

THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

DEPARTMENT OF FINANCE

DOES TIME-TO-IPO INFLUENCE AFTER-IPO LONG RUN STOCK
PERFORMANCE FOR TECH FIRMS?

LILIA CHUNIR
SPRING 2018

A thesis
submitted in partial fulfillment
of the requirements
for a baccalaureate degree
in Finance
with honors in Finance

Reviewed and approved* by the following:

Matthew Gustafson
Assistant Professor of Finance
Thesis Supervisor

Brian Davis
Clinical Associate Professor of Finance
Honors Adviser

* Signatures are on file in the Schreyer Honors College.

ABSTRACT

A stock's return is a prominent factor used to determine the success of an IPO due to the fact that it depicts profitability and investor confidence in the company. This concept raises the question of whether firm age, or Time-to-IPO, has any impact in generating high stock returns in the long run for technology IPOs. In order to investigate this question, this study performs a regression between firm age and the three-year abnormal return of 167 tech firms that went public between 2010-2013. Through the data findings, it was determined that there is no significant correlation between firm age and after-IPO stock returns to claim that the maturities of tech IPOs influence long run stock performance.

TABLE OF CONTENTS

LIST OF FIGURES	iii
LIST OF TABLES	iv
Chapter 1 Introduction	1
Chapter 2 Literature Review	3
Market Changes and Correlation Effect.....	6
Chapter 3 Methodology	8
Alternative Methods.....	10
Chapter 4 Data Analysis	11
Chapter 5 Conclusion.....	14
Appendix A 167 Technology IPOs.....	15
Appendix B CBOE VIX	21
Appendix C Correlation Graph.....	22
BIBLIOGRAPHY	24

LIST OF FIGURES

Figure 1 Graph Using Original Firm Ages	22
Figure 2 Graph using Natural Log of Firm Ages	22
Figure 3 Graph Using Indicator Variable as Firm Ages	23

LIST OF TABLES

Table 1 Descriptive Statistics.....	9
Table 2 Regression Using Original Firm Ages.....	11
Table 3 Regression Using Natural Log of Firm Ages.....	12
Table 4 Regression Using Indicator Variable for Firm Ages	13

Chapter 1

Introduction

This study, which focuses on the subject of IPOs and their success in generating a profitable outcome for investors, came to be after the news of SNAP INC.'s IPO in March 2017. When the parent company of the well-off app Snapchat went public, the question rose whether this IPO would be a success like its fellow tech startup Facebook, which has become the main social media outlet today, or a failure like Twitter whose stock fell more than 50% since its IPO date as of when this study is being done. At its IPO-date, SNAP INC. was still a relatively new and young company in comparison to other public technology companies in the market. This IPO is one of many whose profitability is doubted and thus arises the question of whether firm age (Time-to-IPO) has any causal relationship with the long-run performance of stock returns for tech firms. Answering this question became of interest due to the fact that there are only a few publications regarding this specific topic. Although some publications exist, they do not include IPOs from recent years, particularly those after the 2009 economic recession. Timing is the variable this study will improve upon as IPOs that occurred from 2010 to 2013 will be observed. By narrowing down the types of IPOs to tech firms and the years of IPOs to include more recent years, this research will provide updated, and potentially different, results of the relationship between firm age (time-to-IPO) and after-IPO stock performance for tech firms today.

This study proposes that there is no significant causal relationship between firm age during an IPO and its after-IPO long run stock performance for tech firms. There are other variables that come into play besides firm age that affect how well an IPO's stock does in the

future. For instance, external factors, such as the market environment (i.e. investor sentiment) at the time of IPO consideration, and internal factors, such as the strategy the company uses to time their IPOs, are key. Because the market changes throughout the years, it leads to various returns for firms every year and has the potential to distort any possible relationship between firm age and IPO performance. Because there are various unpredictable factors that contribute to how well a stock performs, this study proposes there is no explicit causal effect between firm age and IPO stock performance.

The quantitative methodology for this study is to perform a regression model between firm age and stock return data of tech IPOs collected from Thomson ONE Banker, Jay Ritter's website and Center for Research in Security Prices (CRSP) (Appendix A). This study narrows down the years to 2010-2013 to observe the most recent three-year stock returns of technology IPOs after the 2009 economic recession. For the purposes of distinguishing young and mature firms, IPOs are divided into two different age groups which include young firms (ages 0-5 years) and mature firms (ages 6 years and over).

Chapter 2

Literature Review

Various studies cover the relationship between firm age (also known as time-to-IPO) and the after-IPO stock performance in the long run. Needless to say, all of these studies simultaneously yield similar and contrasting results. Some of these papers have a similar coverage to the topic studied in this research however some aspects differ which will be discussed later in this section.

Garza comes to the conclusion that there is a positive correlation between these factors when taking into account general IPOs (Garza, 2008). The study observes 9,400 firms that went public during 1935 to 2002 and determines that younger firms, less than 9 years old, were more likely to underperform than older firms. The multiple regression run uses the raw three-year total return on IPOs as the dependent variable. The first, and primary regression, uses age and market as explanatory variables in which age is presented as the logarithm of one plus age. The results show that IPOs underperform by 43% however firm age improves long run performance by 12.43% each logarithmic age year. Garza states the regression indicates that mature firms (over 32 years old) show zero underperformance. Younger firms underperformed compared to mature firms against several benchmarks which include market indexes, size, and book-to-market matched portfolios. This depicts how age has a positive relationship with after-IPO performance in that mature firms tend to offer higher returns post-IPO.

Bisseswar's research also observes IPOs in general and yields similar results to Garza (Bisseswar, 2015). Due to the relevant observations found in this study, this paper is included to provide further insight into the topic. The objective of this research is to analyze the relationship between various IPO characteristics, predominantly firm age, and the long run performance of the IPO to determine if these components were key determinants of how a stock performs in the future.

In order to test this correlation, Bisseswar creates three different age groups to observe the three-year abnormal returns of young, middle aged and old companies that went public between 1980 to 2010. A multiple regression is run for a total of 1925 companies and the cumulative abnormal returns (CAR), buy-and-hold abnormal returns (BHAR) and wealth relatives (WR) are calculated against various market indices. This study observes that there is a somewhat positive correlation between firm age and after-IPO stock performance however there are varying results depending on the measure. Using CAR, the sample of IPOs indicate that these stocks overperform but in using the buy-and-hold returns and wealth relatives measures, the results indicate they underperform. Taking a step further and splitting the IPOs into the aforementioned age groups, the underperformance is observed to be prominent in younger companies. Furthermore, this underperformance is a significant observation in early years but not in recent years. Despite these findings, no significant correlation can be said to exist between IPO performance and firm age since the study generates a low t-statistic which indicates it is not statistically significant. Therefore, this study determines that final conclusions cannot be stated regarding the long run performance of IPOs.

Clark's study observes the same relationship but rather than using general IPOs, it uses technology IPOs that occurred from 1991 and 1997 (Clark, 2002). Its method uses the three-year excess holding period return of 1,234 companies that went public within 1991 and 1997. To test the overall relationship between firm age and after-IPO returns, the study initially performs a regression for both technology and non-technology IPOs as one group. Using the excess holding period return as the target variable, it yields a t-statistic of 1.83 and a p-value of 0.068. This concludes that there is a statistical significant and positive relationship between firm age-at-IPO and post-IPO excess returns. However, when these IPOs are separated into a group of technology firms only, the results change. The findings indicate that there is a negative correlation between firm age and performance where the younger tech firms outperform older tech firms in long-run excess returns, especially between 1995 and 1997. This regression generates a t-statistic of 1.82, p-value 0.70 which signifies this correlation is statistically significant. Thus, using such regression method shows younger tech IPOs are more likely to have an attractive stock return in the long run. Clark further adds that returns for younger technology IPOs may have been so because of the boom in technology IPOs in the late 1990s that led to results being better than expected. Particularly, the high betas for these younger tech IPOs, in comparison to the older IPOs, led to relatively higher returns during the given time period.

Market Changes and Correlation Effect

Although these studies provide an insight into the correlation of firm age and post-IPO long run stock performance, there is a variable present in all of them that could be revised. These studies do not take into account IPOs that occurred in most recent years, especially those after the 2009 recession. Although using an extensive time period could provide a more detailed observation of IPOs, the use of older years runs the risk of yielding outdated results. As mentioned in the Bisseswar study, the discrepancy in the underperformance was significantly correlated to the years these companies were taken from. The time periods used in the studies above do not account for changes in the finance industry or in the relationship between firm age and post-IPO performance in recent years.

The studies above use IPOs that occurred during years of economic recession where investor sentiment was low. Apart from firm age, which is the focus of this study, long run stock performance is also determined by investor sentiment which is observed in Peng's study Investor sentiment, customer satisfaction and stock returns. The study observes how investor sentiment causes stock price variations in that when investors have pessimistic beliefs about the market or the firm, the stock price will be at levels beneath its intrinsic worth. The aforementioned studies use multiple time periods of economic recession which include times of pessimistic investor sentiment. This implies that the stock returns observed would be significantly lower than they normally would be during economic expansions when optimism is at high levels. The CBOE VIX is a key index used to measure investor sentiment, apart from serving as a measure of volatility. During the 2007-2009 recession, the VIX reached an ultimate high of 36.50 in October 2008 indicating overall negative investor sentiment and market fear (Appendix B). Given that the 2007-2009 recession is over, investor sentiment has improved since then. The annual VIX has

been at normal to low levels, staying below 18.43 which was the highest it has ever been post-recession. Ultimately, stock returns of post-recession tech IPOs should reflect this change of sentiment. Since this shift in stock returns exists, the possibility that there is a change in the correlation between long-run stock returns and firm age arises.

Another factor that is different today and could change the aforementioned relationship is the timing of IPOs. In the past, private firms would choose to go public whenever the opportunity presented itself. This was due to the fact there were little to no opportunities to raise immediate private funds as private capital was difficult to secure. However, there are various sources of liquidity today that now allow private firms to be quite selective with their IPO timing. Today, private firms are keen on going public at the prime time in which they can fully maximize profits in the market. This hyper-optimization of IPO timing leads to IPOs occurring at various firm maturities which has the potential of altering the relationship between firm age and stock performance.

Chapter 3

Methodology

In order to analyze the correlation between firm age and long-run stock performance, this study observes the monthly compounded abnormal returns for tech IPOs. Jay Ritter's website was used to extract firm age data for all IPOs (tech and non-tech) that occurred from 1975-2017. This data set was narrowed down to the years 2010-2013 as this period is the focus of this paper. Using data listing historical tech IPOs from Thomson ONE Banker, hi-tech IPOs were separated from the original pool which yielded 195 tech IPOs. Using CRSP, the monthly returns for 167 IPO out of the 195 IPOs were obtained thus shortening the pool of observations.

This paper regards the long-run after-IPO return for each firm as the three-year period (36 months) starting from the first month after the IPO date. The abnormal returns were calculated by comparing each monthly return to that of the S&P 500 at that given time (monthly return – S&P return). However, not all IPOs in this pool made it on the exchange for this 36-month period, some having delisted before then. Therefore, these abnormal returns were compounded so that returns could be compared across all IPOs despite the differences in months. With these two factors in mind, the monthly compounded abnormal return was calculated using the following formula:

$$\text{Compounded Abnormal Return} = \Pi \text{AR}^{(1/m)} - 1$$

where:

AR= Abnormal Returns per IPO

m= total months

In this study, firm age is calculated by subtracting each firm's founding year from the year the firm went public. For the purpose of distinguishing young from mature tech IPOs, two age groups are created where young firms are considered as firms with ages of 0-5 years and mature firms are firms with ages of 6 and over. The formation of these categories was inspired by the Bisseswar paper that used the following three age groups: young firms (less than 6 years old), mature firms (6-15 years old), and old firms (over 15 years old). The final data for this study included the abnormal return of each IPO alongside its firm age (Appendix A). Below are some descriptive statistics for the given data. Within the range of 0-29 years of age, the average firm age is approximately 10 years with the median being 9 years (Table 1). The average return is -1.05% and the median return is -.843%. This indicates that on average these IPOs will lose by roughly 1% in the following three years. Ultimately, a regression analysis was performed on the returns and ages of all of the 167 tech IPOs to analyze the correlation between these two factors.

Average Age	9.72
Average Return	-1.05%
Percentiles	Return
0	-16.60%
25	-3.09%
50	-0.84%
75	1.15%
100	9.81%

Table 1 Descriptive Statistics

Alternative Methods

Due to the fact that the set of firm ages range anywhere from 0 to 29 years old, it was noted that this could impact the regression output. Therefore, to ensure that the large values in the age pool did not misrepresent the correlation between firm age and returns, two additional regressions were performed under different components from the original regression. One scenario would use the natural log of firm age in place of the original age (Appendix A). The other scenario would use an indicator variable in place of the firm age. This method allocates the number 0 to firm ages below 6 years and the number 1 to ages 6 years and above (Appendix A).

Chapter 4

Data Analysis

In performing the first regression with the original firm ages, the R square, t-statistic and p-value were analyzed (Table 2). The regression output lists an R square of roughly .001. This indicates that only about .1% of the abnormal returns can be explained by firm age. Furthermore, the data indicated a low t-statistic of .449 and a high p-value of .654 which depicts the high probability that the abnormal returns occurred at the given firm age by chance. Given this output, no significant correlation was observed between firm age and after-IPO stock performance.

SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0.034972
R Square	0.001223
Adjusted R Square	-0.00483
Standard Error	0.033446
Observations	167

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	0.000226	0.000226	0.202	0.653664
Residual	165	0.184572	0.001119		
Total	166	0.184798			

	<i>Coefficients</i>	<i>Std Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	-0.01272	0.005623	-2.26272	0.025	-0.023826	0.001621
ages	0.000231	0.000514	0.449496	0.6537	-0.000783	0.001245

Table 2 Regression Using Original Firm Ages

The second regression which used the natural log of firm age yields similar results. The R square is close to 0 and indicates that only .01% of the abnormal returns can be explained by the

given firm age. The t-stat was .045 and p-value of .964 also indicating that there is no significant correlation (Table 3).

SUMMARY OUTPUT						
<i>Regression Statistics</i>						
Multiple R		0.003493				
R Square		0.000012				
Adjusted R Square		-0.00605				
Standard Error		0.033466				
Observations		167				
ANOVA						
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>	
Regression	1	2.25E-06	2.25E-06	0.002	0.964270	
Residual	165	0.18479	0.00112			
Total	166	0.18479	8			
	<i>Coefficients</i>	<i>Std Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	-0.01100	0.01187	0.92600	0.355	-0.034453	0.01245
LN(Age)	0.000230	0.00513	0.04486	0.964	-0.009909	0.01036

Table 3 Regression Using Natural Log of Firm Ages

The third regression which uses an indicator variable for firm age yields numbers that differ from the previous results, however not significantly. The output consists of an R square of .004, a slightly higher t-stat of .780 and slightly lower p-value of .436 (Table 4). The results still indicate that the abnormal returns for each age occurred through chance rather than through an existing correlation.

SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0.060647
R Square	0.003678
Adjusted R Square	-0.002360
Standard Error	0.033405
Observations	167

ANOVA						
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>	
Regression	1	0.00068	0.00068	0.609	0.436236	
Residual	165	0.184119	0.001116			
Total	166	0.184798				

	<i>Coefficients</i>	<i>Std Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	-0.01497	0.006313	-2.37204	0.019	-0.027439	0.002510
Age (Indicator Variable)	0.00540	0.00692	0.780464	0.436	-0.008262	0.019063

Table 4 Regression Using Indicator Variable for Firm Ages

Scatter plots were created for each scenario to accompany these results and serve as a visual representation of this correlation (Appendix C). Using trendlines for each graph as an indicator, there seems to be no significant pattern visible between firm age and stock return under the three different circumstances.

Chapter 5

Conclusion

The correlation between firm age and after-IPO stock performance for tech IPOs has been an area of interest observed in previous studies. Private tech companies decide to go public at different points of their company lifespan whether it be a year after being formed or 10 years down the road. The question of whether age has any effect on how profitable a tech IPO is a matter of interest to investors and other players in the market as it will determine whether the IPO is a worthy investment opportunity.

Using the abnormal returns and firm ages of 167 tech IPOs, this study set out to observe the correlation between these two factors. To account for the large values in the pool of firm ages, three scenarios were created in total. The outputs for each scenario indicates that the correlation is not statistically significant in order to declare that the abnormal returns are influenced by firm age. Therefore, according to this data, the three-year returns of tech IPO cannot be determined by firm maturities.

This topic is still an area that could be further analyzed as it only has a few research papers published. Using different variables, such as IPO years, could yield different results and provide a distinct perspective on this correlation. As new and existing tech firms make the decision to go public in the future, it will provide new data that can be used to observe any changes in the correlation between firm age and after-IPO stock performance.

Appendix A

167 Technology IPOs

Date	Company	Return	S&P Mkt Return	Ab. Return	Comp. ab. return	Ages	LN(AGE)	Age (Var.)
20100831	QLIK TECHNOLOGIES INC	0.296	-0.047	1.344	0.012	17	2.890	1
20100930	INTRALINKS HOLDINGS INC	0.301	0.088	1.213	-0.023	14	2.708	1
20100930	ELECTROMED INC N X P	0.019	0.088	0.932	-0.049	18	2.944	1
20100930	SEMICONDUCTORS N V	0.119	0.088	1.031	0.024	4	1.609	0
20100930	NUPATHE INC	-0.083	0.088	0.830	-0.038	5	1.792	0
20100930	REALPAGE INC CORESITE REALTY CORP	0.140	0.088	1.052	-0.006	7	2.079	1
20101029	AEGERION PHARMACEUTICALS INC	-0.081	0.037	0.882	0.013	0	0.000	0
20101130	PACIFIC BIOSCIENCES CALIF INC	-0.064	-0.002	0.938	0.047	5	1.792	0
20101130	CALIF INC	-0.250	-0.002	0.752	-0.046	10	2.398	1
20101231	INPHI CORP ANACOR PHARMACEUTICALS INC	0.264	0.065	1.198	-0.017	10	2.398	1
20101231	COMPLETE GENOMICS INC	0.074	0.065	1.009	0.017	8	2.197	1
20101231	FLEETCOR TECHNOLOGIES INC	-0.036	0.065	0.899	-0.041	5	1.792	0
20110131	GAIN CAPITAL HOLDINGS INC	-0.030	0.023	0.948	0.027	7	2.079	1
20110131	RIGNET INC	0.047	0.023	1.024	-0.016	11	2.485	1
20110131	RIGNET INC	0.009	0.023	0.986	0.024	6	1.946	1
20110331	NEOPHOTONICS CORP ACELRX PHARMACEUTICALS INC	-0.384	-0.001	0.617	-0.032	18	2.944	1
20110331	ENDOCYTE INC	-0.053	-0.001	0.949	0.023	6	1.946	1
20110331	EPOCRATES INC	0.169	-0.001	1.170	0.007	16	2.833	1
20110331	FLUIDIGM CORP CORNERSTONE ONDEMAND INC	-0.088	-0.001	0.913	-0.029	13	2.639	1
20110331	FLUIDIGM CORP CORNERSTONE ONDEMAND INC	0.011	-0.001	1.012	0.024	12	2.565	1
20110429	ONDEMAND INC	0.050	0.028	1.021	0.018	12	2.565	1

	SERVICSOURCE							
20110429	INTERNATIONAL INC	0.026	0.028	0.998	-0.019	12	2.565	1
20110531	ELLIE MAE INC	-0.043	-0.014	0.971	0.024	14	2.708	1
20110531	RESPONSYS INC	0.076	-0.014	1.089	0.009	13	2.639	1
	SAGENT							
	PHARMACEUTICALS							
20110531	INC	0.225	-0.014	1.238	-0.008	5	1.792	0
20110630	ACTIVE NETWORK INC	-0.041	-0.018	0.977	-0.017	13	2.639	1
20110630	LINKEDIN CORP	0.104	-0.018	1.123	0.009	8	2.197	1
20110630	BOINGO WIRELESS INC	-0.029	-0.018	0.989	-0.019	10	2.398	1
20110729	FUSION I O INC	-0.016	-0.021	1.006	-0.037	6	1.946	1
20110729	PANDORA MEDIA INC	-0.202	-0.021	0.819	0.001	11	2.485	1
	VANGUARD HEALTH							
20110729	SYSTEMS INC	0.010	-0.021	1.031	-0.001	14	2.708	1
20110729	HOMEAWAY INC	0.016	-0.021	1.037	-0.014	6	1.946	1
	TEAVANA HOLDINGS							
20110831	INC	-0.080	-0.057	0.977	-0.038	14	2.708	1
20110831	SKULLCANDY INC	-0.145	-0.057	0.912	-0.039	8	2.197	1
20110831	TANGOE INC	-0.046	-0.057	1.011	-0.007	11	2.485	1
20110930	CARBONITE INC	-0.187	-0.072	0.885	-0.023	5	1.792	0
	UBIQUITI NETWORKS							
20111130	INC	-0.059	-0.005	0.946	0.004	6	1.946	1
20111130	ZELTIQ AESTHETICS INC	0.004	-0.005	1.009	0.002	6	1.946	1
20111230	IMPERVA INC	0.249	0.009	1.240	-0.001	9	2.303	1
20111230	INVENSENSE INC	-0.115	0.009	0.876	-0.006	8	2.197	1
20111230	CLOVIS ONCOLOGY INC	0.095	0.009	1.086	0.024	2	1.099	0
20111230	GROUPON INC	0.179	0.009	1.170	-0.038	3	1.386	0
20111230	INTERMOLECULAR INC	-0.028	0.009	0.963	-0.054	7	2.079	1
	NEWLINK GENETICS							
20111230	CORP	0.006	0.009	0.997	0.034	12	2.565	1
20120131	JIVE SOFTWARE INC	-0.072	0.044	0.885	-0.040	10	2.398	1
20120131	ZYNGA INC	0.115	0.044	1.071	-0.047	4	1.609	0
	GUIDEWIRE							
20120229	SOFTWARE INC	0.255	0.041	1.214	0.018	11	2.485	1
20120229	VERASTEM INC	0.058	0.041	1.018	-0.023	2	1.099	0
20120330	EPAM SYSTEMS INC	0.452	0.031	1.421	0.030	19	2.996	1
	GREENWAY MEDICAL							
20120330	TECHNOLOGS INC	0.032	0.031	1.001	0.002	14	2.708	1
20120330	BRIGHTCOVE INC	0.664	0.031	1.633	-0.028	8	2.197	1
20120330	CHEMOCENTRYX INC	0.045	0.031	1.014	-0.019	15	2.773	1
20120330	SYNACOR INC	0.549	0.031	1.518	-0.035	14	2.708	1
20120430	DEMANDWARE INC	-0.086	-0.007	0.922	0.009	8	2.197	1
20120430	EXACTTARGET INC	0.039	-0.007	1.046	0.010	12	2.565	1

	MILLENNIAL MEDIA							
20120430	INC	-0.193	-0.007	0.815	-0.085	6	1.946	1
	VOCERA							
	COMMUNICATIONS							
20120430	INC	-0.053	-0.007	0.954	-0.035	12	2.565	1
20120430	YELP INC	-0.150	-0.007	0.858	0.006	8	2.197	1
20120430	CAFEPRESS INC	-0.124	-0.007	0.884	-0.054	13	2.639	1
	FORUM ENERGY							
20120531	TECHNOLOGIES INC	-0.071	-0.063	0.992	-0.010	23	3.178	1
20120531	INFOBLOX INC	-0.030	-0.063	1.033	-0.008	13	2.639	1
	CLEARSIGN							
20120531	COMBUSTION CORP	0.066	-0.063	1.129	-0.010	4	1.609	0
20120531	ENVIVIO INC	-0.093	-0.063	0.970	-0.056	12	2.565	1
20120531	PROOFPOINT INC	0.089	-0.063	1.152	0.029	10	2.398	1
20120531	SPLUNK INC	-0.041	-0.063	1.022	0.008	9	2.303	1
20120629	AUDIENCE INC	0.088	0.040	1.048	-0.050	12	2.565	1
20120629	FACEBOOK INC	0.051	0.040	1.011	0.014	8	2.197	1
	SUPERNUS							
	PHARMACEUTICALS							
20120629	INC	0.705	0.040	1.665	0.013	7	2.079	1
20120731	SERVICENOW INC	0.098	0.013	1.085	0.019	8	2.197	1
20120731	EXA CORP	-0.055	0.013	0.932	-0.011	21	3.091	1
20120731	TESARO INC	-0.052	0.013	0.935	0.029	2	1.099	0
	PALO ALTO NETWORKS							
20120831	INC	0.127	0.020	1.107	0.022	7	2.079	1
	DURATA							
20120831	THERAPEUTICS INC	0.007	0.020	0.987	0.027	3	1.386	0
20120831	E2OPEN INC	0.013	0.020	0.993	-0.025	9	2.303	1
	HYPERION							
20120831	THERAPEUTICS INC	-0.016	0.020	0.964	0.032	6	1.946	1
20120928	GLOBUS MEDICAL INC	0.133	0.024	1.108	0.002	9	2.303	1
20120928	ELOQUA INC	0.412	0.024	1.387	0.096	6	1.946	1
	PEREGRINE							
	SEMICONDUCTOR							
20120928	CORP	0.065	0.024	1.041	-0.024	22	3.135	1
20121031	TRULIA INC	0.053	-0.020	1.073	0.013	7	2.079	1
20121130	LIFELOCK INC	0.157	0.003	1.154	0.007	7	2.079	1
20121130	SHUTTERSTOCK INC	0.078	0.003	1.075	-0.005	5	1.792	0
20121130	WORKDAY INC	0.033	0.003	1.030	0.003	7	2.079	1
20121130	AMBARELLA INC	0.206	0.003	1.204	0.044	8	2.197	1
	INTERCEPT							
	PHARMACEUTICALS							
20121130	INC	0.294	0.003	1.291	0.049	10	2.398	1

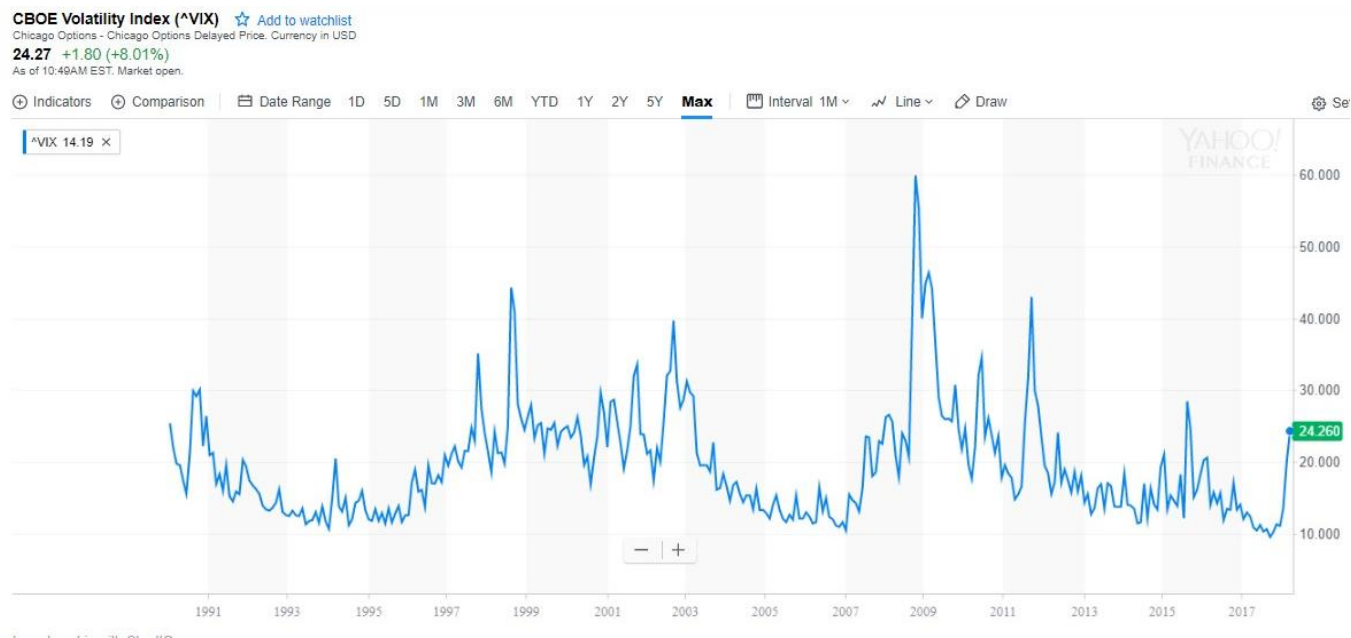
	KYTHERA BIOPHARMACEUTICALS							
20121130	INC	0.113	0.003	1.110	0.026	8	2.197	1
	REGULUS							
20121130	THERAPEUTICS INC	-0.006	0.003	0.991	-0.002	5	1.792	0
20121231	RUCKUS WIRELESS INC	0.702	0.007	1.695	-0.015	8	2.197	1
20130228	CYRUSONE INC	0.007	0.011	0.996	0.011	1	0.693	0
20130228	LIPOSCIENCE INC	-0.071	0.011	0.918	-0.048	19	2.996	1
	STEMLINE							
20130228	THERAPEUTICS	0.102	0.011	1.091	-0.030	10	2.398	1
20130430	MODEL N INC	-0.002	0.018	0.980	-0.024	14	2.708	1
	SILVER SPRING							
20130430	NETWORKS INC	0.042	0.018	1.023	-0.011	11	2.485	1
	ENANTA							
	PHARMACEUTICALS							
20130430	INC	0.097	0.018	1.079	0.005	18	2.944	1
	TETRAPHASE							
	PHARMACEUTICALS							
20130430	INC	0.147	0.018	1.129	-0.014	7	2.079	1
20130430	WEST CORP	0.094	0.018	1.076	0.001	27	3.332	1
	RALLY SOFTWARE							
20130531	DEVELOPMENT CORP	0.210	0.021	1.189	-0.008	11	2.485	1
20130531	CHIMERIX INC	0.079	0.021	1.058	-0.038	13	2.639	1
	CHANNELADVISOR							
20130628	CORP	-0.075	-0.015	0.940	-0.016	12	2.565	1
20130628	CYAN INC	-0.217	-0.015	0.798	-0.043	7	2.079	1
	TABLEAU SOFTWARE							
20130628	INC	0.085	-0.015	1.100	-0.007	9	2.303	1
	AMBIT BIOSCIENCES							
20130628	CORP	0.023	-0.015	1.038	0.037	13	2.639	1
20130628	EPIZYME INC	0.224	-0.015	1.239	-0.026	6	1.946	1
20130628	MARKETO INC	0.051	-0.015	1.066	0.004	3	1.386	0
20130628	RECEPTOS INC	0.253	-0.015	1.268	0.098	5	1.792	0
20130731	BLUEBIRD BIO INC	0.247	0.049	1.197	0.009	21	3.091	1
20130731	C D W CORP NEW	0.155	0.049	1.105	0.015	29	3.401	1
20130731	GOGO INC	-0.139	0.049	0.812	-0.021	5	1.792	0
	NANOSTRING							
20130731	TECHNOLOGIES INC	0.139	0.049	1.089	0.005	10	2.398	1
	ARATANA							
20130731	THERAPEUTICS INC	0.231	0.049	1.182	-0.010	3	1.386	0
	P T C THERAPEUTICS							
20130731	INC	0.044	0.049	0.995	-0.028	15	2.773	1
20130731	TEXTURA CORP	0.160	0.049	1.110	-0.007	9	2.303	1

	AGIOS PHARMACEUTICALS							
20130830	INC	-0.191	-0.031	0.840	0.006	6	1.946	1
	CONATUS PHARMACEUTICALS							
20130830	INC	-0.003	-0.031	1.028	-0.045	8	2.197	1
20130830	HEAT BIOLOGICS INC	0.006	-0.031	1.037	-0.079	5	1.792	0
	CELLULAR DYNAMICS							
20130830	INTL INC	0.314	-0.031	1.345	0.013	6	1.946	1
	LIQUID HOLDINGS							
20130830	GROUP INC	0.034	-0.031	1.065	-0.166	5	1.792	0
	ONCOMED PHARMACEUTICALS							
20130830	INC	-0.196	-0.031	0.836	-0.019	6	1.946	1
20130830	RETAILMENOT INC	0.123	-0.031	1.155	-0.041	6	1.946	1
20130930	CVENT INC	-0.012	0.030	0.958	-0.011	14	2.708	1
20130930	INTREXON CORP	0.090	0.030	1.060	-0.002	15	2.773	1
20130930	YUME INC	0.250	0.030	1.220	-0.034	9	2.303	1
20130930	CANCER GENETICS INC	1.091	0.030	2.061	-0.051	14	2.708	1
	APPLIED							
20131031	OPTOELECTRONICS INC	0.268	0.045	1.223	0.016	16	2.833	1
	BIND THERAPEUTICS							
20131031	INC	-0.073	0.045	0.882	-0.088	7	2.079	1
20131031	BENEFITFOCUS INC	0.019	0.045	0.975	-0.013	13	2.639	1
20131031	COVISINT CORP	-0.044	0.045	0.912	-0.055	5	1.792	0
20131031	EVOKE PHARMA INC	-0.075	0.045	0.881	-0.054	6	1.946	1
20131031	FIREEYE INC	-0.087	0.045	0.868	-0.036	9	2.303	1
	FOUNDATION							
20131031	MEDICINE INC	-0.191	0.045	0.764	-0.022	4	1.609	0
	FIVE PRIME							
20131031	THERAPEUTICS INC	-0.068	0.045	0.887	0.034	12	2.565	1
20131031	OPHTHOTECH CORP	0.128	0.045	1.084	0.007	6	1.946	1
	ACCELERON PHARMA							
20131031	INC	0.014	0.045	0.969	0.007	10	2.398	1
20131129	VEEVA SYSTEMS INC	0.041	0.028	1.013	-0.005	6	1.946	1
	AERIE PHARMACEUTICALS							
20131129	INC	0.071	0.028	1.043	0.027	8	2.197	1
	ENDURANCE INTL							
20131129	GROUP HLDGS INC	0.301	0.028	1.273	-0.015	16	2.833	1
	FATE THERAPEUTICS							
20131129	INC	-0.067	0.028	0.905	-0.034	6	1.946	1
20131129	L D R HOLDING CORP	0.063	0.028	1.035	0.013	13	2.639	1
20131129	MACROGENICS INC	-0.017	0.028	0.955	-0.007	13	2.639	1
20131129	VERACYTE INC	0.048	0.028	1.020	-0.019	7	2.079	1

	BARRACUDA							
20131231	NETWORKS INC	0.917	0.024	1.893	-0.001	10	2.398	1
20131231	CHEGG INC	0.037	0.024	1.013	-0.005	8	2.197	1
20131231	MAVENIR SYSTEMS INC	0.053	0.024	1.029	0.024	8	2.197	1
20131231	TWITTER INC	0.531	0.024	1.508	-0.028	7	2.079	1
20131231	IDEAL POWER INC	-0.241	0.024	0.735	-0.017	6	1.946	1
	KARYOPHARM							
20131231	THERAPEUTICS INC	0.407	0.024	1.383	-0.017	5	1.792	0
20131231	RELYPSA INC	0.454	0.024	1.431	0.015	6	1.946	1
20140131	NIMBLE STORAGE INC	-0.046	-0.036	0.990	-0.052	6	1.946	1
	KINDRED BIOSCIENCES							
20140131	INC	0.390	-0.036	1.426	-0.033	1	0.693	0
	TETRALOGIC							
	PHARMACEUTICALS							
20140131	CORP	-0.065	-0.036	0.970	-0.112	12	2.565	1
20140131	XENCOR INC	-0.038	-0.036	0.997	0.026	16	2.833	1
20141231	ADMA BIOLOGICS INC	-0.097	-0.004	0.907	-0.036	9	2.303	1
	IRONWOOD							
	PHARMACEUTICALS							
20100331	INC	0.048	0.059	0.989	-0.004	12	2.565	1
20100430	CALIX INC	-0.108	0.015	0.877	-0.020	11	2.485	1
20100430	MAXLINEAR INC	-0.050	0.015	0.936	-0.038	7	2.079	1
	A V E O							
	PHARMACEUTICALS							
20100430	INC	0.051	0.015	1.036	-0.014	9	2.303	1
20100430	MERU NETWORKS INC	-0.094	0.015	0.891	-0.035	8	2.197	1
	S S & C TECHNOLOGIES							
20100430	HLDGS INC	0.113	0.015	1.098	0.011	24	3.219	1
20100528	ALIMERA SCIENCES INC	-0.198	-0.082	0.884	-0.044	7	2.079	1
20100528	CODEXIS INC	-0.241	-0.082	0.841	-0.055	8	2.197	1
20100528	CONVIO INC	-0.051	-0.082	1.031	0.014	11	2.485	1
20100528	DYNAVOX INC	0.045	-0.082	1.127	-0.096	17	2.890	1
20100528	S P S COMMERCE INC	-0.105	-0.082	0.977	0.027	23	3.178	1
20100630	CORMEDIX INC	-0.188	-0.054	0.866	-0.059	4	1.609	0
20100630	REACHLOCAL INC	-0.116	-0.054	0.937	-0.013	7	2.079	1
20100630	TELENAV INC	0.000	-0.054	1.054	-0.027	11	2.485	1
	HIGHER ONE							
20100730	HOLDINGS INC	-0.036	0.069	0.895	-0.018	10	2.398	1
20100730	BROADSOFT INC	0.012	0.069	0.943	0.022	12	2.565	1

Appendix B

CBOE VIX



CBOE VIX, 1991-2017. Retrieved from “^VIX Interactive Stock Chart | CBOE Volatility Index Stock.” Yahoo! Finance, Yahoo!

Appendix C

Correlation Graph

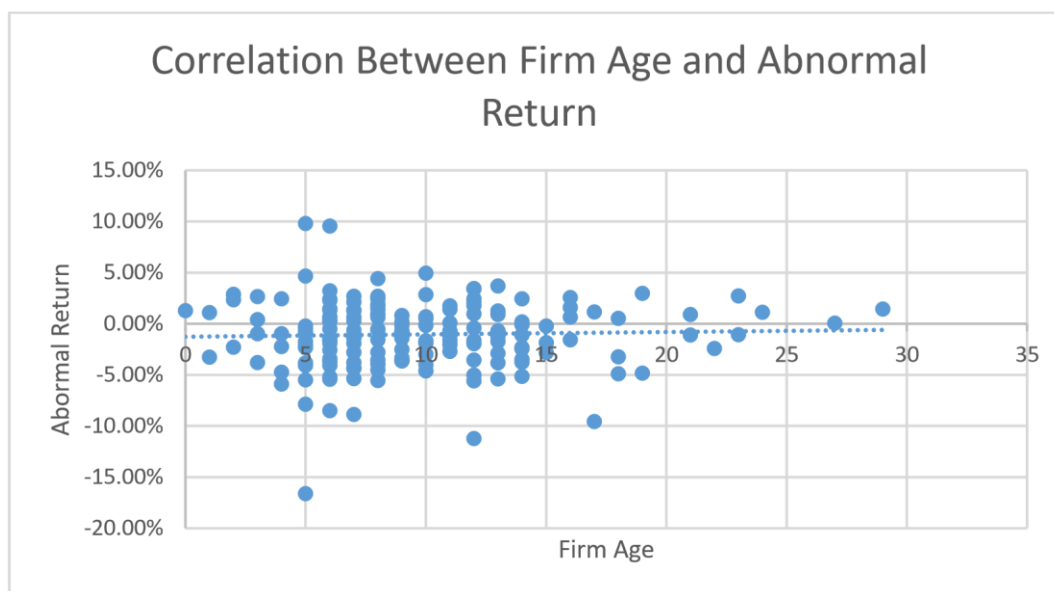


Figure 1 Graph Using Original Firm Ages

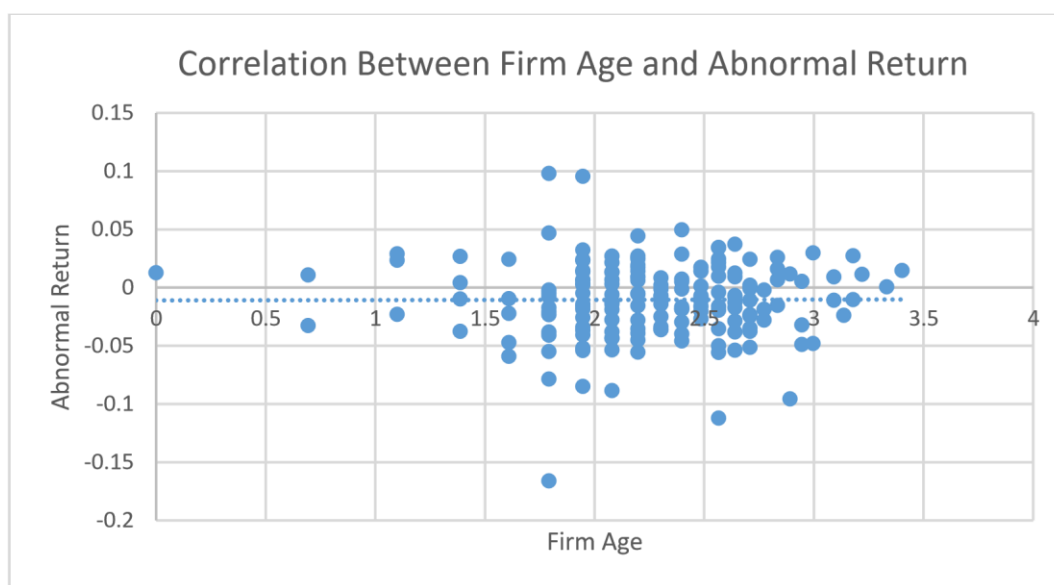


Figure 2 Graph using Natural Log of Firm Ages

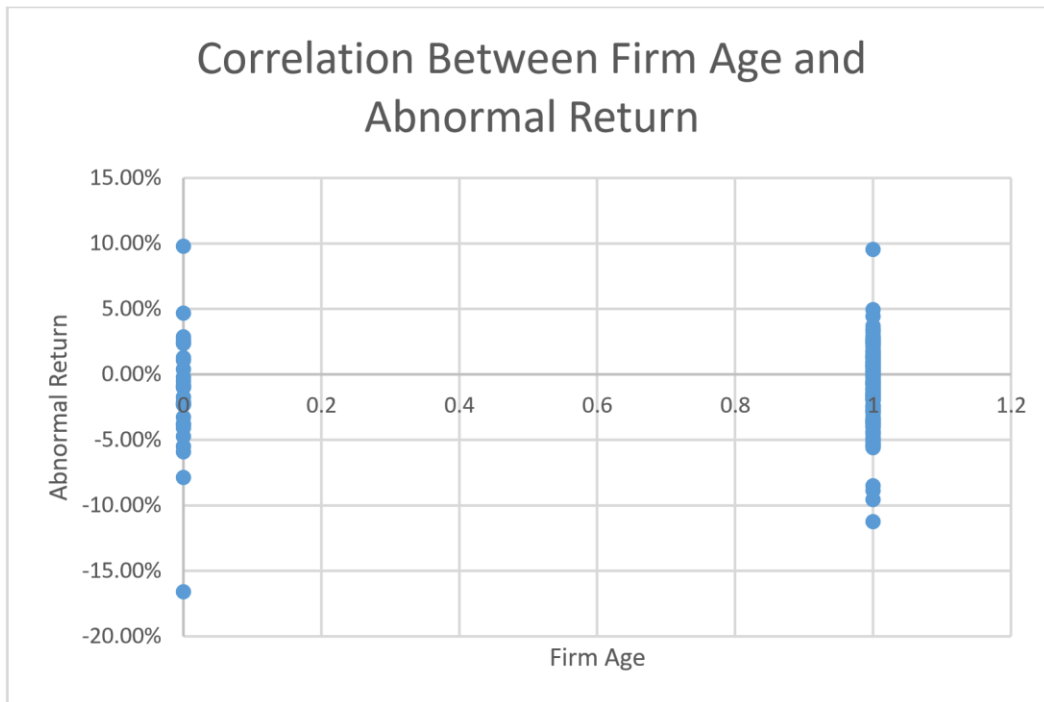


Figure 3 Graph Using Indicator Variable as Firm Ages

BIBLIOGRAPHY

- Bisseswar, Ritesh. "The Long-Run Performance of Initial Public Offerings, and Their Relationship with IPO Characteristics ." University of Amsterdam, [Http://Dare.uva.nl/](http://Dare.uva.nl/), 7 July 2015. <arno.uva.nl/cgi/arno/show.cgi?fid=633816>.
- Clark, D. T. (2002), A Study of the Relationship Between Firm Age-at-IPO and Aftermarket Stock Performance. *Financial Markets, Institutions & Instruments*, 11: 385–400. doi:10.1111/1468-0416.11406.
- Murillo Garza, Jorge A. *The Effects of Firm Maturity: IPO and Post -IPO Performance, Growth, Efficiency, Profitability and Returns; & the Rational Part of Momentum*, Columbia University, Ann Arbor, 2008, ABI/INFORM Collection; ProQuest Dissertations & Theses A&I.
- Peng, Chi-Lu, et al. "Investor Sentiment, Customer Satisfaction and Stock Returns." *European Journal of Marketing* 49.5 (2015): 827-50. ProQuest. 1 Mar. 2018.
- Steiner, Christopher. "Timing A Tech IPO Is Far More Complicated Than It Used To Be." *Forbes*, Forbes Magazine, 27 May 2016. <www.forbes.com/sites/christophersteiner/2016/05/27/timing-a-tech-ipo-is-far-more-complicated-than-it-used-to-be/#269b28f748cd>.
- Tan, Gillian. "Private Equity Aces Its IPO Timing." *Bloomberg.com*, Bloomberg, 30 Sept. 2016. <www.bloomberg.com/gadfly/articles/2016-09-30/private-equity-firms-nail-ipo-timing>.

ACADEMIC VITA

LILIA V. CHUNIR

EDUCATION

The Pennsylvania State University | The Schreyer Honors College
Smeal College of Business | *Bachelor of Science in Finance*
The College of the Liberal Arts | *Minor in Korean*

University Park, PA
Class of 2018
Dean's List

PROFESSIONAL EXPERIENCE

JPMorgan Chase & Co.

Finance Analyst Intern | Regulatory Reporting Policy Team

New York, NY

Jun 2017 – Aug 2017

- Completed the development of an excel database for questions submitted to the Federal Reserve and Office of the Comptroller of the Currency regarding regulatory reporting instructions to serve as a reference for relevant stakeholders
- Presented before the managing director of the Firmwide Regulatory Capital Reporting the online database that was completed in 10 weeks to indicate how it would affect regulatory reporting related questions in the future
- Inspected newly issued changes in the reporting instructions for the balance sheet and income statement to then update the SharePoint file accordingly so as to notify respective reporting teams

Park Avenue Armory

Youth Corps Advisory Board Member

New York, NY

Jun 2017 – May 2018

- Elected to participate in an advisory board to create workshops and content for students visiting the Armory to further promote art within the local youth community
- Collaborated with team to develop an art piece for the October 2017 gala so as to increase the total amount fundraised which would go towards financing activities in the Education Department

LEADERSHIP EXPERIENCE

Wall Street Boot Camp

Participant

University Park, PA

Aug 2015 – Dec 2015

- Chosen out of 400 applicants to engage in sessions designed to prepare 40 students for careers on Wall Street through professional workshops on resumes, cover letters, networking, etiquette and professional protocol

Penn State Investment Association

Financials Sector Member

University Park, PA

Sep 2015 – Dec 2016

- Participated in stock pitch competitions to persuade fund managers to consider buying shares in consumer discretionary companies
- Performed Discounted Cash Flow models to determine the valuation of companies

Korean Pop Music and Dance Club (KPMDC)

Treasurer | Fundraising Chair

University Park, PA

Jan 2017 – Jan 2018

- Managed all membership funds for the organization that totaled \$400 to ensure proper collection and use of club money
- Created various fundraising events, some with local businesses, throughout the semester to raise \$324.96 for the club to fund future events to increase unity among members

Founder & President

Nov 2014 – Jan 2017

- Instituted the first student organization centered on Korean music and dance to raise awareness of the diversity within Penn State
- Directed the functions and projects of the club of over 60 members to ensure effective means of marketing were implemented

Schlow Centre Region Library

Volunteer

State College, PA

Jul 2015 – Nov 2016

- Acquired library items placed on reserve and used the program Horizon to process for pick-up
- Initiated and completed the relabeling project of the Children Board Book collection of over 1,000 items

AWARDS/SKILLS/INTERESTS

- Career Planning and Strategies Scholarship, Michael D. Ferugio Scholarship, and Los Padres Foundation Scholarship
- Fluent in Spanish, working knowledge in Bloomberg Terminal and FactSet
- Other Interests: comedy movies, dancing, karaoke, photography, reading, running, traveling, theatre