BOSTON COLLEGE
Carroll School of Management

Case Studies on
Advanced Micro Devices, Inc.

MFIN 8852 Financial Econometrics

Presented to

Prof. Dec Mullarkey

Lee, Ting hui
Jin, Xiao
Gao, Letian
Varma, Advait A.
Chowdhury, Sushimita
Liu, Zixuan

April 21st, 2021

Case Studies - Ethics Contract

Please upload you documents to Canvas under the Assignment: Case Studies

Please sign, date and note any violations to the following ethics statement:

We did not offer nor did we accept any assistance with others outside our team on this project. All of the work is our own except as listed below.

List any violations to the above statement. If there are no violations, then state none:

___

Name: Xiao Jin

Signed: Xiao Jin Date 4.21.2021

Case Studies - Ethics Contract

Please upload you documents to Canvas under the Assignment: Case Studies

Please sign, date and note any violations to the following ethics statement:

We did not offer nor did we accept any assistance with others outside our team on this project. All of the work is our own except as listed below.

List any violations to the above statement. If there are no violations, then state none:

___

Name: Advait Varma

Signed: AVarma Date April 21, 2021

Case Studies - Ethics Contract

Please upload you documents to Canvas under the Assignment: Case Studies

Please sign, date and note any violations to the following ethics statement:

We did not offer nor did we accept any assistance with others outside our team on this project. All of the work is our own except as listed below.

List any violations to the above statement. If there are no violations, then state none:

____

Name: Tinghui Lee

Signed: Tinghui Lee   Date 4.21.2021

Case Studies - Ethics Contract

Please upload you documents to Canvas under the Assignment: Case Studies

Please sign, date and note any violations to the following ethics statement:

We did not offer nor did we accept any assistance with others outside our team on this project. All of the work is our own except as listed below.

List any violations to the above statement. If there are no violations, then state none:

____

Name: Letian.Gao

Signed: Letian.Gao   Date 04.21.2021

Case Studies - Ethics Contract

Please upload you documents to Canvas under the Assignment: Case Studies

Please sign, date and note any violations to the following ethics statement:

We did not offer nor did we accept any assistance with others outside our team on this project. All of the work is our own except as listed below.

List any violations to the above statement. If there are no violations, then state none:

____

Name: Sushmita Chowdhury

Signed: ______________________ Date 04/21/2021

Table of Contents

CASE 1

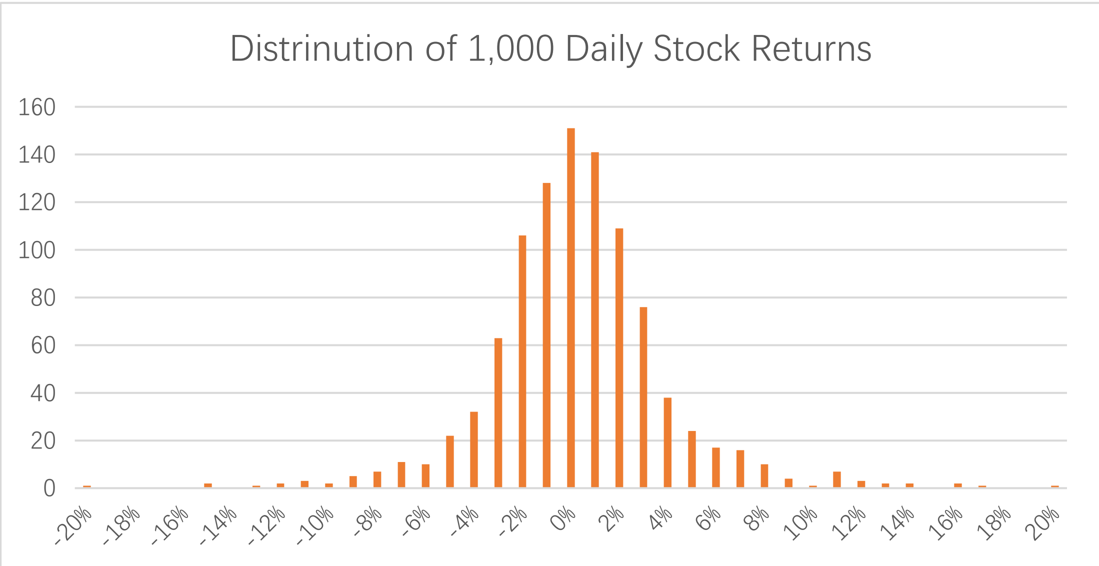
Introduction

Sometimes, we observe that stock returns are very positive or negative, so this phenomenon violates the random walk theory and the efficient market hypothesis theory, which means that arbitrage or excess returns will be possible in these circumstances. Also, we suspect that their standard deviations also become larger, so the stock prices become more volatile or riskier after the events. In this event study, we want to determine whether stock returns and their standard deviations are different after the event from before the event.

The model, data, and highlights

The company we have studied is Advanced Micro Devices (AMD). The event happened on July 21st, 2020. It was founded in 1969 as a Silicon Valley start-up, the AMD journey focused on leading-edge semiconductor products. On July 21st, 2020, AMD announced the world's first and most advanced 7nm x86 desktop processors with built-in graphics for consumer and commercial PC markets and the new AMD Ryzen™ 4000 G-Series Desktop Processors deliver impressive generational leaps in performance3 and amazing power efficiency for consumers, gamers, streamers and creators. AMD shares rose after the announcement. On July 22nd, 2020, the stock price increased 8.4%. After two days, on July 24th, 2020, the company returns surged 16.5%, which was the second highest increase in recent 1,000 trading days.

Are stocks returns normally distributed? The following Graph shows the actual distribution of ADM 1,000 daily stock returns



The distribution looks like a normal distribution, but the graph seems to be slightly concentrated in the middle.

Then, we use KS test to check whether they are normally distributed.

Computation Area				
	Daily	Annualized		
Sample Average	0.277463%	99.909919%		
Variance	0.139761%	34.940143%		
Standard Deviation	3.738457%	59.110188%		
Std Error of Mean	0.118220%			
Confidence Interval for For Mean - Data From 1 to 1000				
Lower Limit	0.045751%	12.114583%		
Mean	0.277463%	99.909919%		
Upper Limit	0.509175%	255.981038%		
	Actual D	Critical D	Mean	Variance
MAX D	0.081040	0.043000	0.002775	0.001398

The null hypothesis is that daily returns are normally distributed. Because observed value of 0.081040 is greater than the critical value of 0.043000, we reject the null hypothesis that the 1,000 daily returns are normally distributed from KS test.

We divide the samples into ten small groups, each has 100 observations and test if smaller groups are normally distributed.

Output Table 1: *Actual and Critical D, Mean and Variance of Samples*

From	To	Actual D	Critical D	Mean	Variance
1	1000	0.081040	0.043000	0.002775	0.001398
1	100	0.150201	0.136000	0.001991	0.001877
101	200	0.079535	0.136000	0.000873	0.001016
201	300	0.086153	0.136000	-0.000646	0.000970
301	400	0.055555	0.136000	0.003457	0.000792
401	500	0.082091	0.136000	0.002892	0.002595
501	600	0.136181	0.136000	0.004146	0.001720
601	700	0.111645	0.136000	0.001423	0.001102
701	800	0.083971	0.136000	0.004632	0.000684
801	900	0.094861	0.136000	0.003558	0.001944
901	1000	0.104952	0.136000	0.005420	0.001371

In the ten sequential periods of 100 daily returns, there are two values of maximum absolute difference greater than critical value of 0.136. Therefore, except for two period, the rest seems to be normal distribution. The results are not the same in ten groups as well as the 1,000 observations.

To check if the two sample are coming from the same distribution, firstly, we test the difference in sample means

Output Table 2: *Difference Between Two Means and Variance*				
	Mean	Variance	Sample Size	Ref Variance
Highest Mean	0.005420	0.001371	100	N38
Lowest Mean	-0.000646	0.000970	100	N31
t Statistic	0.006066	***1.253698***		
	0.004838			
Degrees of Freedom	0.000000	194.289481		
	0.000000			
Approx	198.000000			
One Tailed or Two Tailed Test		*1*		
Confidence Ineterval		95.00%		
Critical t		***1.652586***		
Fail to Reject the Null				

The null hypothesis is that no difference in means of two sample. There are 95% confidence that the two samples are coming from the same distribution.

Secondly, we test the difference in sample variances.

Difference Between Two Variances - Calculated from Above Summary	
Highest Variance	0.002595
Lowest Variance	0.000684
F Statistic	***3.796573***
Critical F	***1.394061***
Reject the Null	

The null hypothesis is that no difference in variances of two sample. The largest variance is significantly different from the smallest variance. That is, not all ten samples are coming from the same distribution.

Conclusions on Case 1

- KS test for 1,000 observations is not normally distributed
- KS test for 10 samples of 100 observations, most samples are normally distributed, except for two period
- T test for difference between two means suggest that there are 95% confidence the highest and the lowest are coming from the same distribution
- F test for difference between two variances suggest that the volatility of two samples is significantly different

For the result of KS test, compare 1,000 observations to 100 observations, we can find out the stock returns were non-stationary in a longer period. Besides, in the first three hundred observations, from 2016 to 2018, the stock returns were significantly lower than recently. However, in this case t test suggests the different average returns in 100 days were coming from the same distribution. Then, F test suggests volatility was significantly different in two samples.

CASE 2

Introduction

The primary goal of case 2 is to test market efficiency through the exploring of Calendar Effects. During case 2, data from the selected company, AMD, along with the market index, S&P 500, is broken into two sample groups.
The first group consists of beginning of month sample, which includes returns on or before 10^{th} of month. The second group consists of end of month sample, which includes returns after the 20^{th} of the month.
The reason that the data is broken into such two groups is that we are trying to replicate Robert Ariel's research "A Monthly Effect in Stock Returns", which states that "the mean return for stocks is positive only for days immediately before and during the first half of calendar months, and indistinguishable from zero for days during the last half of the month".

The model, data, and highlights

The first test conducted is a simple t test. The null hypothesis for the test is AMD or S&P 500 daily returns are significantly different across the month. This test is to examine difference between two means using arithmetic average from both sample groups, and the results will be shown through the t-statistics.
The t-statistics for the difference of the mean daily returns from the two populations are 0.71 and 1.30, respectively. The simple t test is a two-tailed test at 95% confidence interval and the degrees of freedom is 703. Therefore, the critical t value is 1.96, which is obviously higher than both t-statistics.
As a result, we cannot reject the null hypothesis, which suggests that the neither the selected company nor market daily returns are significantly different across the month.
We also conduct this test on differences of variances of AMD and index data. The t-statistics for the difference of the variance of daily returns from the two populations are 1.14 and 1.17, and the critical t value is 1.19, which is higher than both results. Therefore, we cannot reject the null hypothesis and the volatility of both AMD and index are not significantly different across the month.
The result from the first test does not show any monthly effects in stock returns and seems to violate Ariel's finding. However, during the t test arithmetic mean is used to obtain results, and sometimes arithmetic mean is not a reliable indicator of historical stock returns compared to geometric mean. While arithmetic mean only computes a simple average which can be misleading particularly with extreme volatility, geometric mean can show the compounding effects over the measurement period.

Next, a Geometric Brownian Motion (GBM) approach is applied. The GBM approach is used in the Black Scholes model to represent Stock market prices dynamics. After we run the regression analysis, we get the following outcomes. The slope for Company-Beginning of Month, which is the geometric daily return, over 327 days is 0.003836. Assuming 250 trading days per year and the annualized return will be 160.46%. The geometric daily return for Company-End of Month is 0.000194 and the annualized return is 4.96%. The end-of-month return is much lower than the beginning-of-month return, and it seems to be in line with Ariel's findings. Repeat the steps for the S&P 500 data and the annualized returns for beginning and end of month are 26.07% and -0.59%. Again, the beginning-of-month return seems to perform much better than the end-of-month result. After that, we try to test if the difference is significant by looking at the t statistics for intercept and slope in both Beg and End samples. The t stats are displayed in the appendix, and obviously all results are highly significant.

Figure: Regression Output for Company-Beginning of Month Stock

Regression Statistics					
Multiple R	0.905395594				
R Square	0.819741182				
Adjusted R Square	0.819188241				
Standard Error	0.170861365				
Observations	328				
ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	43.27983315	43.27983315	1482.510693	2.5061E-123
Residual	326	9.517115572	0.029193606		
Total	327	52.79694872			

We then conduct the F test of regression. The F test is to confirm if R^2 is significant and therefore if model is relevant. The beginning-of-month regression for AMD has a F value of 1482.51, which is significantly higher than the critical F value of 3.87. The same applies to the beginning-of-month regression for the market index. This implies that these regressions are significant. Accordingly, the model applied here is relevant. However, the F value for the End-of-Month regression for the market index is only at 2.11 and this is smaller than the critical value, which implies this regression is not significant.

The outcome can also be verified by a small R^2 value of 0.56%. Also note that the F value for he End-of-Month regression for AMD is 8.25. While this result is higher than 3.87, it is much closer to the critical value compared to the result generated from both Beginning-of-month regressions. The outcome shows that when the model is applied to the end-of-month data, the relevancy is not that high compared to the model when applied to the beginning-of-month data. In addition, the multiple R from the beginning-of-month regressions for the company and the market index are 0.905396 and 0.845510, respectively.

The multiple R indicates the level of strength of the linear relationship in a regression. Therefore, the high multiple R values indicates that both the LN(Price) of the company and the market index have a relatively strong correlation with the time series at the beginning 10 days of the month. Contrarily, that correlation for the end-of-month data is not that strong with the multiple R values of 0.146744 and 0.074849, much lower compared to the beginning-of-month data.

Figure: Regression Output for Combined Beginning and End of Month Company

Regression Statistics					
Multiple R	0.481854869				
R Square	0.232184115				
Adjusted R Square	0.231091916				
Standard Error	0.278033141				
Observations	705				
ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	16.43326536	16.43326536	212.5840786	2.89232E-42
Residual	703	54.34360664	0.077302428		
Total	704	70.776872			

Lastly, we conduct a Chow test. Chow test is a test of whether the true coefficients in two linear regressions on different data sets are equal. It is often used in time series analysis to test for the presence of a structural break at a period which can be assumed to be known a priori (for instance, a major historical event such as a war).

In our case, Chow test is conducted to see if Beginning and End of month regressions are structurally different and therefore describing different return behavior. The Chow test requires to run one more regression for the combined sample. The F test for the company data is 761.4635, and the critical F value at 5% significance level with 2 degrees of freedom in numerator and 701 in denominator is 3.0086.

Apparently, the F test is much higher than the critical value. Consequently, we reject the null hypothesis and Chow Test shows that two models are statistically different and returns at beginning of the month are significantly different end of the month for the company data.

The approach same applies to the market index data, and the F test is 895.7457, which is also much higher than the critical value. As a result, we can draw the same conclusion as we did for the company data. To summary, the result we retrieve from Chow test is significant and agrees with Ariel's findings.

Conclusions

After all the numerical analysis, we can draw the following conclusions:

- Beginning and End of month samples, for both AMD and S&P 500 from a simple t test using arithmetic returns, showed no significant difference.
- However, results vary if geometric returns are used instead of arithmetic returns. a regression approach to capture geometric returns for both AMD and S&P 500 showed a significant difference between returns from Beginning and End of month. The different test result also indicates that geometric mean is a more reliable indicator than arithmetic mean, especially in situation with extreme volatility. If we plot those daily returns, we can see that they are highly volatile over the selected time period.
- While the regression agrees with Ariel's findings, the model applied, which is the GBM model, is not that relevant for the end-of-month sample data for market index. There are several possible reasons. One possible reason is that the sample size is not large

enough relative to the variability in the data in order to generate expected outcome. The raw data used in our analysis only consists of 1,000 observations, while Ariel's research was conducted based on data from several decades. Another possible reason is that there is no strong relationship between dependent and independent variables. Other reasons may be that a relationship between dependent and independent variables exists but is not linear. In either case, it is likely that a new model should be selected to run the regression analysis.

- Chow test indicates that two models are statistically different and returns at beginning of the month are significantly different end of the month for both sample data.
- Generally, the outcome agrees with Ariel's findings and suggests that calendar effects do exist in the stock market. Therefore, an investor could beat the market by investing in AMD in the first half of the month and trading out of the stocks in the second half of the month.

While the primary goal of Case 2 is to test market efficiency through the exploring of Calendar Effects. The Efficient Market Theory fails if the investing strategy mentioning above succeed. Several other calendar effects also contradict to the Efficient Market Theory. To name a few, Halloween Effect, January Effect, and Weekend Effect. Some of these effects will be tested in the following cases.

CASE 3

Introduction

Event studies are a practical way to test hypothesis or finance theories. They dominate much of the empirical research in corporate finance. Most event studies look at reaction of stock returns to announcement effects. Event studies look at reaction of stock returns to announcement effects. Event studies have also been used extensively in discrimination cases and other litigation. U.S. supreme court has allowed event studies as evidence in insider trading cases. Events can also be macro/ economic wide announcements such as issues related to trade deficit, inflation, currency rates, etc.

Abstract

Case 3 is focused on event study which is an essential tool to examine the impacts of an announcement to stock returns and test market efficiency which refers to the degree to which market prices reflect all available, relevant information. If new information can be absorbed immediately into the market price and additional information will only impact further market prices, we think the market is efficient. Therefore, the primary goal for this case is to test whether “abnormal performance” is significant, whether market is efficient and whether information is leaked before the announcement, indicating the potential of insider trading.

Methodology

Case 3 is based on data centered around a major company event. The case focuses on the event day’s return and other days to measure if significantly different than expected. General methodology is to set up a model to provide a forecast for expected return and then compare to actual Scaling the difference by the standard Error of forecast will help determine significance/ abnormal performance.

The seminal work on event studies was done by Fama, Fisher, Jensen and Roll. Their motivation was to introduce practical tool’s that would support testing for market efficiency where the central tenet is that new news should be instantaneously reflected in Stock price and therefore have no “hangover effect” and otherwise absorbed over a number of days. Most studies show most of the market react within seconds/minutes to new information.

Steps involved:

- Define the event date and event “window” around that date.
- Decide the model, data and estimation period.
- Use model to calculate forecasted return and compare to actual.
- Draw conclusion on event’s relevance.

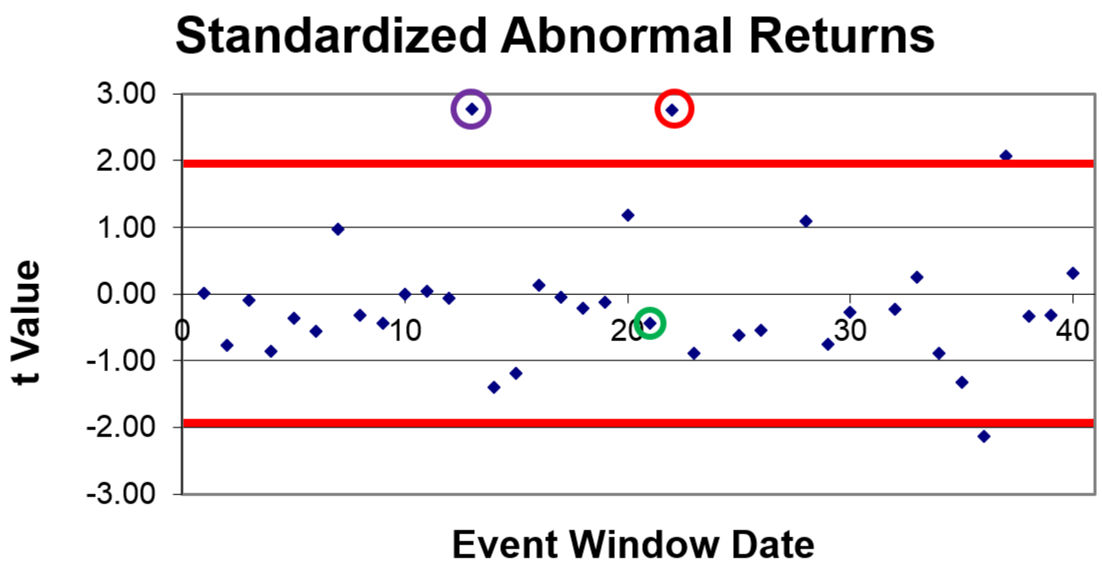
Results

The event for AMD occurred on July 21st, 2020 when AMD announced the world most advanced 7nm x86 desktop processors.

To test for significant "abnormal performance", we need to identify pre-event data and event window.

Pre-event data require a decent and relevant sample size which is typically 120 days from observations 760 to 879. After running regression model, we find the R^2 is 60.31% and F score is 177.79, suggesting significant. Event window is 40 days from observations 880 to 919 which are 20 days before the event day and 19 days after the event day, so enough data are presented to research abnormal activity leading up to and after event.

In the event day 900, the actual return and predicted model return are -0.8006% and 0.4178%, which led to an -1.2183% abnormal return. After that, we calculate standard error of the forecast to define the value of expected return under normal conditions, and to test the significance of the abnormal returns.



The day 900 standard error of the forecast is related to market index returns, variance of the market index returns and number of observations in the regression model, and thus is 0.027335 in this case. After divided the day 900 abnormal return by standard error of forecast, we can get day 900 standardized abnormal return which is -0.45. By calculated standardized abnormal return for 40 days event window period, we draw the standardized abnormal return chart to visually see the abnormal activities. The chart has T score as the X value, and event window date as the Y value, and the critical factor is +/-1.98 for 118 DofF based on two tailed tests at the 95% confidence interval.

As the charts showed, the area between the two red line is the 95% confidence interval, and the day 900 standardized abnormal return is located in the 95% confidence interval, showing insignificant. However, the day after announcement, day 901 standardized abnormal return enclosed by red circle is 2.75, indicating significant. As the announcement day is not significant while the next day of the announcement day 900 is significant, the market returns may need a little bit time to react on the announcement and day 901 is the abnormal performance.

To test the market efficiency, we are looking for the abnormal return and standard abnormal return before and after the event day. From day 901 to day 907, the abnormal return is fluctuated, it has huge increase in day 901, 903, and 906, but a little decrease in day 902, 904, and 905. However, since cumulative abnormal return for 7 days is 32.8%, the major trend for those days is actually upward. On day 903, Intel claims that because of a “defect mode”, it may have to corporate with third-party manufacturers to produce 7-nm chips, which AMD already sells, and thus delay the release of new product to late 2022 or early 2023. Several analysts believe that AMD may gain most from Intel’s dilemma. Also, on day 905, AMD reports second quarter financial results which are exceeded Wall Street expectations. Therefore, analysts, on average, raised their revenue estimates for AMD to $2.49 billion from $2.31 billion for the third quarter after AMD forecast sales of $2.45 billion to $2.65 billion. As comments are continuously join and new information are published, market seems to very optimistic about AMD, and its stock price surged at a fresh record.

For day 899 to 901, we are looking for standard abnormal returns to see if news was anticipated or leaked. The cumulative standard abnormal return (day 899-900) is 2.0112, indicating insignificant and no signs of abnormal returns. Therefore, there has no leakage of information before the event day.

Also, according to the standardized abnormal return chart, day 892 standardized abnormal return enclosed by purple circle is significant. This big rise of stock price may because Bank of America reiterate its buy rating for AMD. After looking for data from day 893 to 899, we can find that the abnormal return was -3.82% on day 893, and standard abnormal return was -1.3978, indicating insignificant. Moreover, the cumulative abnormal return (day 893-899) is -4.56%, which shows that the stock price for those 7 days is in fact 4.56% worse than expected. Therefore, market overreacted

Count	Date Num	Abnormal Return (AR)	Std Error Forecast	Standard AR (SAR)	Cummulative Abnormal Return (CAR)	Standardized CAR (SCAR)
1	893	-0.038227414	0.027348617	-1.39778232	-0.038227414	-1.39778232
2	894	-0.032656507	0.027346016	-1.194196166	-0.070883921	-1.832805564
3	895	0.003630169	0.027357898	0.132691825	-0.067253751	-1.419869816
4	896	-0.001229279	0.027345043	-0.044954361	-0.06848303	-1.252120511
5	897	-0.006009467	0.027335813	-0.219838611	-0.074492497	-1.218245447
6	898	-0.00331682	0.027335253	-0.121338559	-0.077809318	-1.161637112
7	899	0.03217271	0.027343484	1.176613435	-0.045636607	-0.63074891

Count	Date Num	Abnormal Return (AR)	Std Error Forecast	Standard AR (SAR)	Cummulative Abnormal Return (CAR)	Standardized CAR (SCAR)
1	901	0.075251447	0.02733852	2.75257937	0.075251447	2.75257937
2	902	-0.024255558	0.027354582	-0.886709124	0.050995889	1.319369504
3	903	0.169748514	0.027339409	6.20893143	0.220744403	4.661988921
4	904	-0.016845647	0.027341374	-0.616122897	0.203898756	3.729339389
5	905	-0.014665768	0.027339889	-0.536423825	0.189232988	3.095726527
6	906	0.109076611	0.027354556	3.987511599	0.298309599	4.453893545
7	907	0.029700013	0.027336146	1.086474054	0.328009612	4.534152759

on day 892 and was fall back to the normal price level as no further information or comments were published.

Furthermore, the cumulative abnormal return during entire event window is 26.77%, showing that AMD performance is 26.77% greater than expected, and the standardized cumulative abnormal return is 1.5482, suggesting that the abnormal returns for the entire event window are insignificant.

The cumulative standard abnormal return (day 900-901) is 1.6312, and cumulative standard abnormal return (day 892-893) is -0.1399, both suggesting insignificant. Therefore, all information seems to be absorbed into the market price very quickly, and thus market is efficient.

Finally, we need to use Chow test to inspect if the model significantly changed after event day, since some events, such as merger or acquisition, may radically change the model. To do this test, we combine the pre-event data and the event window period data, and then run a regression analysis, which stock return is X series and index return is Y series. Since the critical F table at 95% confidence interval for DofF (2 numerator, 196 denominator) is 3.042 and the F score from Chow test is 0.3064, we cannot reject the null hypothesis, and thus the model is still stable and significant.

Conclusion

After all those data analysis, we can draw following conclusions:

- Although event day 900 has not significant abnormal return, day 901 showed significant abnormal return. This shows that the market sometimes may need a little bit time to absorb new information. Taken day 900 and 901 together are not significant, indicating that some of the abnormal returns were reversed. However, as new information is continuously published, the major trend from day 901 to day 907 is upward, showing that the stock price is rise sharply and market is optimistic for AMD.
- Day 892 is another significant day in event window period, and days 892 and 893 together are not significant, suggesting that some of the abnormal returns on event day were also reversed. This phenomenon mainly because no other institutions joined in discussion of the buy rating of AMD.
- There is no information leakage before the event day, indicating no insider trading.
- Based on the Chow test, the market model is stable and significant pre- and post-event, and thus the event did not dramatically change the risk or return profile of stock.
- Results around event show that the market is efficient. Around event day 900, market price quickly and constantly absorbs the new information as it continuously published. For another significant abnormal day 832, since there were no joining new commons, market price start to fall back after the event day, indicating that all news was absorbed on one day, and thus support market efficiency.

At the end, the event study is not only a powerful tool used in testing market efficiency, but also a popular tool used in testing the impacts of regulations on public policy outcomes. For example, the event study can be used to testing whether the event ends up creating more savings or more spending. It is also applied wildly in forensic accounting and low enforcement to check for suspicious activity.

CASE 4

Introduction

To understand the relationship between the independent and the dependent variable in this scenario, the regression technique has been put in practice. This is used to analyze multivariate data.

The analysis has been conducted to determine the attributes that treat AMD and comprehend the link between the variables and AMD. The analysis put emphasis on linear relationships. The quality of AMD is displayed as the dependent variable, while the rest the factors are the independent variables. The variables under study are displayed on the x-axis, whereas the values depending on the factors are displayed on the y-axis.

In this analysis, the aim is to establish the earlier data on AMD and get an insight on the relationship with its treatment independent variables. This case documents January effect "Rozeff and Kinney in 1976" Capital market seasonality: "The case for stock returns" Journal of Financial Economics. They documented unusually high returns in January, particularly first few days. If persistent, it is inconsistent with EMT. Further research suggested it may be tax loss selling, as investors sell losing stocks in December to qualify for a tax loss for a year. All this selling artificially pushes the price down and creates a buying opportunity in January. Keim found that since there is more selling in December, many closing prices closing prices are based on Bid Prices (lower) while in January, with more buying, process based on ask (higher).

Methodology

For this analysis, the model will be a simple linear regression model, having the form; **y = q + dx + e,** where q is the intercept, d is the coefficient of regression, e is the disturbance or the error term, y is the predicted value (dependent variable), x is the independent factors or variables. X values are depicted here as the independent variable, implying that AMD qualify to be our dependent variable.

First, we calculate the presence of January effect by using a dummy variable. Dummy variable will be turned on for days 1-4 of January and 0 otherwise. Subsequently, we will calculate R^2 with significant F test of regression. Coefficient for Dummy/January effect and Significant T-stat. Next, we use Wald Test to see if "January Effect" significantly improves the model. Following which, we will expand the January model to include other months and run the regression.

Results

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.496174
R Square	0.246189
Adjusted R Square	0.245434
Standard Error	0.032474
Observations	1000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.343731	0.343731	325.9394	2.88E-63
Residual	998	1.052477	0.001055		
Total	999	1.396208			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.001966	0.001028	1.912887	0.056048	-5.1E-05	0.003983	-5.1E-05	0.003983
X Variable 1	1.433364	0.079394	18.05379	2.88E-63	1.277566	1.589163	1.277566	1.589163

Case study four focus on impacts of stock return and return index on the values of the Dummy.

Coefficients form a critical component in the variables, it is the hearth of the linear regression. The several of the Dummy values in association to the stock return and return index are showed by the regression results.

The regression result defines the relationship between variables like the stock market return and index of the return. The multiple R from the regression output is 0.496174. Multiple R highlights the level of strength of the linear relationship between the variables.

The 0.496174 multiple R values show that stock index and Dummy data have an average association between the variables.

The R squared in the regression output is 0.246189, which is the same as 24.6189%. R squared is the coefficient that shows the existing point fall in the regression line. The 24.6189% R squared implying that 24.6189% of y-values variations are found around the mean that is determined by the x-values. 24.618 9% of the data values fit the regression model. A great linear association exists between the stock market return and index of the return supported by the value of the R squared of the regression.

The adjusted R in the regression output is 0.245434. The adjusted R indicates the number of terms found in the model of regression. The 0.245434 value suggests that there is more than one x-value in the regression model. The standard error indicates the standard deviation of the error μ in the regression output. The standard error in the regression results is 0.032474.
This implies that the standard deviation of the error μ is 0.032474. The error is different from the standard error in descriptive statistics. The standard error determines the precision of the regression model coefficient. 1000 observations have been made considering the regression output. The regression coefficients are 1.433364 and 0.001966.
The coefficients are more significant than the standard error, implying that the coefficients' probability is zero. The least-squares estimate is given as 0.001966 and 1.433364 as presented in the coefficient column from the regression output.
The least assessment of the data set standard error is 0.001028 and 0.079394 for the intercepts (x and y) and first X variable, respectively.
The degree of freedom of the data analysis is 0.343731, as shown by the regression MS. The residual degree of freedom and the significance associated with the P-value are 0.056048 and 2.88E-63, respectively. Considering the smaller P-value the data set is statistically significant.
The t statistic here explains a little significance on the model parameters. Hitherto, in this instance, a more reliable coefficient is 18.05379. It explains where 95% of the confidence interval fall.

Regression output for January Effect

Regression Statistics	
Multiple R	0.498897
R Square	0.248898
Adjusted R Square	0.247392
Standard Error	0.032432
Observations	1000

ANOVA

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	2	0.347514	0.173757	165.1918	1.09E-62
Residual	997	1.048694	0.001052		
Total	999	1.396208			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.001773	0.001032	1.71905	0.085916	-0.00025	0.003798	-0.00025	0.003798
X Variable 1	1.428834	0.079332	18.01074	5.28E-63	1.273157	1.584512	1.273157	1.584512
X Variable 2	0.019546	0.010312	1.895366	0.058333	-0.00069	0.039783	-0.00069	0.039783

The output of the first data set for Dummy has is provided below.

Now that we have calculated the Multiple regression for the January Effect. R^2 is 24.8898 and the significant F test of the regression is 165.1918. Coefficient for Dummy/January effect is 0.019546 and significant T-stat of 1.895366.
This suggests that on average daily return for January 1-4 is greater by 1.9546% compared to average from rest of year. Result is consistent with January effect.

The multiple R from the regression output is 0.498897. Multiple R highlights the level of strength of the linear relationship between the variables. The 0.498897 multiple R values show that stock index and Dummy data have an average association between the variables.
The R squared in the regression output is 0.248898, which is the same as 24.8898%. R squared is the coefficient that shows the existing point fall in the regression line. The 24.8898% R squared implying that 24.8898% of y-values variations are found around the mean that is determined by the x-values. 24.8898% of the data values fit the regression model.
A great linear association exists between the stock market return and index of the return supported by the value of the R squared of the regression.

The adjusted R in the regression output is 0.247392. The adjusted R indicates the number of terms found in the model of regression. The 0.247392 suggests that there is more than one x-value in the regression model.
The standard error indicates the standard deviation of the error μ in the regression output. The standard error in the regression results is 0.032432. This implies that the standard deviation of the error μ is 0.032432.
The error is different from the standard error in descriptive statistics. The standard error determines the precision of the regression model coefficient. 1000 observations have been made considering the regression output.

The regression coefficients are 1.428834 and 0.0019546. The coefficients are more significant than the standard error, implying that the coefficients' probability is zero. The least-squares estimate is given as 1.428834 and 0.0019546 as presented in the coefficient column from the regression output.
The least assessment of the data set standard error is 0.001032 and 0.079332 for the intercepts (x and y) and first X variable, respectively. The degree of freedom of the data analysis is 0.173757, as shown by the regression MS.
The residual degree of freedom and the significance associated with the P-value are 0.173757 and 5.28E-63, respectively. Considering the smaller P-value the data set is statistically significant.

Now we calculate the Wald test to see if "January Effect" significantly improves the model.
Using this formula:

$$\frac{SSE_r - SSE_{ur} / m}{SSE_{ur} / n - k - 1}$$

= 3.59652

At 95% significance level with 1 and 997 degrees of freedom critical F is 3.85. Therefore, expanded model with is not a significant improvement over simple market method.

The output of the second data set for Dummy has is provided below

SUMMARY OUTPUT (Calendar Model - 12 Dummy Variables)

Regression Statistics	
Multiple R	0.504483
R Square	0.254503
Adjusted R Square	0.244674
Standard Error	0.032491
Observations	1000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	13	0.355339	0.027334	25.89285	1.69E-54
Residual	986	1.040869	0.001056		
Total	999	1.396208			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.002039	0.003804	0.535864	0.592174	-0.00543	0.009504	-0.00543	0.009504
Slope	1.421546	0.079784	17.81753	8.86E-62	1.264981	1.578111	1.264981	1.578111
Jan1-4	0.019314	0.010958	1.762441	0.078305	-0.00219	0.040818	-0.00219	0.040818
Feb	0.001484	0.005327	0.27858	0.780626	-0.00897	0.011938	-0.00897	0.011938
Mar	-0.00047	0.005161	-0.09115	0.927391	-0.0106	0.009658	-0.0106	0.009658
April	-0.00199	0.005229	-0.37992	0.704087	-0.01225	0.008274	-0.01225	0.008274
May	-0.00042	0.005172	-0.08031	0.936005	-0.01056	0.009733	-0.01056	0.009733
June	0.000114	0.005185	0.022043	0.982418	-0.01006	0.010289	-0.01006	0.010289
July	0.004624	0.005185	0.891794	0.372721	-0.00555	0.014798	-0.00555	0.014798
Aug	0.002442	0.005131	0.475989	0.634188	-0.00763	0.01251	-0.00763	0.01251
Sept	-0.00159	0.00526	-0.30147	0.763122	-0.01191	0.008737	-0.01191	0.008737
Oct	-0.0071	0.00512	-1.38763	0.165563	-0.01715	0.002943	-0.01715	0.002943
Nov	0.001371	0.005229	0.262159	0.793253	-0.00889	0.011631	-0.00889	0.011631
Dec	-0.00131	0.005345	-0.24518	0.806365	-0.0118	0.009178	-0.0118	0.009178

This is a multiple regression with 13 slopes plus intercept. Only dummy variables that are off are Jan 5-31. R^2 is 25.4503% and F test value is 25.89285, which is significant. The multiple R from the regression output is 0.504483. Multiple R highlights the level of strength of the linear relationship between the variables. The 0.504483. multiple R values show that stock index and Dummy data have an average association between the variables. The R squared in the regression output is 0.254503, which is the same as 25.4503%. R squared is the coefficient that shows the existing point fall in the regression line. The 25.4503% R squared implying that 25.4503% of y-values variations are found around the mean that is determined by the x-values. 25.4503% of the data values fit the regression model. A great linear association exists between the stock market return and index of the return supported by the value of the R squared of the regression.

The adjusted R in the regression output is 0.244674. The adjusted R indicates the number of terms found in the model of regression. The 0.244674 suggests that there is more than one x-value in the regression model. The standard error indicates the standard deviation of the error μ in the regression output. The standard error in the regression results is 0.032491. This implies that the standard deviation of the error μ is 0.032491. The error is different from the standard error in descriptive statistics. The standard error determines the precision of the regression model coefficient. 1000 observations have been made considering the regression output.

The regression coefficients 1.421546 is more significant than the standard error, implying that the coefficients' probability is zero. The least-squares estimate is given as 1.421546 as presented in the coefficient column from the regression output. The least assessment of the data set standard error is 0.002039 and 1.421546 for the intercepts (x and y) and the slope parameter, respectively. The degree of freedom of the data analysis is 0.027334, as shown by the regression MS. The residual degree of freedom and the significance associated with the P-value for January, July and October are relatively small. Considering the smaller P-value for the three months, the data set is statistically significant.

And now doing a Wald test gives us the value of 7.4952. At 95% significance level with 1 and 997 degrees of freedom critical F is 3.85. Therefore, expanded model with is a significant improvement over simple market method.

<u>Conclusion:</u>

We can observe a January effect in AMD, but it is not significant.
Wald test suggests January effect was not significant to simple market model.
Expanding the model to include other months showed no other significant coefficients.
Also, Wald Test showed "All month model" has a significant improvement over January effect.
The conclusion is that January effect no longer exists. As a clear correlation between the two cannot be seen.

References

Advanced Micro Devices. (2020). AMD Reports Second Quarter 2020 Financial Results. Retrieved from https://www.globenewswire.com/news-release/2020/07/28/2069033/0/en/AMD-Reports-Second-Quarter-2020-Financial-Results.html

Aiken, L.S., West, S.G. (1991). Multiple regression. Testing and interpreting interactions.

Almini, A.A., Kulahci, M., Montgomery, D.C. (2009). Checking the adequacy of fit of models from split-plot designs. Journal of Quality Technology 38:58-190.

Wang, Nelson. (2020). AMD, Expedia, Xerox: Tech Stock Midday Movers. Retrieved from https://www.thestreet.com/investing/amd-expedia-xerox-thursday-midday-tech-stock-movers

Witkowski, Wallace. (2020). AMD stock price closes above Intel's as next-gen chip saga takes surprise turn. Retrieved from https://www.marketwatch.com/story/amd-stock-price-closes-above-intels-as-next-gen-chip-saga-takes-surprise-turn-2020-07-24

Witkowski, Wallace. (2020). AMD stock surges to record after outlook contrasts with Intel’s ‘faceplant’. Retrieved from https://www.marketwatch.com/story/amd-stock-surges-to-record-after-outlook-contrasts-with-intels-faceplant-2020-07-29