (195) pioneering (normal) satellite launches. Second, we split our sample into successful and failed launches. We define a launch as a successful event if the status column is reported as "success" and otherwise a failed one. There are 257 successful launches and 43 failed ones. Third, we also divide our sample into manned and unmanned launches. There are 161 manned launches and 139 unmanned ones. To examine the impact of international satellite launches on U.S. stock return comovements, we collect and use 222 satellite launches by the RCI nations (i.e., Russia, China, and India) and 95 satellite launches by other countries.

[Insert Table 1 about Here]

[10] Find more information at: https://en.wikipedia.org/wiki/Timeline_of_artificial_satellites_and_space_probes. It is worth noting we cross-check satellite launch events from Wikipedia against other available data sources such as the UCS satellite database, https://www.ucsusa.org/resources/satellite-database, the Indian Space Research Organization database, and the European Space Agency database). Besides, to ensure the "cleanest" shock as possible, we exclude all the commercial launches.

Next, we obtain daily stock related data such as stock return, trading volume, and shares outstanding from the Centre for Research in Security Prices (CRSP). Our sample includes common stocks that have share codes of 10 and 11 trading on NYSE/Amex and Nasdaq. We exclude firms that have less than 40 years in the research period of 1957–2019. Our final sample includes 2,095 firms. We also obtain daily and weekly Google Search Volume Index for the term "satellite" from Google Trends. Since our study focuses on U.S. investors' attention, we select the search region as the U.S. The data starts on 4th January 2004 and ends on 31st December 2019.[11]

3. Satellite Launch Events as Exogenous Shocks to Investors' Attention

In our study, we argue that on a satellite launch day, investors allocate more attention to the exciting event that their stock investments, which results in an increase in stock return comovement with the market. In this section, we validate satellite launches as exogenous shocks to investors' attention using share turnover and Google search volume.

Following the literature (e.g., Gervais, Kaniel, and Mingelgrin, 2001), we first use share turnover, measured as the ratio of daily trading volume to total shares outstanding, to proxy for investors' attention to the stock market. If investors are distracted from the stock market due to a satellite launch event, we expect that their stock trading activities are lower on the event day compared to other days. We measure daily share turnover as daily trading volume divided by shares outstanding.

Consistent with our expectations, Panel A of Table 2 shows that share turnover is lower on launch days than that on non-launch days. Specifically, the mean and median differences in

[11] The earliest data available for SVI are from January 4, 2004. Find more information at: https://trends.google.com/trends/explore?q=satellite&geo=US

share turnover between launch and non-launch days are -2.3% and -2.0%, statistically significant at the 1% level, respectively. We estimate a regression of share turnover on the launch day dummy controlling for firm, year, month, and day of week fixed effects. The result in Panel B shows a statistically significant decrease of -2.9% in daily share turnover on launch days.

Next, we follow Da, Engelberg, and Gao (2011) and use Google SVI for the key word "satellite" to capture for investors' attention to satellite launch events. We also extract SVI for the names of firms in the S&P 500 index. These firms represent between 75–80% of the U.S. stock market in terms of market capitalization. If satellite launches attract investors' attention, Google SVI for "satellite" should be higher on launch days than that on non-launch days. In contrast, we expect a drop in firm SVI on event days. We follow Huang, Huang, and Lin (2019) to calculate daily normal and abnormal SVI for "satellite" as below:

$$SVI_{AD,t} = SVI_{w} * (SVI_{UN,t} / MESVI_{w}) \tag{1}$$

$$ASVI_{AD,t} = (SVI_{AD,t} - MDSVI_{AD,25\text{-}5}) / MDSVI_{AD,25\text{-}5} \tag{2}$$

where $SVI_{AD,t}$ ($SVI_{UN,t}$) is adjusted (raw) SVI for "satellite" on day *t*. SVI_{w} is the weekly SVI to which a raw daily SVI belongs. $MESVI_{w}$ is weekly average of $SVI_{UN,t}$. $ASVI_{AD,t}$ is the abnormal SVI for "satellite" on day *t* and $MDSVI_{AD,25\text{-}5}$ is the median of adjusted SVI from the previous 25th week to 5th week. We apply the same process to calculate abnormal firm SVI.

The results in Table 2 indeed confirm our expectation. The mean and median differences in abnormal SVI between launch and non-launch days are 2.330 and 0.991 while the corresponding differences for abnormal firm SVI are -0.041 and -0.012, respectively. All difference tests are statistically significant at the 1% level. These results are robust in a regression framework that controls for firm, year, month, and day of week fixed effects. Overall, the results for share turnover and Google SVI provide supportive evidence that investors become more attentive to satellite launch events and inattentive to stock investments.

[Insert Table 2 about Here]

4. U.S. Satellite Launch Events and Stock Return Comovement

4.1. Baseline Results

Given the above evidence on satellite-induced shocks to investors' stock market attention, we move on to test whether there is an increase in comovement between stock returns and the market in this section. Following the literature, we construct two proxies for stock return comovement.

The first proxy is the time series Pearson correlation coefficient between the stock excess return and the market excess return (e.g., Anton and Polk, 2014; Huang, Huang, and Lin, 2019). For each stock *i*, we calculate the correlation coefficients using daily excess returns for launch days and non-launch days separately and denote them as $\rho_{SL,i}$ and $\rho_{NSL,i}$, respectively. We then test the mean and median differences between $\rho_{SL,i}$ and $\rho_{NSL,i}$ across our sample stocks. The second proxy is the adjusted R^2 of the CAPM model using daily excess returns. We denote stock *i*'s adjusted R^2s for launch days and non-launch days as $R2_{SL,i}$ and $R2_{NSL,i}$, respectively. We then test whether the mean and median differences between $R2_{SL,i}$ and $R2_{NSL,i}$ are significantly positive since higher R^2 indicates more (less) explanatory power of market (firm-specific) shocks in stock returns (e.g., Morck, Yeung, and Yu, 2000; Durnev, Morck, and Yeung, 2004).

We present the results in Panel A of Table 3. Consistent with our expectation, we find that individual stocks experience an increase in return comovement with the market on launch days. Specifically, the return correlation coefficient is higher on launch days than on non-launch days, and the increase is statistically significant for both mean and median coefficients. The mean (median) difference between $\rho_{SL,i}$ and $\rho_{NSL,i}$ is 0.030 (0.027), indicating an economically meaningful increase of 11% (10%) in return correlation between stocks and the market. The results for the adjusted R^2 exhibit similar patterns. The mean adjusted R^2 is 0.103 and 0.085 for satellite launch and non-launch days respectively, marking a statistically significant change of 0.019 or a 22% increase in economic terms relative to the non-launch adjusted R^2. The median increase between $R2_{SL,i}$ and $R2_{NSL,i}$ is also statistically and economically significant. To put our results in perspective, Huang, Huang, and Lin (2019) report an average increase of 4% (10%) in correlation coefficient (adjusted R^2) on large jackpot days in Taiwan, and Ma et al. (in press) show a corresponding increase of 3% (5%) in climate disaster months. Our results provide the first set of evidence on the rise in stock-market return comovement due to investor distraction by satellite launch events.

[Insert Table 3 about Here]

4.2. Decomposition of Changes in Correlation Coefficient

In this subsection, we investigate which is the primary factor that drives the changes in correlation coefficient by following Huang, Huang, and Lin (2019) to decompose the difference in logged correlation coefficient between launch and non-launch days into three components as below:

$$log\frac{\rho_{SL,i}}{\rho_{NSL,i}} = log\frac{\sigma_{i,Mkt}^{SL}}{\sigma_{i,Mkt}^{NSL}} - log\frac{\sigma_{SL,i}}{\sigma_{NSL,i}} - log\frac{\sigma_{SL,Mkt}}{\sigma_{NSL,Mkt}} \quad (3)$$

where $\rho_{SL,i}$ and $\rho_{NSL,i}$ denote the correlation coefficients between stock i's excess returns and market excess returns on satellite launch and non-launch days, respectively. $\sigma_{SL,i}$ ($\sigma_{SL,Mkt}$) and $\sigma_{NSL,i}$ ($\sigma_{NSL,Mkt}$) denote the standard deviations of stock (market) excess returns on launch and non-launch event days, respectively. $\sigma_{i,Mkt}^{SL}$ and $\sigma_{i,Mkt}^{NSL}$ denote the excess return covariances between firm i and the market on launch and non-launch days, respectively.

To find out how much (in %) each of these three components contribute to the change in correlation coefficient, we divide both sides of Eq. (3) by the change in correlation coefficient.

$$1 = \underbrace{\frac{log\frac{\sigma_{i,Mkt}^{SL}}{\sigma_{i,Mkt}^{NSL}}}{log\frac{\rho_{SL,i}}{\rho_{NSL,i}}}}_{X} + \left[\underbrace{-\frac{log\frac{\sigma_{SL,i}}{\sigma_{NSL,i}}}{log\frac{\rho_{SL,i}}{\rho_{NSL,i}}}}_{Y}\right] + \left[\underbrace{-\frac{log\frac{\sigma_{SL,Mkt}}{\sigma_{NSL,Mkt}}}{log\frac{\rho_{SL,i}}{\rho_{NSL,i}}}}_{Z}\right] \tag{4}$$

where X represents the percentage contribution from covariance between stock excess returns and market excess returns. Y (Z) represents the percentage contribution from the volatility of stock (market) excess returns.

We report the results in Panel B of Table 3, which show that the change in covariance, X, is the primary driver of the change in correlation coefficient with its mean and median percentage contributions of around 131% and 108%, respectively. The results for Y and Z do not indicate any positive contribution from stock and market return volatilities. In the last column, we calculate the percentage change in return covariance, i.e., $\sigma_{i,Mkt}^{SL}/\sigma_{i,Mkt}^{SL} - 1$, and test if this is significantly different from zero. The result shows that this percentage change is positive and statistically significant, confirming that stock returns covary more with market returns on satellite launch days, which further supports our baseline results.

4.3. Spillover Effects of Satellite Launch Events

Since a satellite launch date may be already known in advance via media coverage, it is likely that investor attention starts to pick up a couple days before the event date. In addition, the attention towards the launch may remain relatively high before dying out completely after the event. If so, we expect that satellite-induced return comovement spills over to days around the launch date.

We test this spillover effect using two and four days before and after the event date and report the results in Table 4. In general, we find that stock return comovements with the market are lower on preceding and following trading days than that on the official launch day but higher than that on non-launch days. For example, the mean and median of differences in return correlation with the market between launch days and two preceding (following) days are 0.014 (0.013) and 0.016 (0.015) while the differences between two preceding (following) days and non-launch days are 0.017 (0.019) and 0.011 (0.012), respectively. All difference tests are statistically significant. In addition, we find no significant differences in return correlation with the market between preceding and following days. We also find robust results with the adjusted R^2. The results remain consistent within tests on four preceding and following trading days.

Figure 2 visualizes an increasing pattern of stock return comovement with the market four days prior to the launch date and peaks on the event day before decreasing on post-event days. The results indicate that satellite launch events attract investors’ attention on pre-event days to some extent and this attraction peaks on official launch days before it dissipates gradually after the event day.

[Insert Table 4 about Here]

[Insert Figure 2 about Here]

4.4. Trading Strategy

In this section we analyse the financial implication of our main findings by designing a hypothetical trading strategy that exploits the investor inattention on the satellite launch days. Our previous analysis shows that when investors are distracted by the satellite launches, they will focus more on the market-level information rather than idiosyncratic information at stock level, therefore stock returns will comove more with market returns. This implies that, on average, stocks are mispriced to some extent on a short-term basis because this inattention delays the incorporation of stock-level information into stock prices around the satellite launch days. When investor inattention dissipates, stock prices will be adjusted to incorporate those not-yet-reflected stock-level information. Therefore, chances for trading profitability emerge. We conjecture that if a stock strongly comoves with the market on a satellite launch day and the market price increases (decreases) on the day, it is likely that the stock is overpriced (underpriced) on average due to the investor inattention. Therefore, if one longs the portfolio of underpriced stocks and shorts the portfolio of overpriced stocks, the strategy can earn abnormal returns. We test this conjecture by performing the following analyses.

For each satellite event on date *t*, we employ one year data up to 10 days prior to the event (i.e., from *t* - 375 to *t* - 10) to run the below regression. We use this model to capture the "additional" sensitivity of a stock's returns to market returns on previous satellite launch days,[12] and decompose it depending on the direction of the market price movement.

$$
\begin{aligned}
(R_{i,w} - R_{f,w}) = \alpha_i &+ \beta_{i,o,t}\,(R_{mkt,w} - R_{f,w})*\mathrm{I}(R_{mkt,w} > 0)*Satellite_w \,+ \\
&\beta_{i,u,t}\,(R_{mkt,w} - R_{f,w})*\mathrm{I}(R_{mkt,w} < 0)*Satellite_w \,+ \\
&\beta_1\,(R_{mkt,w} - R_{f,w}) + \beta_2 SMB_w + \beta_3 HML_w + \beta_4 RMW_w + \beta_5 CMA_w + e_{i,w} \qquad (5)
\end{aligned}
$$

[12] This additional sensitivity is the amount of beta which is on top of the non-satellite day beta. Note that we exclude firms related to the aerospace industry in this section to better focus on the investor inattention perspective of satellite launches.

where $R_{i,w}$ is the return of firm i on day w ($w = t - 375, \ldots, t - 10$); $R_{f,w}$ is the risk-free rate on day w. $Satellite_w$ is dummy satellite event, which receives a value of one on launch days and zero on other days within the estimation window. I(.) receives value of one if the logical function is correct and zero otherwise. Controls are the Fama–French five common risk factors: the CRSP value-weighted market excess return, (R_{mkt} - $R_{f,w}$), and the size (*SMB*), book-to-market (*HML*), operating profitability (*RMW*), and investment (*CMA*) factors. As per our conjecture discussed previously, $\beta_{i,o,t}$ in Eq. (5) represents the additional sensitivity of the stock's returns to market returns, leading to the stock's being overpriced on satellite launch days. Hence, we name $\beta_{i,o,t}$ as "overpriced" beta. Similarly, $\beta_{i,u,t}$ can be considered as "underpriced" beta. The higher the beta, the higher the mispricing possibility.

Next, based on the values of the "overpriced" and "underpriced" betas for each satellite event, we sort each type of betas into quintiles to form the portfolios. As a result, we obtain five portfolios associated with "overpriced" betas, and five portfolios associated with "underpriced" betas corresponding to each satellite event. Finally, we assess the abnormal return of each portfolio, α_p, by regressing its excess returns on the Fama–French five factors using different holding periods h, where h = [-2, 0], [-2, 1], [-2, 2], [-3, 0], and [-3, 1]. Note that for the "underpriced" ("overpriced") beta portfolios, we long (short) them at the beginning of a holding period and short (long) at the end of the holding period.

We report α_p from equal- and value-weight portfolio returns in Panels A and B of Table 5, respectively. The last columns show the alphas of long-short strategies that long the "underpriced" beta portfolios and short the corresponding "overpriced" beta portfolios. Consistent with our conjecture mentioned earlier, we find that only portfolios of stocks that are most sensitive to satellite launches (i.e., beta quintiles 4 and 5) experience a significant increase in alpha across the holding windows. These groups represent the portfolios of stocks which have the highest possibility of mispricing induced by satellite launches. Meanwhile, the portfolios with the lowest "underpriced" or "overpriced" betas do not generate abnormal returns. These groups include stocks that are insignificantly affected by the satellite-driven investor attention, and therefore have the lowest possibility of the mispricing induced by satellite launches. Interestingly, the long "underpriced" beta portfolios – short "overpriced" beta portfolios strategy normally generates larger abnormal returns when it starts two days before the satellite launch events, 15.2% (14.7%), 13.7% (14.5%), and of 17.3% (17.2%) for equal weights (value weights) over the [-2, 0], [-2, 1], and [-2, 2] holding horizons.[13] These results can be interpreted through Figure 2 when we observe that the highest rate of an increase in the stock return comovement with the market starts from two days prior to the event.

[Insert Table 5 about Here]

5. Satellite Launch and Stock Return Comovement: Cross-Border Effects

Since World War II, the U.S. has been a leader in space research and space exploration. However, the last few decades have seen the growth of a number of international space organizations, particularly from Russia and China, that can challenge the U.S. leadership. Besides, the space program of India has been attracting significant attention due to its most cost-effective but successful missions. Hence, we are interested to explore whether worldwide competitions in the aerospace area also drive U.S. investors' attention and hence induce U.S. stock return comovements.

To address this question, we conduct two analyses. First, we separate the stock return comovement with the market on satellite launch days in pre- and post-Soviet Union dissolution

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[13] Based on Fong, Holden, and Trzcinka (2017), the average round-trip effective spread for U.S. listed stocks is approximately 2 basis points. Our strategy generates an average return between 15.6 and 20.6 basis points over a 3- or 4-day window surrounding the satellite launch date. This suggests that our trading strategy remains significantly profitable after adjusting for transaction costs.

and investigate the difference. Second, we calculate U.S. stock return comovement with the market on launch days by the RCI group (i.e., Russia, China, and India) or by other countries and then compare with that on U.S. satellite launch days.

5.1. Pre- and Post-Soviet Union Dissolution (1991)

Prior to Soviet Union dissolution, Space Race was aggressive between the two Cold War rivals, the United States and the Soviet Union. Even though the Space Race formally ended in the middle of 1975, the end of Cold War had not come until the Soviet Union dissolution in late 1991. As the two major rivals and the two giants in space exploration, geopolitical tensions as well as space competition between the United States and the Soviet Union might intensify investor attention on satellite launch. Therefore, we conjecture that stock return comovement with the market on satellite launch days can be larger in the pre-Soviet Union dissolution compared to the post-dissolution period.

We test this conjecture by firstly separating our U.S. satellite launches into pre- and post-Soviet Union dissolution periods. We then calculate stock return comovement with the markets on launch days in pre- and post-Soviet Union dissolution periods and on non-launch days. The results reported in Table 6 show that the stock return comovements with the market on launch days for both pre- and post-Soviet dissolution periods are higher than that on non-launch days and that the differences are larger for the Soviet period. For example, compared to the 0.264 mean correlation coefficient on non-launch days, the mean coefficients for Soviet and post-Soviet periods are 0.332 and 0.283, indicating an increase of 26% and 7%, respectively. In addition, the mean difference in correlation coefficient between launch days in pre- and post-Soviet Union dissolution periods is 0.049 statistically significant and economically meaningful since it represents a 17% higher satellite-induced return comovement during the Soviet period. The mean difference of 0.027 in adjusted R^2 is economically even more astounding since it indicates that stock return comovement with the market on launch days is 30% higher during the Soviet period compared to the post-Soviet period. The results for median differences are similar, albeit smaller in magnitude. Overall, the findings support our conjecture that U.S. investors pay more attention to satellite launch events when the U.S. is pressured by the competition with the Soviet Union during Cold War.

[Insert Table 6 about Here]

5.2. International Satellite Launches and U.S. Stock Return Comovement

In the above section, we investigate U.S. satellite launches and their induced return comovements under space competition between U.S. and Russia. In this section, we employ a more direct test using satellite launches by foreign countries. We expect that U.S. investors would also be attracted by non-U.S. satellite launches due to worldwide competitions in the aerospace industry. To test our conjecture, we collect international satellite launches and obtain 222 events by the RCI group, and 95 events by other foreign countries. We separately calculate stock return comovement with the market on U.S. launch days, RCI launch days, other foreign launch days and non-launch days.

We report the results in Table 7. In general, we first find that the stock returns comove more with the market on all launch days than that on non-launch days. More interestingly, we find that the return comovement is lower on U.S. launch days than that on RCI launch days but higher than that on other foreign launch days. Specifically, the mean difference in correlation coefficient between U.S. launch days and RCI (other) launch days is -0.038 (0.009), representing a decrease (increase) of 13% (3%). Compared to other foreign launch days, the mean correlation coefficient for RCI launch days is 17% higher. We also find consistent results for adjusted R^2 differences. Therefore, the results in Table 7 are supportive our argument that

U.S. investors are strongly attracted by the worldwide competition in the aerospace area, which distract them from their stock investments on international launch days, leading to an increase in stock return comovement with the market.

[Insert Table 7 about Here]

6. Additional and Robustness Tests

6.1. Subsamples Based on Launch Characteristics

In this section, we perform some additional tests. We split satellite launch events into: (1) pioneering and normal events, (2) successful and failed events, and (3) manned and unmanned events and replicate the main analysis. All results are reported in Table 8.

First, since launches involved the first satellite of a certain type, going for a new mission, or using a new technology tend to draw stronger interest among the public than flights without any unique features, we expect that the satellite-induced return comovement for these pioneering launches are likely to be higher than that for normal launches. To test our hypothesis, we manually check information in the description column and divide our satellite launches into two sub-groups: pioneering and normal satellite launches. We define a pioneering one as a very first satellite either goes into the space or discover a new aspect of universe. For example, we identify Explorer 1 launched by the U.S. on 31 January 1957 as a pioneering event since it is described as the "first American satellite in space". Another example is Mariner 2 launched on 27 August 1962 described as the "first spacecraft to visit another planet [Venus]", or Intelsat 1 on 6 April 1965 as the "first commercial communications satellite in orbit".[14]

[14] Some examples in recent times include Mars Pathfinder in 1996 as the "first automated surface exploration of another planet", OSIRIS-Rex in 2016 as the "first American asteroid sample return spacecraft", and Parker Solar Probe in 2018 as "the first spacecraft to visit the outer corona of the Sun".

We identify 105 launches as pioneering events, leaving the remaining 195 launches as normal events. We re-estimate the return comovement proxies for these two groups separately and compare them with the corresponding estimates on non-launch days. The results in Panel A of Table 8 show that while both return correlation coefficients for pioneering launches and normal launches are higher than those on normal launch days, the coefficients for pioneering events are substantially larger. For instance, the pioneering – normal correlation difference is, on average, 0.080, representing an increase of 29% relative to the correlation coefficient for normal launches. The corresponding percentage difference in adjusted R^2 is also significantly high at 29%. These results confirm our hypothesis on the effect of pioneering launches on satellite-induced stock return comovement with the market.

[Insert Table 8 about Here]

Second, satellite launches can be either successful or failed. Hence, we also are interested to investigate whether investors are differently attracted to successful and failed launch events, leading stocks to comove differently with the market on these days. Our conjecture is motivated by the findings in psychology discipline (e.g., Taylor, 1991; Rozin and Royzman, 2001) which show a remarkably stronger cognitive effect of negative events on humans compared to positive events. Specifically, Pratto and John (1991) show experimental evidence that people automatically direct their attention away from the current task toward extraneous stimuli, and this shift is faster and remains longer for stimuli with negative traits than positive traits. Baumeister et al. (2001), and Rozin and Royzman (2001) review the literature on the power of negative events and find that negative stimuli, which includes social information, seem to command more attention, and their impact on attention is stronger and spreads more rapidly compared to positive events. In addition, media outlets generally consider bad events and depressing stories more newsworthy and attract more reader attention (e.g., Trussler and Soroka, 2014).

Our database reports the outcomes of satellite launches. We divide our sample into two sub-groups: 257 successful and 43 failed satellite launches. As before, we obtain means, medians, and their differences in return comovement for these successful and failed launch events. The results in Panel B of Table 8 show that the mean return correlation coefficient for failed (successful) launches is 0.336 (0.272), representing a significant increase of 24% relative to the coefficient for successful launches. The corresponding fail – success mean difference in adjusted R^2 is 0.040 or a considerably large increase of 44% from the adjusted R^2 of successful events. As expected, the return comovements for both types of launches are higher than those on non-launch days. The results in Panel B, therefore, are consistent with the psychology literature regarding increased attention toward negative events, which yields increased stock return comovement with the market for failed satellite launches.

Third, satellites can be either manned or unmanned. We define a launch as manned one if the satellite is controlled by humans and otherwise an unmanned one. Neil Amstrong with the historic walk on the Moon has been a hero in people's mind. A survey conducted by Pew Research Center in 2015 shows that 59% (39%) public participants (dis)agree that human astronauts are vital for the future of U.S. space programs.[15] Therefore, we conjecture that investors' attention to manned and unmanned launch can be different, in which the manned one can have a larger impact. Our sample has 161 manned and 139 unmanned launch events for which we separately re-estimate the return comovement proxies and test their differences. We report the results in Panel C of Table 8. Apart from the expected pattern that both manned and unmanned launches generate higher return comovement with the market compared to non-launch days, we find that the return correlation coefficient for manned launches is higher than

[15] https://www.pewresearch.org/science/2015/07/01/chapter-8-attitudes-on-space-issues/

that for unmanned launches by 0.027 in mean correlation and 0.015 in mean adjusted R^2. These represent an increase of 10% and 15% for the two respective comovement measures. These findings support our prediction of increased public attention to space missions with astronauts, which results in greater investor inattention to the stock market and hence its associated increase in stock return comovement.

6.2. Stock Return Comovement with Associated Industries

On attention-grabbing days, investors switch to category learning of market-wide information rather than firm-specific information. This category learning argument can also apply to industry-level information, albeit to a lesser extent, on satellite launch days. In this section, we test this prediction and investigate whether stocks comove more with their associated primary industry on launch event days than on other days. Similar to section 4.1, we use return correlation coefficient and adjusted R^2 as proxies for return comovement; however, we replace market excess returns with industry excess returns based on 2-digit SIC codes and estimate these proxies for each sample firm for launch and non-launch days separately.

We present the results in Table 9. Consistent with our expectation, we find that individual stocks experience an increase in return comovement with their associated industry on launch days. The mean (median) increase is 0.020 (0.013) or 7% (5%) relative to the return correlation on non-launch days. The corresponding percentage mean (median) increase is 8% (10%) in adjusted R^2. Nonetheless, compared to the changes in return comovement with the market in Table 3, the findings in Table 9 are relatively smaller in magnitude and weaker in statistical significance, which is also in line with our expectation and the results in Huang, Huang, and Lin (2019).

[Insert Table 9 about Here]

6.3. Excluding Firms in the Aerospace Industry

There is a possible concern that a satellite launch event is able to fundamentally impact stock returns of the aerospace associated firms, which can subsequently drive the market. Hence, to address this concern, we perform a robust test by excluding aerospace associated firms out of the sample and replicate the main analysis.

The results in Table 10 show that the increase in return comovement for non-aerospace firms remains highly significant on launch event days. For example, the mean correlation coefficient (adjusted R^2) difference is 0.023 (0.017) equivalent to an 9% (20%) increase relative to that on non-launch days. Although these percentage changes are relatively smaller in magnitude compared to the corresponding 11% (22%) changes in Table 3 when aerospace firms are included, the message remains the same: investors get distracted due to satellite launches, resulting in the returns of their stock investments incorporating more market-level information on those event days. As expected, increases in return comovement on launch days are significantly larger across all tests, especially for the medians.

[Insert Table 10 about Here]

7. Conclusion

Existing theoretical research forecasts when investors are attracted away from the stock market, they pay relatively less attention to firm-specific information than market shocks, leading to higher correlations between individual stock returns and the market returns. However, empirical works testing the theory is scant due to the challenge in finding an exogenous shock to investor attention. Our study contributes to this strand of literature by introducing satellite launches as unique exogenous shocks to U.S. investors' attention and stock return comovements. We further contribute an imperative financial implication by designing a trading strategy that can exploit the potential satellite-induced mispricing on a short-term basis.

We firstly validate satellite launches as exogenous shocks to investors' attention using share turnover and Google SVI for firm names and the term "satellite". Our results indicate that investor trading activity decreases on the days when a satellite is launched. Investors' search for firm names is also lower whereas their Google search for "satellite" jumps substantially on the event dates.

We subsequently link satellite launches to stock return comovement and find that stock returns comove more with the market returns on launch days compared to non-launch days. We find a similar, albeit relatively weaker, comovement pattern between stock returns and its associated industry returns. In addition, our results show that the satellite launch events trigger a gradual increase in return comovement with the market on pre-event days, which peaks on official launch days before dying down on post-event days. We further explore the implication of our main finding by designing a trading strategy that aims to exploit the potential misprising due to investor inattention to stock specific information during the satellite launch days. Our empirical results show that by longing the portfolio of stocks with highest satellite-induced comovements with a decreasing market and shorting the portfolio of stocks with highest satellite-induced comovements with an increasing market, we can generate an abnormal risk-adjusted-return by between 10% to 17% per year within the 4-day window around the launching events.

There are other interesting findings when we partition the sample events based on their launch characteristics. First, we find that stock returns comove much more with the market during pioneering, failed, and manned satellite launch events. Second, given the rivalry between the U.S. and Russia in space exploration, we explore and find that the increase in return comovement is larger for U.S. launches during the Cold War period, i.e., before the

Soviet Union was dissolved in 1991, than those in the post-Soviet period. Third, we extend our sample and include non-U.S. satellite launches and examine whether foreign launches also affect U.S. investors' attention and its induced return comovement. Indeed, we find that the increase in stock return comovement with market is largest for launches by Russia, China, and India, arguably the three old and rising main competitors to the U.S. in the aerospace area. The results provide fresh evidence that U.S. investors are strongly attracted by international space competition. Finally, our findings are highly robust when we exclude aerospace associated firms to distinguish the impact of investor attention and fundamentals on stock return comovement.

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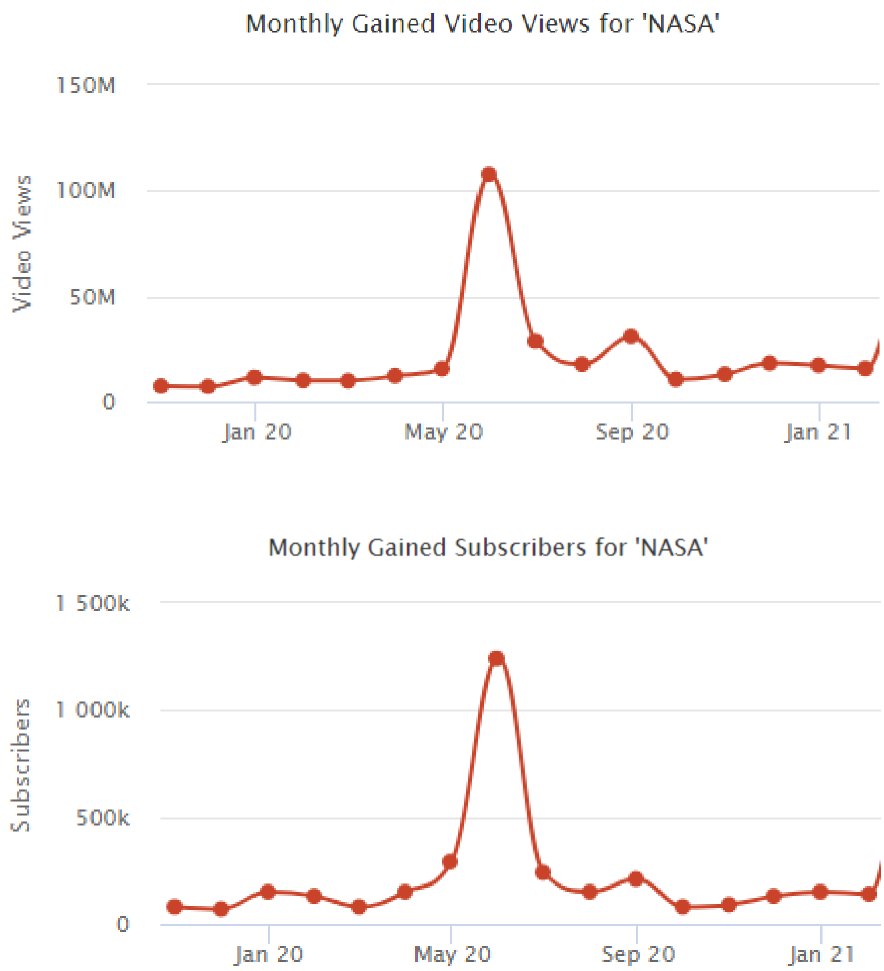

Figure 1: Monthly gains in video view and subscribers for NASA. The spikes correspond to the launch of NASA-SpaceX Falcon 9 rocket (Demo-2 mission) in May 2020.

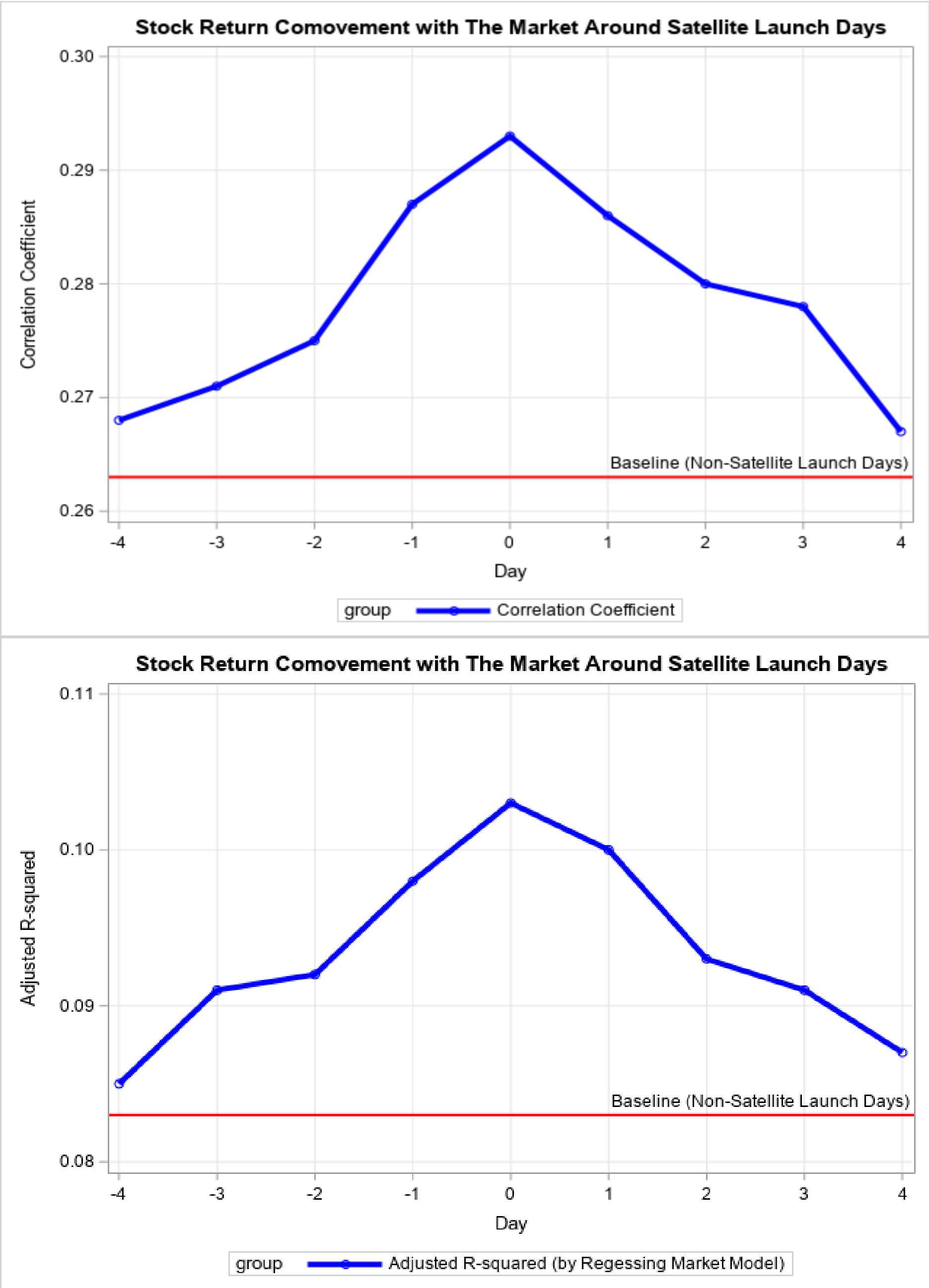

Figure 2: Stock return comovement with the market around satellite launch days. The top panel shows the pattern of Pearson correlations of stock excess returns and market excess returns around satellite launch days in a comparison to the baseline correlation for the non-launch days. The bottom panel show the corresponding pattern for adjusted R^2.

Table 1: Summary Statistics (U.S. Satellite Launches)

	N events	Pioneer	Normal	Success	Fail	Manned	Unmanned
Pre-Soviet Union Dissolution							
1957-1970	95	49	46	68	27	25	70
1971-1980	27	10	17	25	2	7	20
1981-1991	48	16	32	47	1	37	11
Post-Soviet Union Dissolution							
1992-2000	68	20	48	65	3	54	14
2001-2010	48	7	41	42	6	34	14
2011-2019	14	3	11	10	4	4	10
Total	300	105	195	257	43	161	139

The table presents summary statistics on the number of U.S. satellite launch events in the period from 1957 to 2019. We use Soviet Union dissolution event in 1991 as a breakpoint year and present the sample distribution by approximate 10-year periods. Pioneering indicates whether a launch is of the first satellite, for new mission, or with a new technology; otherwise, it is defined as normal. Other characteristics are whether a launch is considered a successful or failed mission, or whether the satellite has a crew or not.

Table 2: Share Turnover & Google Search Volume Index

Panel A: Difference Tests

	Share Turnover		Firm SVI		Satellite SVI	
	Mean	Median	Mean	Median	Mean	Median
Launch Days	0.292	0.224	0.255	0.001	2.387	0.968
Non-Launch Days	0.315	0.244	0.297	0.013	0.057	-0.023
Difference	-0.023***	-0.020***	-0.041***	-0.012***	2.330**	0.991***
	(0.002)	(0.006)	(0.000)	(0.003)	(0.014)	(0.000)

Panel B: Regression

	Share Turnover	Firm SVI	Firm ASVI	Satellite SVI	Satellite ASVI
Launch Day	-0.029***	-0.992**	-0.041***	45.244***	2.355***
	(0.000)	(0.018)	(0.000)	(0.000)	(0.000)
Fixed Effects	Yes	Yes	Yes	Yes	Yes
Adj. R2	0.025	0.024	0.043	0.535	0.158
Obs.	17,454,234	2,509,209	2,346,558	5,841	5,666

This table shows investors' trading activity and Google Search Volume Index (SVI) for launch and non-launch days. Share turnover is measured as the ratio of daily trading volume to total shares outstanding. We follow Huang, Huang, and Lin (2019) to calculate daily normal and abnormal SVI for "satellite" using the below equations:

$SVI_{AD,t} = SVI_w * (SVI_{UN,t} / MESVI_w)$ (1), $ASVI_{AD,t} = (SVI_{AD,t} - MDSVI_{AD,25\text{-}5}) / MDSVI_{AD,25\text{-}5}$ (2),

where $SVI_{AD,t}$ ($SVI_{UN,t}$) is adjusted (raw) SVI for "satellite" on day t. SVI_w is the weekly SVI to which a raw daily SVI belongs. $MESVI_w$ is weekly average of $SVI_{UN,t}$. $ASVI_{AD,t}$ is the abnormal SVI for "satellite" on day t and $MDSVI_{AD,25\text{-}5}$ is the median of adjusted SVI from the previous 25th week to 5th week. We apply the same process to calculate abnormal SVI for the names of firms in the S&P 500. *Launch Day* is a dummy variable with a value of one for satellite launch event days and zero otherwise. We include firm, year, month, and day of the week fixed effects in all regressions but exclude firm fixed effects from satellite SVI and ASVI regressions. *p*-values based on robust standard errors are in parentheses. ∗∗∗, ∗∗, and ∗ indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 3: Individual Stock Return Comovement with the Market

Panel A: Comovements

	Correlation Coefficient		Adjusted R^2	
	Mean	Median	Mean	Median
Launch Days	0.294	0.298	0.103	0.110
Non-Launch Days	0.264	0.271	0.085	0.088
Difference	0.030***	0.027***	0.019***	0.022***
	(0.000)	(0.000)	(0.000)	(0.000)

Panel B: Decomposition of the Changes in Correlation Coefficient

	Percentage Contribution			%Δ in Covariance
	X	Y	Z	
Mean	131%***	-0.6%	-19%***	0.129***
	(0.000)	(0.945)	(0.000)	(0.000)
Median	108%**	-0.8%	-6%*	0.089**
	(0.030)	(0.955)	(0.055)	(0.042)

Panel A presents the correlation coefficients of stock excess returns and market excess returns for satellite launch and non-launch days separately. The CAPM model's adjusted R^2s are also obtained for the respective two groups. In Panel B, we follow Huang, Huang, and Lin (2019) and decompose the change in logged correlation coefficient as below:

$$log\,\frac{\rho_{SL,i}}{\rho_{NSL,i}} = log\,\frac{\sigma_{i,Mkt}^{SL}}{\sigma_{i,Mkt}^{NSL}} - log\,\frac{\sigma_{SL,i}}{\sigma_{NSL,i}} - log\,\frac{\sigma_{SL,Mkt}}{\sigma_{NSL,Mkt}} \tag{3}$$

where $\rho_{SL,i}$ and $\rho_{NSL,i}$ denote the correlation coefficients between stock i's excess returns and market excess returns on satellite launch and non-launch days, respectively. $\sigma_{SL,i}$ ($\sigma_{SL,Mkt}$) and $\sigma_{NSL,i}$ ($\sigma_{NSL,Mkt}$) denote stock (market) excess return volatilities on launch and non-launch event days, respectively. $\sigma_{i,Mkt}^{SL}$ and $\sigma_{i,Mkt}^{NSL}$ denote the excess return covariances between firm i and the market on launch and non-launch days, respectively. The percentage contribution of each component to the correlation change is calculated as below:

$$1 = \underbrace{\frac{log\frac{\sigma_{i,Mkt}^{SL}}{\sigma_{i,Mkt}^{NSL}}}{log\frac{\rho_{SL,i}}{\rho_{NSL,i}}}}_{X} + \left[\underbrace{-\frac{log\frac{\sigma_{SL,i}}{\sigma_{NSL,i}}}{log\frac{\rho_{SL,i}}{\rho_{NSL,i}}}}_{Y}\right] + \left[\underbrace{-\frac{log\frac{\sigma_{SL,Mkt}}{\sigma_{NSL,Mkt}}}{log\frac{\rho_{SL,i}}{\rho_{NSL,i}}}}_{Z}\right] \tag{4}$$

The last column in Panel B shows the percentage change in return covariance, i.e., $\sigma_{i,Mkt}^{SL}/\sigma_{i,Mkt}^{SL} - 1$. We apply the paired t-test for the mean difference and Wilcoxon signed-rank for the median difference. p-values are in parentheses. $***$, $**$, and $*$ indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 4: Spillover Effects of Stock Return Comovement with the Market

	$k = 2$				$k = 4$			
	Correlation Coefficient		Adjusted R^2		Correlation Coefficient		Adjusted R^2	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
(1) Launch Day *t*	0.294	0.298	0.103	0.110	0.294	0.298	0.103	0.110
(2) Pre-Launch Days (*t* - *k*)	0.279	0.282	0.094	0.094	0.270	0.275	0.090	0.090
(3) Post-Launch Days (*t* + *k*)	0.281	0.283	0.095	0.093	0.277	0.274	0.089	0.090
(4) Non-Launch Days	0.262	0.270	0.081	0.086	0.263	0.271	0.083	0.087
(1) - (2)	0.014***	0.016**	0.009***	0.017***	0.023***	0.023***	0.013***	0.021***
	(0.002)	(0.041)	(0.000)	(0.003)	(0.000)	(0.003)	(0.000)	(0.000)
(1) - (3)	0.013***	0.015*	0.008***	0.017***	0.017***	0.024***	0.014***	0.02***
	(0.006)	(0.061)	(0.000)	(0.003)	(0.000)	(0.002)	(0.000)	(0.000)
(1) - (4)	0.032***	0.028***	0.022***	0.024***	0.03***	0.027***	0.02***	0.023***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
(2) - (3)	-0.001	-0.001	-0.001	0.001	-0.006	0.001	0.001	-0.001
	(0.761)	(0.911)	(0.569)	(0.976)	(0.136)	(0.911)	(0.457)	(0.857)
(2) - (4)	0.017***	0.011*	0.013***	0.008*	0.007*	0.005	0.007***	0.002
	(0.000)	(0.087)	(0.000)	(0.069)	(0.06)	(0.446)	(0.000)	(0.586)
(3) - (4)	0.019***	0.012*	0.014***	0.008*	0.013***	0.004	0.006***	0.003
	(0.000)	(0.076)	(0.000)	(0.086)	(0.001)	(0.543)	(0.000)	(0.468)

This table presents the correlation coefficients of stock excess returns and market excess returns for satellite launch days, their preceding and following *k* days, and other non-launch days separately. The CAPM model's adjusted R^2s are also obtained for the respective four groups. We apply the paired *t*-test for the mean difference and Wilcoxon signed-rank for the median difference. *p*-values are in parentheses. $***$, $**$, and $*$ indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 5: Trading Strategy

Panel A: Equal Weights

	"Underpriced" Betas					"Overpriced" Betas					Long-Short Strategy				
Holding Periods	1 (Lowest)	2	3	4	5 (Highest)	1 (Lowest)	2	3	4	5 (Highest)	1 (Lowest)	2	3	4	5 (Highest)
[-2, 0]	0.004	0.006	0.023	0.068***	0.101***	0.014	-0.003	0.01	0.035*	0.05**	0.018	0.003	0.033	0.103***	0.152***
	(0.024)	(0.022)	(0.02)	(0.02)	(0.02)	(0.023)	(0.021)	(0.019)	(0.021)	(0.024)	(0.047)	(0.042)	(0.038)	(0.041)	(0.044)
[-2, 1]	-0.002	-0.002	0.028*	0.052***	0.097***	-0.006	-0.003	0.015	0.026	0.04**	-0.008	-0.005	0.043	0.079**	0.137***
	(0.021)	(0.018)	(0.016)	(0.016)	(0.015)	(0.02)	(0.018)	(0.016)	(0.017)	(0.018)	(0.041)	(0.035)	(0.031)	(0.032)	(0.032)
[-2, 2]	0.019	0.02	0.033**	0.07***	0.115***	0.028	0.016	0.028*	0.041***	0.058***	0.047	0.036	0.061**	0.111***	0.173***
	(0.02)	(0.017)	(0.016)	(0.014)	(0.014)	(0.019)	(0.018)	(0.015)	(0.015)	(0.017)	(0.038)	(0.034)	(0.03)	(0.029)	(0.029)
[-3, 0]	-0.005	-0.013	0.018	0.062***	0.081***	-0.009	-0.003	-0.004	0.033*	0.017	-0.017	-0.022	0.029	0.064**	0.107***
	(0.023)	(0.02)	(0.018)	(0.019)	(0.019)	(0.024)	(0.02)	(0.018)	(0.019)	(0.022)	(0.04)	(0.035)	(0.03)	(0.032)	(0.033)
[-3, 1]	-0.005	-0.013	0.022	0.04**	0.077***	-0.012	-0.009	0.007	0.024	0.030*	-0.014	-0.016	0.014	0.095***	0.098**
	(0.02)	(0.018)	(0.016)	(0.016)	(0.015)	(0.021)	(0.018)	(0.015)	(0.016)	(0.019)	(0.046)	(0.038)	(0.035)	(0.037)	(0.04)

Panel B: Value Weights

	"Underpriced" Betas					"Overpriced" Betas					Long-Short Strategy				
Holding Periods	1 (Lowest)	2	3	4	5 (Highest)	1 (Lowest)	2	3	4	5 (Highest)	1 (Lowest)	2	3	4	5 (Highest)
[-2, 0]	0.008	0.01	0.025	0.071***	0.093***	0.016	0.008	0.014	0.042**	0.054**	0.024	0.018	0.039	0.113***	0.147***
	(0.024)	(0.022)	(0.02)	(0.02)	(0.021)	(0.023)	(0.021)	(0.018)	(0.021)	(0.024)	(0.047)	(0.041)	(0.037)	(0.041)	(0.044)
[-2, 1]	0.000	0.000	0.029*	0.061***	0.096***	0.002	0.008	0.019	0.039**	0.049***	0.002	0.008	0.048	0.101***	0.145***
	(0.021)	(0.018)	(0.016)	(0.015)	(0.015)	(0.02)	(0.018)	(0.016)	(0.016)	(0.018)	(0.04)	(0.035)	(0.031)	(0.031)	(0.032)
[-2, 2]	0.027	0.02	0.039***	0.071***	0.111***	0.03*	0.020	0.035**	0.051***	0.061***	0.057	0.04	0.074**	0.123***	0.172***
	(0.02)	(0.017)	(0.015)	(0.014)	(0.014)	(0.018)	(0.017)	(0.015)	(0.015)	(0.017)	(0.037)	(0.033)	(0.03)	(0.029)	(0.029)
[-3, 0]	-0.002	-0.011	0.024	0.044***	0.075***	-0.005	-0.006	0.009	0.025	0.034*	-0.007	-0.016	0.033	0.069**	0.108***
	(0.02)	(0.018)	(0.016)	(0.016)	(0.016)	(0.02)	(0.018)	(0.015)	(0.016)	(0.018)	(0.04)	(0.035)	(0.03)	(0.032)	(0.033)
[-3, 1]	0.001	-0.01	0.02	0.066***	0.078***	-0.004	0.000	0.002	0.036*	0.033	-0.003	-0.01	0.021	0.102***	0.111***
	(0.023)	(0.02)	(0.018)	(0.019)	(0.019)	(0.023)	(0.019)	(0.017)	(0.019)	(0.022)	(0.045)	(0.038)	(0.034)	(0.037)	(0.04)

This table presents the abnormal returns of each portfolio, α_p, by regressing its excess returns on the Fama–French five factors using different holding periods. Note that for the "underpriced" ("overpriced") beta portfolios, we long (short) them at the beginning of a holding period and short (long) at the end of the holding period. The last five columns represent the abnormal returns of the long "underpriced" beta portfolio and short "overpriced" beta portfolio in the corresponding quintile. The portfolios are formed corresponding to quintiles of the "underpriced" betas ($\beta_{i,u,t}$), and "overpriced" betas ($\beta_{i,o,t}$), which are estimated by firm by satellite events as follows. For each satellite event on date t, we employ one year data up to 10 days prior to the event (i.e., from $t - 375$ to $t - 10$) to run the following model:

$$(R_{i,w} - R_{f,w}) = \alpha_i + \beta_{i,o,t}(R_{mkt,w} - R_{f,w})*\mathrm{I}(R_{mkt,w} > 0)*Satellite_w + \beta_{i,u,t}(R_{mkt,w} - R_{f,w})*\mathrm{I}(R_{mkt,w} < 0)*Satellite_w + \beta_1(R_{mkt,w} - R_{f,w}) + \beta_2 SMB_w + \beta_3 HML_w + \beta_4 RMW_w + \beta_5 CMA_w + e_{i,w} \quad (5)$$

where $R_{i,w}$ is the return of firm i on day w ($w = t - 375, \ldots, t - 10$); $R_{f,w}$ is the risk-free rate on day w. $Satellite_w$ is dummy satellite event, which receives a value of one on the launch days and zero in other days within the estimation window. I(.) receives value of one if the logical function is correct and zero otherwise. Controls are the Fama–French five common risk factors: the CRSP value-weighted market excess return, (R_{mkt} - $R_{f,w}$), and the size (SMB), book-to-market (HML), operating profitability (RMW), and investment (CMA) factors. Robust standard errors are in parentheses. ∗∗∗, ∗∗, and ∗ indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 6: Stock Return Comovement Pre- and Post-Soviet Union Dissolution

	Correlation Coefficient		Adjusted R^2	
	Mean	Median	Mean	Median
(1) Launch Days in Soviet Period	0.332	0.329	0.117	0.115
(2) Launch Days post-Soviet Period	0.283	0.286	0.090	0.102
(3) Non-Launch Days	0.264	0.271	0.085	0.088
(1) - (2)	0.049***	0.042***	0.027***	0.012*
	(0.000)	(0.000)	(0.000)	(0.071)
(1) - (3)	0.068***	0.057***	0.033***	0.027***
	(0.000)	(0.000)	(0.000)	(0.000)
(2) - (3)	0.019***	0.015**	0.006***	0.014***
	(0.000)	(0.048)	(0.002)	(0.008)

This table presents the correlation coefficients of stock excess returns and market excess returns for satellite launch days during the Soviet and post-Soviet periods, and for non-launch days separately. The CAPM model's adjusted R^2s are also obtained for the respective three groups. We apply the paired *t*-test for the mean difference and Wilcoxon signed-rank for the median difference. *p*-values are in parentheses. $***$, $**$, and $*$ indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 7: U.S. Stock Return Comovement for International Satellite Launches

	Correlation Coefficient		Adjusted R^2	
	Mean	Median	Mean	Median
(1) U.S. Launch Days	0.294	0.298	0.103	0.110
(2) RIC Launch Days	0.331	0.331	0.122	0.132
(3) Other Launch Days	0.284	0.289	0.091	0.100
(4) Non-Launch Days	0.261	0.270	0.085	0.089
(1) - (2)	-0.038***	-0.033***	-0.019***	-0.022***
	(0.000)	(0.000)	(0.000)	(0.001)
(1) - (3)	0.009**	0.009	0.012***	0.010*
	(0.048)	(0.239)	(0.000)	(0.081)
(1) - (4)	0.032***	0.028***	0.019***	0.021***
	(0.000)	(0.000)	(0.000)	(0.000)
(2) - (3)	0.047***	0.043***	0.031***	0.032***
	(0.000)	(0.000)	(0.000)	(0.000)
(2) - (4)	0.07***	0.061***	0.037***	0.043***
	(0.000)	(0.000)	(0.000)	(0.000)
(3) - (4)	0.023***	0.018***	0.006***	0.011**
	(0.000)	(0.006)	(0.000)	(0.016)

This table presents the correlation coefficients of stock excess returns and market excess returns for satellite launches by the U.S., the RCI countries (i.e., Russia, China, and India), and other countries. The correlation coefficient for other days without any satellite launches is also estimated. The CAPM model's adjusted R^2s are obtained for the respective four groups. We apply the paired *t*-test for the mean difference and Wilcoxon signed-rank for the median difference. *p*-values are in parentheses. ∗∗∗, ∗∗, and ∗ indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 8: Stock Return Comovement for Subsamples

	Correlation Coefficient		Adjusted R^2	
	Mean	Median	Mean	Median
(1) Non-Launch Days	0.264	0.271	0.085	0.088
Panel A: Pioneering/Normal Launch				
(2) Pioneer Launches	0.359	0.387	0.121	0.126
(3) Normal Launches	0.280	0.287	0.094	0.099
(2) - (3)	0.080***	0.099***	0.027***	0.027***
	(0.000)	(0.000)	(0.000)	(0.000)
(2) - (1)	0.095***	0.116***	0.036***	0.038***
	(0.000)	(0.000)	(0.000)	(0.000)
(3) - (1)	0.016***	0.016**	0.009***	0.011**
	(0.000)	(0.019)	(0.000)	(0.024)
Panel B: Successful/Failed Launch				
(4) Successful Launches	0.272	0.292	0.091	0.098
(5) Failed Launches	0.336	0.348	0.131	0.135
(4) - (5)	-0.064***	-0.056***	-0.040***	-0.037***
	(0.000)	(0.000)	(0.000)	(0.000)
(4) - (1)	0.009**	0.021***	0.006***	0.009**
	(0.025)	(0.001)	(0.000)	(0.03)
(5) - (1)	0.072***	0.077***	0.046***	0.047***
	(0.000)	(0.000)	(0.000)	(0.000)
Panel C: Manned/Unmanned Launch				
(6) Manned Launches	0.300	0.326	0.114	0.129
(7) Unmanned Launches	0.273	0.292	0.099	0.106
(6) - (7)	0.027***	0.034***	0.015***	0.023***
	(0.000)	(0.000)	(0.000)	(0.001)
(6) - (1)	0.036***	0.055***	0.029***	0.041***
	(0.000)	(0.000)	(0.000)	(0.000)
(7) - (1)	0.009**	0.020***	0.014***	0.018***
	(0.018)	(0.002)	(0.000)	(0.000)

This table presents the correlation coefficients of stock excess returns and market excess returns for non-launch days and for satellite launches classified as pioneering or normal, successful or failed, and manned or unmanned. The CAPM model's adjusted R^2s are obtained for the respective seven groups. We apply the paired *t*-test for the mean difference and Wilcoxon signed-rank for the median difference. *p*-values are in parentheses. $***$, $**$, and $*$ indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 9: Stock Return Comovement with Associated Industries

	Correlation Coefficient		Adjusted R^2	
	Mean	Median	Mean	Median
(1) Launches Days	0.289	0.281	0.090	0.087
(2) Non-Launch Days	0.269	0.268	0.083	0.079
(1) - (2)	0.020***	0.013*	0.007***	0.008*
	(0.000)	(0.076)	(0.001)	0

This table presents the correlation coefficients of stock excess returns and industry excess returns for satellite launch days and non-launch days separately. The adjusted R^2s by regressing stock excess returns on industry excess returns are also obtained for the respective two groups. We apply the paired *t*-test for the mean difference and Wilcoxon signed-rank for the median difference. *p*-values are in parentheses. $***$, $**$, and $*$ indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 10: Stock Return Comovement Excluding Aerospace-Associated Firms

	Correlation Coefficient		Adjusted R^2	
	Mean	Median	Mean	Median
(1) Launch Days - Aerospace Firms	0.298	0.360	0.108	0.156
(2) Launch Days - Non-Aerospace Firms	0.287	0.290	0.101	0.106
(3) Non-Launch Days	0.264	0.271	0.084	0.087
(1) - (3)	0.034*	0.089***	0.024**	0.069***
	(0.065)	(0.000)	(0.022)	(0.000)
(2) - (3)	0.023***	0.019***	0.017***	0.019***
	(0.000)	(0.005)	(0.000)	(0.000)

This table presents the correlation coefficients of stock excess returns and market excess returns for launch days and non-launch days separately. The CAPM model's adjusted R^2s are also obtained. These comovement proxies are then grouped by firms in the aerospace industry and other industries. We apply the paired *t*-test for the mean difference and Wilcoxon signed-rank for the median difference. *p*-values are in parentheses. $***$, $**$, and $*$ indicate statistical significance at the 1%, 5%, and 10% levels, respectively.