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INFOSYS: An Analysis of the Degree of Covariance Between the Firm's Nationally Traded Stock and its American Depository (ADS)

Abstract

Researchers have proved the influence of the American stock markets on their Indian counterparts during the IT boom. This paper tests these market-wide results on a stockspecific basis by analyzing the degree of covariance between the equity issued by the Indian firm Infosys on the Bombay Stock Exchange (Stock) and its American Depositary Shares (ADS) on the NASDAQ. The study finds that unlike the influence of the American bourses on the Indian markets, the Infosys ADS does not have an economically significant influence on the Stock. This supports the efficient market hypothesis. However, unlike current research which finds an absence of influence of the Indian markets on America's, this study finds that the Infosys stock has a statistically and economically significant influence on its ADS. Thus, market-wide results cannot be extended to specific stocks without a separate analysis.

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INFOSYS: An Analysis of the Degree of Covariance Between the Firm's Nationally Traded Stock and its American Depositary Shares (ADS)

ROHAN POOJARA

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EXECUTIVE SUMMARY

Researchers have proved the influence of the American stock markets on their Indian counterparts during the IT boom. This paper tests these market-wide results on a stock-specific basis by analyzing the degree of covariance between the equity issued by the Indian firm Infosys on the Bombay Stock Exchange (Stock) and its American Depositary Shares (ADS) on the NASDAQ. The study finds that unlike the influence of the American bourses on the Indian markets, the Infosys ADS does not have an economically significant influence on the Stock. This supports the efficient market hypothesis. However, unlike current research which finds an absence of influence of the Indian markets on America's, this study finds that the Infosys stock has a statistically and economically significant influence on its ADS. Thus, market-wide results cannot be extended to specific stocks without a separate analysis.

INTRODUCTION

The stock markets are one of the most popular investment destinations for individuals and institutions alike. Therefore, we find a lot of research on the various factors that affect the movement of these markets. The amount of covariance between global stock market indices is of special interest to several researchers and one of the most widely analyzed theories is the impact of a highly liquid and developed market, such as the NASDAQ or S&P 500, on the stock market indices of other countries.

Since the early 1970's, researchers have been studying the covariance between different stock markets. While their work was initially focused on developed economies, the rise of India and China in the world economic order has inspired a new set of researchers to test the impact of the U.S. markets on these nations' stock markets. These researchers have proven that the American markets, specifically the NASDAQ, have a noticeable influence on Indian indices like the SENSEX and BSE IT Index. However, this influence is unidirectional and fluctuations in the Indian markets have been found to have no meaningful influence on trading in the NASDAQ. This paper seeks to determine if the proven index-wide influence of the American markets on Indian indices can be extended to a stock-specific basis. Furthermore, it will test if there a bidirectional influence if an Indian stock is utilized in the study.

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The answer to these questions will be determined by analyzing the correlation between the Stock and American Depository Share (ADS) of the only Indian firm, Infosys, which trades on both the Bombay Stock Exchange and the NASDAQ. "Stock" refers to equity issued by the company that trades on Indian bourses whereas "ADS" is equity issued by the firm that is traded on American markets. Infosys is one of the leading providers of IT services in the world and is represented in the SENSEX and BSE IT index on the Bombay Stock Exchange. The firm has been trading on the BSE since February 1993, listed its ADS on the NASDAQ in March 1999 and is highly liquid on both markets.

Therefore, more specifically, this paper will test if the Infosys ADS has a strong impact on the firm's Stock just like the NASDAQ does on the SENSEX and BSE IT index and whether the direction of impact is reversed since Infosys is an Indian company. If this is the case, the Infosys Stock will have a stronger impact on the ADS.

It is crucial to recognize that the time-lag between the American and Indian markets makes this research possible. On any given day, the Indian markets close first and are followed after a few hours by the open of the American markets. The American markets are then open for six hours of trading and are followed at their close by the open of Indian markets (on the next calendar day). This pattern forms the basis of our ability to analyze the daily influence of American and Indian markets on each other.

Finally, it is important to note the practical applications of this research, of which developing trading strategies is the foremost. It also provides risk-return profiles whereby one can determine optimum diversification based on the degree of covariance between a firm's stock and its ADS. Although the time constraints on this paper restrict the analysis

to Infosys, there are several Indian companies listed on other markets, such as the New York Stock Exchange, which can be tested for similar correlations between their stock and ADS.

LITERATURE REVIEW

The correlation between the stock market indices of various countries in the world has fascinated researchers for quite a while now. Therefore, not surprisingly, my study of the correlation between the stock price of an Indian company, Infosys, and its American Depository Share (ADS) trading on the NASDAQ is preceded by several important works which examine similar linkages on an index-wide basis and lay a foundation for my analysis to build upon. The following literature review presents a brief synopsis of the most relevant of the scholarly articles.

Ripley (1973) investigates the systematic covariation between stock prices in developed countries. His theoretical explanation of the fundamental fact that "covariation may reflect causation or it may indicate similar reactions to external stimuli" is crucial for assessing the outcome of all the research in this field. The data for Ripley's empirical work consists of the average monthly stock-price indices for nineteen developed countries from 1960 through 1970. The paper measures the extent to which these statistical series move together using factor analysis, a multivariate statistical technique. However, a major drawback of this technique is its inability to use control variables for specific political and economic events. This is something I intend to improve upon in my regressions. Ripley's final analysis shows that countries relatively more open to capital

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flow and trade have higher covariance with the stock markets of other countries and vice-versa. In fact, the strongest linkage between equity prices in the 1960's existed between the United States and Canada and was a motivating factor for my analysis of a company trading in the United States and India, two countries that engaged in high levels of trade during the tech boom of the 1990's.

Sharma and Kennedy (1977) tested the applicability of the random walk hypothesis in the stock markets of New York, London and Bombay. The methodology used in the analysis is a nonparametric test for randomness and a parametric test for independence, which are purely statistical analyses and will not be used in my regressions. However, Sharma and Kennedy's conclusion that the Bombay Stock Exchange (BSE) obeys the random walk theory just like New York and London is crucial for two reasons. Firstly, it highlights the fact that the Indian markets are not inefficient or skewed by the actions of just a few investors, thereby making my analysis of a firm in the market more interesting and relevant. Furthermore, proof in future papers that the markets in Bombay track indices like the NASDAQ indicate that the randomness of the BSE has been affected over time and serve as a basis for my current analysis of the Infosys stock and its ADS.

Bhattacharya (2003) examines the linkage between the NASDAQ and the Bombay Stock Exchange (BSE) during January to October of 2000. Given the strong proven linkage between the NASDAQ and other global indices like the Japanese market during the tech boom of the 1990's, he decided to analyze the impact of NASDAQ "news" on the SENSEX (the BSE's 30 share composite index). Bhattacharya tested the impact of the close of the NASDAQ (independent variable) on the open and close of the

SENSEX (dependent variables in two separate regressions) using OLS equations under cointegration and error correction framework. He found a strong linkage between the NASDAQ and SENSEX during opening trades in India but a decreasing impact as the day wore on.

The other paper, coauthored by Kapur, Poojara and Yurdakul (2006), which forms the basis of my current work, examines the impact of the NASDAQ on the BSE Information Technology (BSE IT) Index. This analysis was as an extension of Bhattacharya's work. It replaced the SENSEX, a wide representation of Indian companies, with the BSE IT Index, a bourse similar to the NASDAQ due to its composure of primarily "new economy" firms. The principal question of this work was to examine whether the impact of the NASDAQ was greater on the BSE IT Index than it was on the SENSEX during the same January to October 2000 period. This is what would be expected due to the similarity in the stocks represented in the NASDAQ and BSE IT Index. Similar to Bhattacharya, Kapur et al. used the closing trade in the NASDAQ as the independent variable, but the opening and closing trades of the BSE IT Index replaced the SENSEX as the dependent variables respectively, for the two regressions. Kapur et al. also extended Bhattacharya's work by using control variables for other factors such as political and economic news that affect the movement of a stock market. Their hypothesis was affirmed as the impact of the NASDAQ on the BSE IT Index was found to be consistent throughout the day and did not wane as in Bhattacharya's analysis.

Khan (2005) extends this research to additional geographic markets and time periods. He tested interlinkages between the NASDAQ, Nikkei (Japan), SENSEX and NIFTY (India) between 1999 and 2004 using the Johansen co-integration test. Like

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Bhattacharya, he finds a stronger causal relationship between the Indian and US markets from 1999 – 2001 but a decreasing impact during the 2002 – 2004 period. It is useful to see this affirmation of a link between the US and Indian markets for the period during which I will be testing my stock-specific hypothesis.

My current research will primarily be an extension of the Bhattacharya and Kapur et al. articles. Ingebretsen's book, "NASDAQ: A History of the Market That Changed the World," provided me with all the necessary information about the NASDAQ and its constituents, especially the definition and concept of an ADS which inspired me to extend Bhattacharya and Kapur et al.'s index-wide analysis to a stock-specific study. I intend to use the same methodology as Bhattacharya and Kapur et al- running regressions to test impact but will be replacing the Indian and American indices with a single Indian stock that trades on the Indian and American markets. Additionally, I will not only use Bhattacharya's and Kapur et al's. strategy of testing the impact of American news on India but also run reverse regressions to test if the direction of impact is inverted given Infosys' Indian domicile. It is also important to note that besides inspiring my research question, specific details for my methodology are also derived from the above works. Bhattacharya and Kapur et al. lag the American data in their respective studies by one day as the American markets open after the Indian markets have closed on a given calendar day. A similar lag will be necessary for the analysis of Infosys and its ADS. Thus, my work is heavily indebted to the above two articles that provided the motivation for my research question and a handy start on the model.

Finally, Throop (1994) provides the basis for the control variables I chose to use for my regressions. He asserts that the movement on any index, albeit statistically linked

to another, has to have certain other exogenous variables that affect its return. Therefore, I chose to use overall stock market returns (NASDAQ and SENSEX indices as proxies) and economic returns (risk free interest rate as a measure) as control variables for my regressions.

THEORY

Stock markets are one of the most widely studied markets in economics and finance due to the variety of agents- individual investors, fund managers, policy makers, governments and forecasters- that they affect. For the same reason, a number of theories have been developed to explain the factors that influence the movement of equity markets and stocks. In this section, I use the broad theories to explain the specific hypotheses for my question.

The efficient market hypothesis (EMH) is the most prevalent theory to be considered when analyzing covariation between stocks traded on different geographical markets. It asserts that financial markets are "informationally efficient", or that prices on traded assets, such as stocks, already reflect all known information. Therefore, it is impossible to consistently outperform the market by using any information that the market already knows. Given this theory, the change in the Infosys ADS should not yield any statistically or economically significant result for the close in the Infosys stock or vice-versa. (It is important to note that the open of the stock or ADS being influenced by the change in the other during its previous trading session would not violate the EMH since this would be the first opportunity for the stock to absorb the American (ADS) news and not provide any profit-making opportunities.)

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H_1: According to the efficient market hypothesis, the change in the Infosys ADS should not have an economically and statistically significant effect on the close of the Infosys stock or vice-versa.

Despite the stock-specific conclusions of the efficient market hypothesis, covariation between different stock markets of the world has been witnessed since decades. Ripley (1973) stressed in his research that "this covariation may reflect causation or it may indicate similar reaction to external stimuli." Bhattacharya and Kapur et al. tested the causation aspect of this theory for the NASDAQ and the Indian markets during the IT boom by controlling for external stimuli such as economic and political news. This paper will primarily test the applicability of the aforementioned theory (covariation reflecting causation) on a stock specific basis.

Covariation may be the result of various factors including- i) Developed countries tend to influence the markets of developing nations due to their impact on the global economy and investor psychology. For example, American market movements are closely tracked by investors worldwide and a degree of covariation between the markets in the U.S. and developing nations is expected. ii) Nations engaged in high levels of bilateral trade also find their stock markets to be highly interlinked. iii) Most importantly, Ripley (1973) stressed an expected covariation between markets that contain the stock of the same multinational firm. Therefore, keeping the above factors in mind and based on previous research that the change in the NASDAQ has a significant effect on the Indian markets, we would hypothesize that the change in the Infosys ADS will have a significant impact on the Infosys stock in its next trading session. Control variables will be used to isolate the impact of the ADS on the stock by controlling for the effects of the overall Indian stock market and economy on the Infosys stock.

H_2: Similar to the influence of NASDAQ "news" on the SENSEX and BSE IT Index, change in the Infosys ADS will influence the movement of the Infosys stock in India in its next trading session.

Research thus far has shown a unidirectional influence of American markets on India with a very limited influence of Indian markets on the NASDAQ. However, it is conceivable that since Infosys is an Indian firm, with majority of company specific news released during trading hours in India, the geographical direction of impact may be reversed. This would be a case of information asymmetry whereby the superior information of Indian market participants and their greater ability to interpret information about an Indian company would lead to a more significant and lasting impact of the Infosys stock on its ADS, despite the lack of influence of the Indian markets on the NASDAQ.

H_3: Contrary to the direction of influence observed for market-wide activity, information asymmetry would lead us to believe that the Infosys stock should have a more significant and lasting impact on its ADS since India is the firm's country of domicile.

At this point it is necessary to provide some detailed information about the control variables to be used in the regressions. There are several factors that influence the movement of a stock besides covariation and these factors such as overall stock market and economic returns need to be isolated through control variables. For the regressions testing the impact of the Infosys ADS on the firm's stock, the change in the SENSEX, the 30-share composite index of the Bombay Stock Exchange, will be used to measure overall market returns. The interest rate on the 91-day T-bill issued by India's central bank, the Reserve Bank of India, will be used to measure overall economic return. Similarly, for the influence of the Infosys stock on its ADS, the change in the NASDAQ and the risk free interest rate as measured by the 3 month T-bill rate will be used as

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proxies for overall market and economic returns, respectively. These control variables will ensure the completeness of the model.

As stated, the purpose of this paper is to test whether the 'covariation due to causation' theory can be extended from a market-wide to a stock-specific basis. Therefore, H_2 and H_3 will be the primary hypotheses to be tested. However, it is important to bear in mind that if proven, they would contradict the efficient market hypothesis.

To test H_2, that is, the influence of the Infosys ADS on its stock, the change in the ADS, measured as a percentage difference from the previous day's close will serve as the primary independent variable. Two regressions- the first to test the influence of the ADS on the opening price of the Infosys stock and the other on its close- will be used to test the hypothesis. Therefore, the percentage change in the open and close of the Infosys stock from the previous day's close will serve as the dependent variables for the two regressions which will test if the covariation reflecting causation theory can be extended to specific stocks. The statements below summarize the expected relationships:

Infosys Stock Open Change = f [ADS Open Change (+), SENSEX Open Change (+), Indian 91-day T-bill rate] -- Reg. I

Infosys Stock Close Change = f [ADS Close Change (+), SENSEX Close Change (+), Indian 91-day T-bill rate] -- Reg. II

The second major objective of this paper, that is, to test the direction of influence or H_3 will require two more regressions which have the change in the Infosys stock as the primary independent variable. The percentage change in the open and close of the ADS will serve as the dependent variables for the two regressions. The time for which the influence lasts on the ADS and the measure of R-squared will help determine whether

Indian stock news is having a significant impact on the ADS in the U.S. The statements below summarize the expected relationships:

Infosys ADS Open Change = f [Stock Open Change (+), NASDAQ Open Change(+), US 3-month T-bill rate] -- Reg. III

Infosys ADS Close Change = f [Stock Close Change (+), NASDAQ Close Change (+), US 3-month T-bill rate] -- Reg. IV

REGRESSION MODEL

Regressions I and II

Definition of Dependent Variables:

1) STOCKOC- The dependent variable for the first regression (i.e. the influence of the Infosys ADS on its stock during opening trading hours on the Indian markets) is Stock Open Change. It is defined as the Infosys Stock '(Opening Price on day *n* - Closing Price on day *n-1*) / (Closing Price on day *n-1)*'

2) STOCKCC- The dependent variable for the second regression (i.e. the influence of the Infosys ADS on its stock at the end of the trading day on the Indian markets) is Stock Close Change. It is defined as the Infosys Stock '(Closing Price on day *n* - Closing Price on day *n-1*) / (Closing Price on day *n-1)*'

Definition of Focal Independent Variable:

1) ADSCC- The influence of the ADS will be measured by its change from one day to the next. Thus, the focal independent variable used in both regressions will be ADSCC defined as the Infosys ADS '(Closing Price on day *n* - Closing Price on day *n-1*) / (Closing Price on day *n-1)*'

Regressions III and IV

Definition of Dependent Variables:

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1) ADSOC- The dependent variable for the third regression (i.e. the influence of the Infosys stock on its ADS during opening trading hours on the NASDAQ) is ADSOC. It is defined as the Infosys ADS '(Opening Price on day *n* - Closing Price on day *n-1*) / (Closing Price on day *n-1)*'

2) ADSCC- The dependent variable for the fourth regression (i.e. the influence of the Infosys stock on its ADS at the end of the trading day on the NASDAQ) is ADSCC. It is defined as the Infosys ADS '(Closing Price on day *n* - Closing Price on day *n-1*) / (Closing Price on day *n-1)*'

Definition of Focal Independent Variable:

1) STOCKCC- The influence of the stock will be measured by its change from one day to the next. Thus, the focal independent variable used in both regressions will be SCC defined as the Infosys Stock '(Closing Price on day *n* - Closing Price on day *n-1*) / (Closing Price on day *n-1)*'

Control Variables:

1) SENSEXOC: The SENSEX Open Change, defined as the SENSEX '(Opening Quote on day *n* - Closing Quote on day *n-1*) / (Closing Quote on day *n-1)*' will be used as the market return control variable for Regression I.

2) SENSEXCC: The SENSEX Close Change, defined as the SENSEX '(Closing Quote on day *n* - Closing Quote on day *n-1*) / (Closing Quote on day *n-1)*' will be used as the market return control variable for Regression II.

3) NASDAQOC: The NASDAQ Open Change, defined as the NASDAQ '(Opening Quote on day *n* - Closing Quote on day *n-1*) / (Closing Quote on day *n-1)*' will be used as the market return control variable for Regression III.

4) NASDAQCC: The NASDAQ Close Change, defined as the NASDAQ '(Closing Quote on day *n* - Closing Quote on day *n-1*) / (Closing Quote on day *n-1)*' will be used as the market return control variable for Regression IV.

5) ITBILL: The Indian 91-day T-bill rate will be used as the economic return control variable for regressions I and II.

6) USTBILL: The US 3-month T-bill rate will be used as the economic return control variable for regressions III and IV.

Sample

This work extends upon the longitudinal studies of Bhattacharya and Kapur et al and therefore uses the same time period of January through October 2000. The 210-day-long period under study is of special significance, because it was during the time of the IT boom and NASDAQ fluctuations affected indices worldwide. This study tests stock-specific influences in this period and incorporates daily changes in the Infosys stock and ADS quotes. However, it can be extended to other stocks and their foreign depositary shares for all other periods of time. Also, all the data is derived from public information representing live transactions, and therefore there are no biases in its collection.

Data Sources

The Securities and Exchange Board of India (SEBI) maintains records of the SENSEX and Infosys stock opening and closing quotes. The Securities and Exchange Commission (SEC) in the US maintains similar data for the NASDAQ and Infosys ADS quotes. The central banks of India and the U.S. maintain records of the risk free interest rate measured by the 91-day T-bill in India and 3-month T-bill in the U.S, respectively. These records are available on several websites such as Yahoo Finance, Google Finance etc. Thus, the data promises accuracy as a result of its widely publicized and quantitative nature.

Regression Equations:

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Regression I:

$Y = \beta_0 + \beta_1(X_1) + \beta_2(X_2) + \beta_3(X_3)$

where, Y= STOCKOC
X_1= ADSCC
X_2= SENSEXOC
X_3= ITBILL
This equation tells us that we expect Y to have a positive relationship with the focal independent variable X_1 as well as the control variables X_2 and X_3.

Regression II:

$Y = \beta_0 + \beta_1(X_1) + \beta_2(X_2) + \beta_3(X_3)$

where, Y= STOCKCC
X_1= ADSCC
X_2= SENSEXCC
X_3= ITBILL

This equation tells us that we expect Y to have a positive relationship with the focal independent variable X_1 as well as the control variables X_2 and X_3.

Regression III:

$Y = \beta_0 + \beta_1(X_1) + \beta_2(X_2) + \beta_3(X_3)$

where, Y= ADSOC
X_1= STOCKOC
X_2= NASDAQOC
X_3= USTBILL

This equation tells us that we expect Y to have a positive relationship with the focal independent variable X_1 as well as the control variables X_2 and X_3.

Regression IV:

$Y = \beta_0 + \beta_1(X_1) + \beta_2(X_2) + \beta_3(X_3)$

where, Y= ADSCC
X_1= STOCKCC
X_2= NASDAQCC
X_3= USTBILL

This equation tells us that we expect Y to have a positive relationship with the focal independent variable X_1 as well as the control variables X_2 and X_3.

DATA MANIPULATION

The first step, prior to running the regressions, is to ensure the completeness of the data set. All the data consists of information derived from publically traded stocks. However, stock markets are often closed for holidays which leads to missing data points. Furthermore, these holidays vary by market. Since the objective of this study is to test the daily covariation between the Infosys Stock and ADS, it is necessary to account for these missing variables.

For the influence of the ADS on the Infosys Stock, that is, for regressions I and II, U.S. ADS changes influence the Indian Stock on its trading session on the next calendar day. The nine and a half hour time difference between New York and Mumbai is responsible for this.

The procedure used to accomplish the completeness of the data set is best illustrated with a table:

ADS/Independent (U.S.)	Influence on	Stock/Dependent (India)
1st	->	2nd
2nd	->	3rd
3rd data missing*	->	4th
4th	->	5th
5th	->	6th data missing**
6th	->	7th

* use previous day ADS quote
** use next day stock quote

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The logic behind using the above procedure is quite simple. As shown in the example, the ADS change on the 2nd influences the Stock movement on the 3rd. The ADS change for the 3rd is expected to influence the Stock on the 4th. Since 3rd data is missing for the ADS (U.S. markets closed), the ADS change on the 2nd would be expected to continue to influence the Stock on the 4th. Similarly, the ADS change on the 5th is expected to influence the Stock on the 6th. However, the data point for the stock change on the 6th is missing as the Indian markets were closed. Therefore, the ADS change on the 5th would simply influence the Stock in its next trading session, that is, the 7th. In effect, ADS changes on the 5th and 6th are influencing the movement of the stock on the 7th.

The above table also highlights the need to lag the Indian market data for Regressions I and II. ADS information will influence the Indian Stock in its next trading session, that is, on the next calendar day. Therefore, the Indian stock data must be appropriately lagged by one day to account for this difference prior to running the regression.

A similar methodology is adopted to address the problem with missing variables for Regressions III and IV. However, it is important to note that the dependent and primary independent variables are interchanged for these regressions as the objective is to test the impact of the Infosys Stock on its ADS. The table below illustrates this more fully:

Stock/Independent (India)	Influence on	ADS/Dependent (U.S.)
1st	->	1st
2nd	->	2nd
↓ 3rd data missing*	->	3rd
4th	->	4th

5^{th}	->	5^{th} data missing**
6^{th}	->	6^{th}

* use previous day stock quote
** use next day ADS quote

The explanation for the process is the same as for Regressions I and II. However, note that there is no need to lag the data for regressions III and IV since the Indian stock influences the ADS on the same calendar day.

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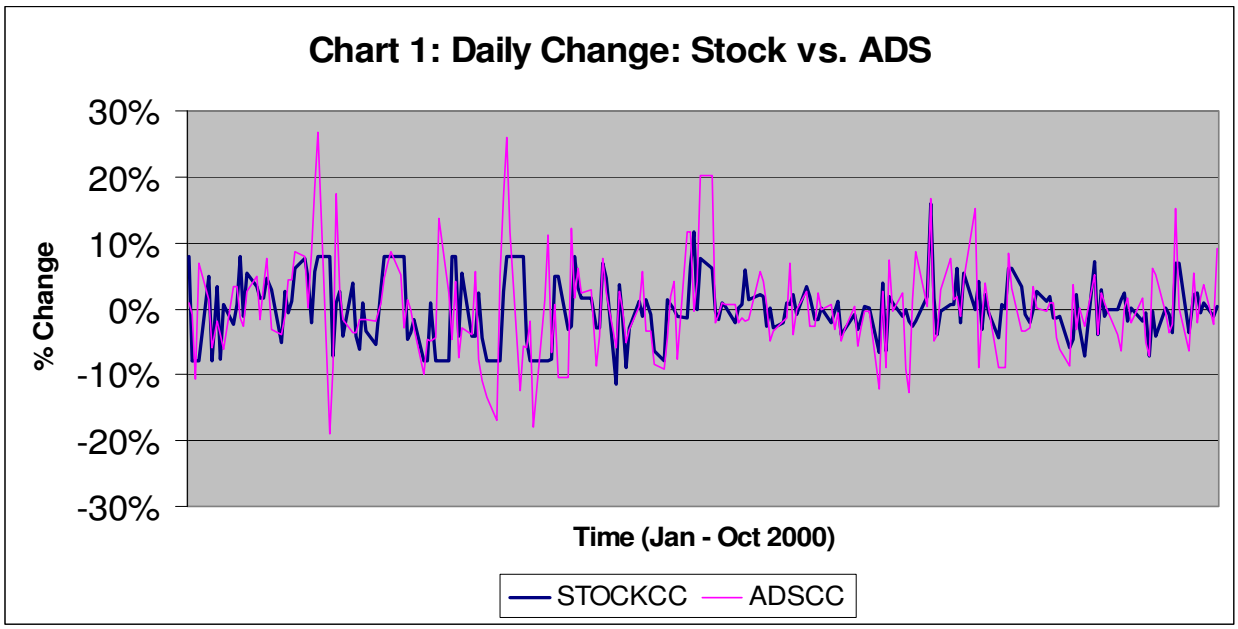
DESCRIPTIVE STATISTICS

The sample used in this study and the data sources have already been discussed in the theory and model section. The table below shows the descriptive statistics for the four primary variables, that is, the percentage change in the Stock and ADS opening and closing quotes.

Variable	Observations	Mean	Std Dev	Min	Max
STOCKOC	215	.00162	.029	-.08	.08
STOCKCC	215	.00109	.047	-.113	.158
ADSOC	215	.00378	.038	-.120	.231
ADSCC	215	-.0000623	.067	-.189	.267

The average movement of the Stock and ADS is rather small. However, this is not an issue as it only suggests that during the 215 trading sessions analyzed, the stock and ADS had an even number of good and bad days. More importantly, the high standard deviations and values of min and max for the variables suggests that there was a lot of intra-day activity which makes the regression outcomes very useful.

Chart 1 below shows the daily changes in the ADS and Stock closing prices from January – October 2000. It illustrates that both the ADS and Stock were very active during the period.



Finally, the table below shows the descriptive statistics for the control variables used in all the regressions:

Variable	Observations	Mean	Std Dev	Min	Max
SENSEXOC	215	.003	.0166	-.0723	.0528
SENSEXCC	215	-.0015	.0217	-.0715	.0724
ITBILL	215	.0578	.0024	.0522	.0618
NASDAQOC	215	.0019	.0134	-.0555	.05
NASDAQCC	215	-.0005	.0287	-.0966	.0793
USTBILL	215	.0578	.0024	.0522	.062

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DATA ANALYSIS: REGRESSIONS I & II

It has been established through numerous papers that the NASDAQ had a strong influence on several global stock markets, including India's SENSEX and BSE IT Index, during the IT boom. Therefore, the first question to be answered by this paper is whether this index-wide influence can be extended to a stock-specific basis. Regressions I and II test the influence of the Infosys ADS on the company Stock. (The complete results of the regressions are included in the Appendix at the end of the Conclusion section.)

Regression I: $STOCKOC = \beta_0 + \beta_1(ADSCC) + \beta_2(SENSEXOC) + \beta_3(ITBILL)$

tests the influence of the ADS on the opening of the Stock in its next trading session. Running the regression yields an adjusted R^2 of .4733 which is a good fit considering that the regression is testing hard to explain stock price fluctuations

We get a statistically significant β_1 of .1077 which signifies that a 1% change in the ADS accounts for a 0.1% change in the open of the stock. Given that a 1% change in the NASDAQ accounted for over a 1% change in the Indian markets, this result is insufficient proof for hypothesis II, that is, the applicability of market-wide results to stock-specific data. Also, it is unrealistic to expect a trader to profit from such information given the high transaction costs that would be necessary to act upon it. Therefore, the result is not economically significant.

SENSEXOC is statistically significant while ITBILL is not. This is not as important though because the two are only control variables.

Regression II: $STOCKCC = \beta_0 + \beta_1(ADSCC) + \beta_2(SENSEXCC) + \beta_3(ITBILL)$ is only different from regression I in that it tests the influence of the ADS on the close of the Stock. It yields an adjusted R^2 of .4903 which is good for reasons explained before.

We again get a statistically significant β_1 of .1848 which signifies that a 1% change in the ADS accounts for almost a 0.2% change in the stock. This does demonstrate that the influence of the ADS on the stock increases through the trading session or as more people get time to digest the information. However, as with regression I, the ADS influence on the stock is not strong enough to prove hypothesis II. Traders cannot realistically profit from this information either and the result is not economically significant.

As with Regression I, SENSEXCC is statistically significant while ITBILL is not. We do get one useful piece of information in this case. β_2 or the coefficient of SENSEXCC gives us the beta of the Infosys stock. (The beta of a stock is defined as the percentage change in the stock for a 1% change in the market.) For this sample, that is, during the time period January to October 2000, it is 1.28 This suggests that the Infosys stock offered higher returns than the benchmark BSE SENSEX. This is an expected result given that the firm is in the IT business which is traditionally viewed as a riskier sector.

Thus, Regressions I and II yield the following important information:

1) The β's of ADSOC and ADSCC have the expected sign and are statistically significant. A positive change in the ADS leads to the stock rising and vice-versa.

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However, the magnitude of the β's is relatively small in both regressions and is economically insignificant. This means that the theory of the influence of the American markets on India cannot be extended to a stock-specific basis.

2) The absence of tradable information for the stock from the ADS is proof for hypothesis I, that is, the efficient market hypothesis (EMH). The EMH asserts that it is not possible to make excess returns by using publically available information. This is supported by the absence of an economically significant influence of the Infosys ADS on the firm's Stock.

DATA ANALYSIS: REGRESSIONS III & IV

While research done so far has found a significant influence of American markets on their Indian counterparts, the reverse has not been true. Therefore, the final question this paper examines is if this is true on a stock specific basis as well. Given that this study is using an Indian stock we would hypothesize (hypothesis III) that the Infosys Stock has a significant influence on its ADS. (Regressions III and IV are also included in the Appendix.)

Regression III: $ADSOC = \beta_0 + \beta_1(STOCKCC) + \beta_2(NASDAQOC) + \beta_3(USTBILL)$ tests the influence of the Stock on the ADS in its next trading sessions and yields a satisfactory adjusted R^2 of .3445

We observe a statistically significant β_1 of .2588 which signifies that a 1% change in the Stock accounts for a 0.25% change in the open of the ADS. Although this β is higher than for Regressions I and II it is hard to assert economic significance. The regression definitely shows that the Stock has a more significant influence on the ADS but it is necessary to consider the result of Regression IV before making any conclusions regarding information asymmetry.

From the control variables, NASDAQOC is statistically significant while USTBILL is not.

Regression IV: $ADSCC = \beta_0 + \beta_1(STOCKCC) + \beta_2(NASDAQCC) + \beta_3(USTBILL)$

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tests the influence of the Infosys Stock on its ADS at the end of the trading session and yields a satisfactory adjusted R^2 of .3109

We observe a statistically significant β_1 of .5176 which signifies that a 1% change in the Stock accounts for a 0.52% change in the close of the ADS. This result clearly supports hypothesis III. A 0.5% change in the ADS is an economically significant result and one that traders could act upon. Thus, while Indian information does not have an influence on the U.S. on a market-wide basis, it has a statistically and economically significant influence on a stock-specific basis.

NASDAQCC is statistically significant while USTBILL is not. As with regression II we get the beta of the ADS for the January to October 2000 period through this regression. The beta of the ADS is .9586 (or almost 1) in this case as opposed to 1.3 for the stock. It is interesting that the equity of the same company trading on two markets have such markedly different betas. Although not proved here, this may have to do with the perception of the company in the two countries. In India, Infosys is viewed as a entrepreneurial IT firm whereas Americans associate the company with its more stable outsourcing and consulting operations.

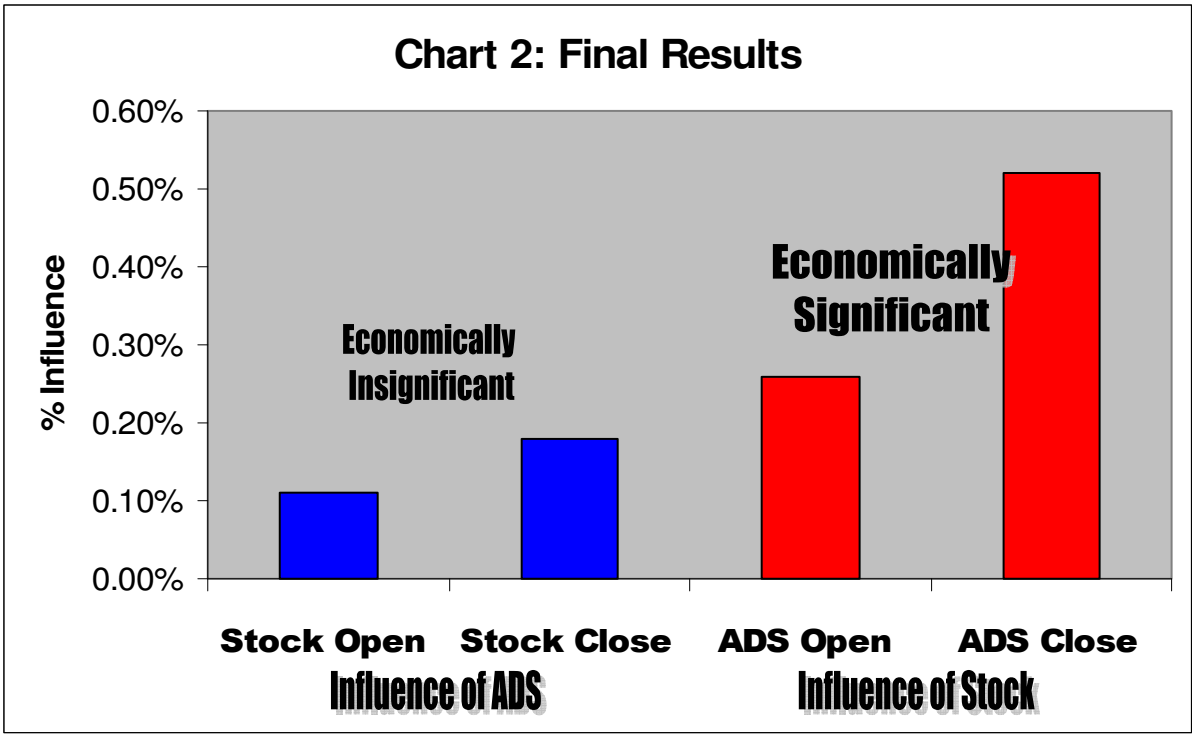
Thus, the primary results of Regressions III and IV are:

1) The β's of STOCKOC and STOCKCC have the expected sign and are statistically significant. A positive change in the Stock leads to the ADS rising and vice-versa. Additionally, the magnitude of the β's is large in both regressions and is therefore economically significant. When viewed in contrast to the lack of economic significance for the ADS, this result asserts that there is information asymmetry with the fluctuations of equity of a firm listed on two different market. It also proves that

the theory of the lack of influence of the Indian markets on the U.S. cannot be extended to a stock-specific basis (at least in the case of the Indian firm Infosys).

CONCLUSION

Chart 2 below summarizes the results of this study:



Although statistically significant, the influence of the ADS on the Infosys Stock is too small to be considered economically significant. This supports the efficient market hypothesis but also asserts that the influence of the American markets on Indian markets cannot be extended to a stock specific basis. On the other hand, the Infosys Stock has an statistically and economically significant influence on the firm's ADS. This is in contrast to current research which concludes that the Indian markets have no influence on the American bourses.

It is important to reiterate that this study only analyzes the Infosys Stock and ADS due to time constraints. There are several other Indian companies that trade on American

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markets like the Dow Jones and New York Stock Exchange that could be individually analyzed. Moreover, there are non-American companies from many other countries of the world that issue equity in U.S. markets which could also be studied. It is quite likely that the results for each company will vary based upon the time period considered, the firm's country of domicile or industry sector. Yet, the results from the study of Infosys support the view that the outcomes from market-wide studies cannot simply be extended to all stocks in that market.

Finally, it is important to consider the implications of the results of this study. For starters, in the new global economy with companies issuing equity on markets in various countries, the number of factors that influence a company's stock price are increasing by the day. It is essential for an investor to stay alert to profit opportunities created by arbitrage situations. Companies themselves benefit from the ability to raise funds in different countries but take on the risk of under pricing in all markets due to mispricing in one. This would reduce the amount of capital they could raise though future equity offerings. All in all, listing of equity of the same firm on different markets complicates the already very difficult process of stock valuation. However, it does present profit-making opportunities for the savvy investor.

APPENDIX

Regression I

```
. regress  STOCKOC ADSCC SENSEXOC ITBILL
```

Source	SS	df	MS	Number of obs = 215
Model	.086582428	3	.028860809	F(3, 211) = 65.10
Residual	.093546139	211	.000443347	Prob > F = 0.0000
				R-squared = 0.4807
Total	.180128567	214	.000841722	Adj R-squared = 0.4733
				Root MSE = .02106

STOCKOC	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ADSCC	.1077378	.026423	4.08	0.000	.0556509	.1598246
SENSEXOC	.9021935	.1091211	8.27	0.000	.6870863	1.117301
ITBILL	.3653315	.6044725	0.60	0.546	-.8262473	1.55691
_cons	-.0222153	.0350537	-0.63	0.527	-.0913156	.0468851

Regression II

```
. regress  STOCKCC ADSCC SENSEXCC ITBILL
```

Source	SS	df	MS	Number of obs = 215
Model	.237796942	3	.079265647	F(3, 211) = 69.61
Residual	.240283078	211	.001138782	Prob > F = 0.0000
				R-squared = 0.4974
Total	.47808002	214	.002234019	Adj R-squared = 0.4903
				Root MSE = .03375

STOCKCC	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ADSCC	.184821	.035155	5.26	0.000	.115521	.254121
SENSEXCC	1.284778	.1096258	11.72	0.000	1.068676	1.50088
ITBILL	.3100424	.9515583	0.33	0.745	-1.565737	2.185821
_cons	-.0147859	.0550738	-0.27	0.789	-.1233513	.0937794

Regression III

```
. regress  ADSOC STOCKCC NASDAQOC USTBILL
```

Source	SS	df	MS	Number of obs = 216
Model	.138079902	3	.046026634	F(3, 212) = 38.66
Residual	.252408998	212	.001190608	Prob > F = 0.0000
				R-squared = 0.3536
Total	.3904889	215	.001816227	Adj R-squared = 0.3445
				Root MSE = .03451

ADSOC	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
STOCKCC	.2587763	.0510292	5.07	0.000	.1581867	.3593659
NASDAQOC	1.467831	.1805565	8.13	0.000	1.111915	1.823747
USTBILL	.5653993	.9487326	0.60	0.552	-1.304758	2.435557
_cons	-.0314949	.0550019	-0.57	0.568	-.1399156	.0769258

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Regression IV

```
. regress  ADSCC STOCKCC NASDAQCC USTBILL
```

Source	SS	df	MS	Number of obs =	216
Model	.340102568	3	.113367523	F(3, 212) =	33.33
Residual	.721069259	212	.00340127	Prob > F =	0.0000
				R-squared =	0.3205
				Adj R-squared =	0.3109
Total	1.06117183	215	.004935683	Root MSE =	.05832

ADSCC	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
STOCKCC	.5176576	.0850634	6.09	0.000	.3499791	.6853361
NASDAQCC	.9586757	.1401352	6.84	0.000	.6824389	1.234913
USTBILL	-.9199328	1.601045	-0.57	0.566	-4.075941	2.236075
_cons	.0543187	.0927741	0.59	0.559	-.1285592	.2371965

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