Chapter 5

Performance Appraisal of Stock Trade of S & P 500

Introduction

This segment manages the writing that spotlights on portfolio execution considering trade costs examination. Bacidore et al. (2012) acquainted another philosophy which exactly distinguishing the essential methodologies utilized by a dealer utilizing just post-trade fill information. This approach is especially helpful since it doesn't oblige changes to dealer work processes or post-trade frameworks to catch technique or benchmark data. Once the basic systems have been distinguished and arranges grouped, TCA should be possible by procedure. Examination by methodology is significant in the light of the fact that the decision of procedure can regularly be the essential determinant of a dealer's execution. Visual portrayals of the basic systems normally propose the broker's benchmark, yielding applicable and helpful examination. Results can be imparted both outwardly and numerically, making this a down to earth apparatus for any merchant. Kissell et al. (2004) give both a choice structure to gauge trade costs and create ideal trading techniques to accomplish the best execution. The strategy depends on an unbundling approach whereby expenses are sorted into straightforward and covered up, and settled and variable segments. The characterization fills in as the establishment for creating execution systems for a reserve's usage objectives. This technique effortlessly adjusts to methodologies went for protecting resource possible by strategy. Analysis by strategy is significant in light of the fact that the decision of strategy can regularly be the primary determinant of a trader's execution. Visual portrayals of the underline strategies normally propose the trader's benchmark, yielding applicable and helpful analysis. Results can be imparted both visually and numerically, making this a tool for any trader.

Literature Review

Kissell et al. (2004) give both a choice structure to estimate transaction costs and create optimal trading strategies to accomplish the best execution. The strategy depends on an unbundling approach whereby costs are sorted into transparent and hidden, and fixed and variable components. The characterization fills in as the establishment for developing execution strategies for a fund's implementation goals. This technique effortlessly adjusts to strategies aimed at protecting asset value, accomplishing the closing price or volume weighted average price ("VWAP"), and limiting tracking error. It is proposed to fill in as a structure to estimate costs and risk, decide optimal trading strategies, develop the Efficient Trading Frontier, and assess the best execution. At long last, it is essential that managers and traders cooperate and characterize suitable implementation plans that are in sync with the overall investment objectives and goals. Else, it is unlikely best execution will be accomplished.

Kissell et al. (2005) highlight that with the coming of algorithmic trading it is fundamental that investors turn out to be more proactive in the basic leadership procedure to guarantee selection of the most suitable algorithm within the sight of benchmark price, implementation goal, and preferred deviation strategy. It is essential that traders not only develop tweaked algorithms so that expected transaction costs (e.g., market impact and timing risk) are steady with their overall investment objectives, but that they likewise analyze and contrast alternative algorithms to decide the most appropriate algorithm. In addition, it requires investors to choose brokers who can best alter algorithms with investor implementation and investment goals. Only then will investors have most noteworthy opportunities to accomplish their investment goals.

Kissell and Summer (2006) call attention to that to help investors comprehend these costs and how they influence trading performance, nine components of transaction costs ought to be considered. This categorization process, the extended implementation shortfall, depends on the work of Perold (1988) and Wagner and Edwards (1993), and along these lines fills in as establishment for understanding transaction costs and contriving an execution strategy that is consistent with the overall investment objective.

Kissell and Malamut (2007) introduce a procedure to guarantee consistency over the investment and trading choices by giving a framework that overlays the efficient trading frontier (ETF) onto the efficient investment frontier to decide the "single" best execution trading strategy. This structure additionally discovers the cost-adjusted frontier with the most elevated amount of investor utility. The analysis demonstrates that while a traditional Almgren-Chriss trade cost optimization brings about various proficient strategies, there is just a solitary "optimal" execution strategy consistent with the underlying investment objective. Furthermore, just this strategy can be viewed as best execution. The analysis that overlaid the ETF on the Investment Frontier likewise revealed that the appropriate level of risk aversion to use in mean-risk trade schedule optimization is equivalent to the Sharpe ratio of the fund. The analysis also demonstrates that a conventional VWAP strategy is not consistent with the investment objective and will probably trade off portfolio managers' stock selection by bringing about lower levels of investor utility.

Kissell and Summer (2011) demonstrate that Transaction Cost Analysis (TCA) has advanced drastically in the course of the last decade. It has turned out to be a significant instrument for traders and portfolio managers alike, and is giving the establishment to more informed trading and investment decisions. In today's dynamic, competitive electronic marketplace, where Kissell and Summer (2011) find that TCA has morphed into a priceless set of disciplines for traders to enhance execution, analyze information on algorithmic trading performance, and aid in the development of portfolios. Portfolio managers have started installing TCA into the investment process keeping in mind the goal to accomplish predominant returns, and also guaranteeing consistency between investment objectives and trading goals. They are discovering an incentive in TCA as an extra channel, or quant overlay, to decide cost curves that fuse alpha, and in the process of portfolio optimization. Those are dependent upon an exact and custom fitted market impact model. An essential trend in TCA includes joining costs into the investment process centers for back-testing indices to precisely assess the potential returns of investment ideas.

Lee and Ready (1991) assess elective techniques for categorizing individual trades as market buy or market sell orders utilizing intraday trade and quote data. They demonstrate that the price-based trade classification method generally known as the “tick test” gives surprisingly precise directional deductions. Moreover, two potential issues with characterizing trades as buys or sells using quoted spreads are recognized. In a sample of trades on the NYSE amid 1988, more than half of the quote changes resulting from trades are recorded ahead of the trade. Moreover, 35 percent of all trade prices fall inside the latest spread. Lee and Ready present proof that trading inside the spread is expected to a great extent to “standing orders” that make the viable spread be narrower than the quoted spread.

Perold (1988) demonstrates that actualizing investment decisions can be exorbitant. The costs emerge both in executing decisions (execution cost) and in neglecting to execute decisions (opportunity cost). These costs prompt a shortfall in performance. The amount of the shortfall will rely on upon the sort of choices investors are attempting to actualize and how great are at executing them. Execution costs and opportunity costs are at inverse ends of a seesaw. Lowering one generally will increase the other. To decrease the shortfall, one must lower one bp(basis point) more than one expands the other.

Schwartz and Wood (2003) bring up that most importantly the best execution is a multifaceted idea that is hard to characterize and much additionally difficult to gauge. In huge part this is because the quality of executions received by members depends not only on their individual needs and trading choices but also on the attributes of a particular trade or package, on the stock traded, on the goal of the substance that asked for the execution, and on conditions in the market as the order is being executed. The best execution additionally relies on upon the general proficiency of market structure.

Recent developments in PC innovation, analytic skills, and data accessibility have encouraged transaction cost analysis and order management. The capacity to evaluate transaction costs and to utilize shrewd order directing systems, be that as it may, does not really let us measure and acquire the best execution. Transaction costs are regularly measured ex post (i.e., after the trade), and smart order steering systems can just endeavor to control transaction costs. The best execution relies on upon knowing ex stake (i.e., before the trade) what execution expenses will be—if taken literally, the best execution implies that the absolute best of every single possible trade has been made. The best execution is a more extensive idea than transaction cost analysis. For one thing, the best execution obligation conveys with it a guardian duty. Wagner and Glass (2001) attest that transaction costs are a critical matter for the plan sponsors, managers and brokers alike. To fulfill their fiduciary obligation to guarantee the best execution, plan sponsors ought to be set up to investigate their manager's trading practices. While this is not necessarily a simple undertaking, founding a sound observing program is a decent place to begin.

Objective

The main objective of this chapter is to conduct a performance appraisal of stock trade on S & P 500 companies by using transaction cost analysis (Implementation Shortfall). To achieve this objective the following hypotheses has been designed.

Hypotheses

The hypotheses are:

A. H01: There is no significant association between relative performance (RPM) and transaction cost (measured by implementation shortfall);

B. H02: There is no significant association between RPM and APM (Absolute performance) benchmark performance;

C. H03: There is no significant association between RPM and VWAP benchmark performance;

D. H04: There is no significant association between RPM and TWAP benchmark performance;

E. H05: There is no significant association between RPM and OHLC benchmark performance;

F. H06: There is no significant association between RPM and IMP_SHORTFAL, ABS_RPM, VWAP, TWAP, OHLC benchmark performances,

G. H07: There is no significant association between performance and trade timing.

Research Question

The research question for this chapter is weather TC has any impact on RPM of trade?

This chapter also inquires weather IMP_SHORTFAL, ABS_RPM, VWAP, TWAP, OHLC, individually or together have any impact on RPM?

Research methodology

The study is conducted using the following research methodology:

Types of Research

It is an empirical research with hypothesis testing.

The Universe of the Study

The universe of the study comprises of S&P 500 companies listed in USA.

The Data

The study conducts an empirical analysis based on secondary data collected from US stock market. Intraday trading data of S&P 500 Companies are selected from the US stock exchange. An appropriate sample size of 81 Stock at 95% confidence level, and 10% confidence interval are taken for the study using fair representation of all the sectors proportionately that are part of S & P 500.

The review considers six months back to back intraday traded data of a trader. Not all traders can engage in short selling as a result the only focus was on buy side transaction and its analysis.

Data Analysis Tools and Techniques

Initially collected print data rearranged and the required field calculated by using JAVA platform computer software. Microsoft excel, E-views and other statistical packages are also used in conducting analysis.

Analysis of Data

The objectives of the study to determine the relationship among variables (i.e. Imp_shortfal, RPM, APM, different phase of time, OHLC, VWAP, TWAP). Microsoft excel, E-views and other statistical packages are used to conduct the study. All these variable data series are tested for their stationarity as Granger and Newbold (1974) note that the regression result with non-stationary data is spurious. For incorporating stationary data series, it is significant to examine the existence of unit root in the data series. In this case unit root test is applied by considering Augmented Dickey-Fuller (ADF) Test. All of our variables are stationary at level. Then applying several regression model which describes the relationships between a dependent variable and more than one independent variables. Multicollinerity is tested to determine the whether variables got serial correlation or not. To find out the long run and short run it is required to run the VECM model. Before running VECM, Unit root and co-integration is required. If the variables are integrated then VECM can run, otherwise it is not possible to run VECM rather VAR model. After getting integration VECM is conducted. So Wald test is conducted to determine the short run relationship and significant of coefficient. The Granger causality test is a statistical hypothesis test for determining whether one time series is useful in forecasting another.

Analysis and Findings

The impact of IS on RPM

H01: There is no significant association between relative performance (RPM) and transaction cost (measured by implementation shortfall);

RPM= C+ B1(IMP_SHORTFAL) + ε --- --- --- Equation (A)

Table 5.07.01: Effect of Implementation shortfall on relative performance (RPM)

Dependent Variable: RPM
Method: Panel Least Squares
Date: 02/01/17 Time: 20:56
Sample: 1 734
Periods included: 81
Cross-sections included: 120
Total panel (unbalanced) observations: 734

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	43.23344	0.769114	56.21204	0.0000
IMP_SHORTFAL	0.001646	0.000679	2.423300	0.0156

R-squared	0.007959	Mean dependent var	43.42968
Adjusted R-squared	0.006603	S.D. dependent var	20.79010
S.E. of regression	20.72134	Akaike info criterion	8.902927
Sum squared resid	314301.8	Schwarz criterion	8.915457
Log likelihood	-3265.374	Hannan-Quinn criter.	8.907759
F-statistic	5.872382	Durbin-W atson stat	2.023957
Prob(F-statistic)	0.015622		

Interpretation: The coefficient of IMP_SHORTFAL is positive and the value of R-squared is very insignificant. Meaning that the change of RPM cannot be accurately predicted by IMP_SHORTFAL. However, there is a relation between RPM and IMP_SHORTFAL (P=.015622).

The impact of ABS_RPM on RPM

H02: There is no significant association between RPM and APM (Absolute performance) benchmark performance;

RPM= C+ B1(ABS_RPM) + ε --- --- --- Equation (B)

Table 5.07.02: Effect of ABS_RPM on relative performance (RPM)

Dependent Variable: RPM
Method: Panel Least Squares
Date: 02/01/17 Time: 20:45
Sample: 1 734
Periods included: 81
Cross-sections included: 120
Total panel (unbalanced) observations: 734

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.446685	0.471179	5.192684	0.0000
ABS_RPM	93.67867	0.967829	96.79253	0.0000

R-squared	0.927530	Mean dependent var	43.42968
Adjusted R-squared	0.927431	S.D. dependent var	20.79010
S.E. of regression	5.600551	Akaike info criterion	6.286328
Sum squared resid	22960.03	Schwarz criterion	6.298858
Log likelihood	-2305.082	Hannan-Quinn criter.	6.291161
F-statistic	9368.795	Durbin-W atson stat	1.465833
Prob(F-statistic)	0.000000		

Interpretation: The coefficient of ABS_RPM is positive and significant. The value of R-squared (.927530) means that the 92 percent variability of RPM can be explained by ABS_RPM. Besides, one can reject the null hypothesis meaning that there is a relationship between RPM and ABS_RPM.

The impact of VWAP on RPM

H03: There is no significant association between RPM and VWAP benchmark performance;

RPM= C+ B1(VWAP) + ε --- --- --- Equation (C)

Table 5.07.03: Effect of VWAP on relative performance (RPM)

Dependent Variable: RPM
Method: Panel Least Squares
Date: 02/01/17 Time: 20:59
Sample: 1 734
Periods included: 81
Cross-sections included: 120
Total panel (unbalanced) observations: 734

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	46.78968	1.262865	37.05041	0.0000
VW AP	-0.039751	0.011913	-3.336736	0.0009

R-squared	0.014982	Mean dependent var	43.42968
Adjusted R-squared	0.013637	S.D. dependent var	20.79010
S.E. of regression	20.64786	Akaike info criterion	8.895821
Sum squared resid	312076.5	Schwarz criterion	8.908351
Log likelihood	-3262.766	Hannan-Quinn criter.	8.900654
F-statistic	11.13380	Durbin-W atson stat	2.013867
Prob(F-statistic)	0.000890		

Interpretation: Like OHLC, VWAP also got negative relation with RPM and coefficient is significant. F-statistic signifies that the null hypothesis cannot be accepted, meaning thereby, there is an association ship between RPM and VWAP.

The impact of TWAP on RPM

H04: There is no significant association between RPM and TWAP benchmark performance;

RPM= C+ B1(TWAP) + ε --- --- --- Equation (D)

Table 5.07.04: Effect of TWAP on relative performance (RPM)

Dependent Variable: RPM
Method: Panel Least Squares
Date: 02/01/17 Time: 21:05
Sample: 1 734
Periods included: 81
Cross-sections included: 120
Total panel (unbalanced) observations: 734

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	46.21892	1.220901	37.85641	0.0000
TW AP	-0.032688	0.011166	-2.927537	0.0035

R-squared	0.011573	Mean dependent var	43.42968
Adjusted R-squared	0.010222	S.D. dependent var	20.79010
S.E. of regression	20.68356	Akaike info criterion	8.899277
Sum squared resid	313156.7	Schwarz criterion	8.911807
Log likelihood	-3264.035	Hannan-Quinn criter.	8.904110
F-statistic	8.570472	Durbin-W atson stat	2.011492
Prob(F-statistic)	0.003523		

Interpretation: The coefficient of TWAP is nearly zero but negative. Although the prediction power of TWAP is also insignificant (.0115773), F-statistic (.003523) prove that there is a relation between RPM and TWAP.

The impact of OHLC on RPM

H05: There is no significant association between RPM and OHLC benchmark performance;

RPM= C+ B1(OHLC) + ε --- --- --- Equation (E)

Table 5.07.05: Effect of OHLC on relative performance (RPM)

Dependent Variable: RPM
Method: Panel Least Squares
Date: 02/01/17 Time: 20:57
Sample: 1 734
Periods included: 81
Cross-sections included: 120
Total panel (unbalanced) observations: 734

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	46.21137	1.220089	37.87542	0.0000
OHLC	-0.032612	0.011157	-2.922842	0.0036

R-squared	0.011536	Mean dependent var	43.42968
Adjusted R-squared	0.010186	S.D. dependent var	20.79010
S.E. of regression	20.68394	Akaike info criterion	8.899314
Sum squared resid	313168.3	Schwarz criterion	8.911844
Log likelihood	-3264.048	Hannan-Quinn criter.	8.904147
F-statistic	8.543008	Durbin-W atson stat	2.011595
Prob(F-statistic)	0.003575		

Interpretation: By observing probability (0.003575), the null hypothesis is rejected, meaning that there is an association between RPM and OHLC. Besides the coefficient of OHLC is significant (p=.0036) and got negative relation between two variables.

The impact of all five independent variables on RPM

H06: There is no significant association between RPM and IMP_SHORTFAL, ABS_RPM, VWAP, TWAP, OHLC benchmark performances,

RPM= C+ B1(IMP_SHORTFAL) + B2(ABS_RPM) + B3(VWAP)+ B4(OHLC)+ B5(TWAP) + ε --- --- --- Equation (F)

Table 5.07.06: Effect of all five independent variables on relative performance (RPM)

Dependent Variable: RPM
Method: Panel Least Squares
Date: 02/01/17 Time: 21:06
Sample: 1 734
Periods included: 81
Cross-sections included: 120
Total panel (unbalanced) observations: 734

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.946650	0.572332	5.148496	0.0000
IMP_SHORTFAL	-0.000317	0.000185	-1.712068	0.0873
ABS_RPM	93.67234	0.979190	95.66305	0.0000
VW AP	-0.012884	0.011294	-1.140824	0.2543
OHLC	-0.074431	0.210624	-0.353384	0.7239
TW AP	0.081783	0.215371	0.379730	0.7043

R-squared	0.928166	Mean dependent var	43.42968
Adjusted R-squared	0.927673	S.D. dependent var	20.79010
S.E. of regression	5.591230	Akaike info criterion	6.288416
Sum squared resid	22758.63	Schwarz criterion	6.326006
Log likelihood	-2301.849	Hannan-Quinn criter.	6.302915
F-statistic	1881.300	Durbin-W atson stat	1.487392
Prob(F-statistic)	0.000000		

Interpretation: The above calculation shows the regression results for each of the five factors and their relationship with RPM. When individually tested, results show that each of the five factors identified in the literature is significant and influences the performance of a portfolio. However, when all factors are taken together and a multiple regression is run, it shows that only ABS_RPM is significant making implementation shortfall and other factors insignificant at 1% and 5% level of significance. The adjusted R-squared is also very high validating the powerfulness of the significant factor. About 93% of variability of RPM can be jointly explained by all independent variables. By rejecting null hypothesis, it is inferred that there is relationship with RPM and all independent variables.

However, Durbin-Watson statistics indicating the chance of auto-correlation.

To make any inference from equation F, it is required to estimate some diagnostic test to check the stability and suitability of the selected model. First, correlation among the variables is checked. Then unit-root of all variables is assessed using various test offered by various scholars. Finally, co-integration test is used to select between Vector Auto-Regressive (VAR) and Vector Error Correction Model (VECM). It is worth mentioning that VAR or VECM are applied in the current data set to estimate the probable long-run and short run relationship among the variables.

Correlation:

Table 5.07.06.01.01: Correlation matrix for all variables

	RPM	IMP_SHO...	ABS_RPM	VWAP	TWAP	OHLC
RPM	1	0.0892106...	0.9630838...	-0.1224019...	-0.1075769...	-0.1074064...
IMP_SHO...	0.0892106...	1	0.1112314...	0.0554044...	0.0506523...	0.0495941...
ABS_RPM	0.9630838...	0.1112314...	1	-0.1091501...	-0.0967182...	-0.0965890...
VWAP	-0.1224019...	0.0554044...	-0.1091501...	1	0.9478919...	0.9455320...
TWAP	-0.1075769...	0.0506523...	-0.0967182...	0.9478919...	1	0.9998723...
OHLC	-0.1074064...	0.0495941...	-0.0965890...	0.9455320...	0.9998723...	1

Interpretation: From correlation matrix, it is observed that ABS_RPM and RPM are collinear (.9630838). Again the correlation among VWAP, TWAP and OHLC are very high. All variables having more than 0.8 correlation which may cause multicollinearity problem. So, to avoid the multicollinearity problem only three variables (RPM, IMP_SHORTFAL, and VWAP) have been selected where the correlations are minimum (less than 0.15).

Unit Root test:

Table 5.07.06.02.01: Panel Unit Root Test for RPM

Panel unit root test: Summary
Series: RPM
Date: 02/01/17 Time: 21:25
Sample: 1 734
Exogenous variables: Individual effects
User-specified lags: 1
Newey-W est automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-15.0187	0.0000	39	240
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W -stat	-4.22608	0.0000	39	240
ADF - Fisher Chi-square	148.241	0.0000	39	240
PP - Fisher Chi-square	251.476	0.0000	39	279

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table 5.07.06.02.02: Panel Unit Root Test for IS

Panel unit root test: Summary
Series: IMP_SHORTFAL
Date: 02/01/17 Time: 21:25
Sample: 1 734
Exogenous variables: Individual effects
User-specified lags: 1
Newey-W est automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	1.4E+11	1.0000	33	208
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W -stat	-440.440	0.0000	33	208
ADF - Fisher Chi-square	73.7533	0.2396	33	208
PP - Fisher Chi-square	212.597	0.0000	33	241

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table 5.07.06.02.03: Panel Unit Root Test for ABS_RPM

Panel unit root test: Summary
Series: ABS_RPM
Date: 02/01/17 Time: 22:13
Sample: 1 734
Exogenous variables: Individual effects
User-specified lags: 1
Newey-W est automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-18.0055	0.0000	39	240
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W -stat	-6.34959	0.0000	39	240
ADF - Fisher Chi-square	175.380	0.0000	39	240
PP - Fisher Chi-square	263.104	0.0000	39	279

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table 5.07.06.02.04: Panel Unit Root Test for VWAP

Panel unit root test: Summary
Series: VW AP
Date: 02/01/17 Time: 21:26
Sample: 1 734
Exogenous variables: Individual effects
User-specified lags: 1
Newey-W est automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-24.0584	0.0000	39	240
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W -stat	-5.06053	0.0000	39	240
ADF - Fisher Chi-square	153.450	0.0000	39	240
PP - Fisher Chi-square	173.636	0.0000	39	279

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table 5.07.06.02.05: Panel Unit Root Test for TWAP

Panel unit root test: Summary
Series: TW AP
Date: 02/01/17 Time: 21:30
Sample: 1 734
Exogenous variables: Individual effects
User-specified lags: 1
Newey-W est automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-24.0677	0.0000	39	240
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W -stat	-5.06238	0.0000	39	240
ADF - Fisher Chi-square	153.450	0.0000	39	240
PP - Fisher Chi-square	173.654	0.0000	39	279

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table 5.07.06.02.06: Panel Unit Root Test for OHLC

Panel unit root test: Summary
Series: OHLC
Date: 02/01/17 Time: 21:30
Sample: 1 734
Exogenous variables: Individual effects
User-specified lags: 1
Newey-W est automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-23.5391	0.0000	39	240
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W -stat	-4.99053	0.0000	39	240
ADF - Fisher Chi-square	153.008	0.0000	39	240
PP - Fisher Chi-square	171.694	0.0000	39	279

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table 5.07.06.02.07: Summary of Panel unit root test (From table 5.07.06.02.01 – .06)

Variables	**lag s**	**Im, pesaran and Shin W-stat**		**ADF**		**PP**	
		Statistic	**Prob.**	**Statistic**	**Prob.**	**Statistic**	**Prob.**
RPM	1	-4.22608	0.0000	148.241	0.0000	251.476	0.0000
ABS_RPM		-6.34959	0.0000	175.380	0.0000	263.104	0.0000
IMP_SHORTFAL		-440.440	0.0000	73.7533	0.2396	212.597	0.0000
VWAP		-5.06053	0.0000	153.450	0.0000	173.636	0.0000
OHLC		-4.99053	0.0000	153.008	0.0000	171.694	0.0000
TWAP		-5.06238	0.0000	153.450	0.0000	173.654	0.0000

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Interpretation: Augmented Dickey-Fuller (ADF) Test is applied to justify the unit root of all endogenous and exogenous variables. Under ADF, PP and Im, Pesaran and Shin W-stat method the null hypothesis is that there is no unit root in the data series. After comparing test statistic value with that of test critical value at 5 percent significance and considering p-value, it is found that all of our variables are stationary at level.

Cointentegration test:

Table 5.07.06.03.01 Johansen Fisher Panel Cointegration Test

Johansen Fisher Panel Cointegration Test
Series: RPM IMP_SHORTFAL VW AP
Date: 02/01/17 Time: 21:33
Sample: 1 734
Included observations: 734
Trend assumption: Linear deterministic trend
Lags interval (in first differences): 1 1

Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)

Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen t...	Prob.
None	42.21	0.0000	36.51	0.0000
At most 1	29.61	0.0002	28.83	0.0003
At most 2	11.58	0.1710	11.58	0.1710

* Probabilities are computed using asymptotic Chi-square distribution.

Interpretation: Here empirical results show, in both tests, there are two co-integrating equations exist. The test shows rejection of null hypothesis (there is r integrating vector) in none and at most 1. As at most 2 scenarios are smaller than its critical value, the null hypothesis cannot be rejected. These above results confirm the variables are co-integrated. As there are two co-integrating equations found, there is causality in at least one direction. As in the presence of co-integrating relationship among variables, VAR model might mislead the statistical inference. For determination of Granger-cause of RPM and other variables (IMP_SHORTFAL, VWAP) and vice versa Vector Error Correction Model (VECM) is used. According to Engle & Granger (1987), if two variables are co-integrated, then a more comprehensive test of causality, which has become known as an error correction model, should be applied.

VECM (Vector Error Correction Model):

Table: 5.07.06.04.01 Vector Error Correction Estimates

Vector Error Correction Estimates
Date: 04/02/17 Time: 18:47
Sample: 1 734
Included observations: 378
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	CointEq2	
RPM(-1)	1.000000	0.000000	
IMP_SHORTFAL(-1)	0.000000	1.000000	
VW AP(-1)	1.970483	-658.0765	
	(0.09639)	(31.1886)	
	[20.4436]	[-21.0999]	
C	-186.4768	47351.23	
Error Correction:	**D(RPM)**	**D(IMP_SH...**	**D(VW AP)**
CointEq1	-0.994277	-13.79468	0.094839
	(0.09013)	(5.36767)	(0.11825)
	[-11.0320]	[-2.56996]	[0.80205]
CointEq2	-0.002950	-0.034528	0.001984
	(0.00027)	(0.01611)	(0.00035)
	[-10.9104]	[-2.14394]	[5.59116]
D(RPM(-1))	-0.016686	7.310299	-0.088916
	(0.07461)	(4.44331)	(0.09788)
	[-0.22366]	[1.64524]	[-0.90839]
D(RPM(-2))	-0.032504	1.721376	-0.025091
	(0.05447)	(3.24429)	(0.07147)
	[-0.59669]	[0.53059]	[-0.35107]
D(IMP_SHORTFAL(-1))	0.004026	-0.531460	-0.002731
	(0.00119)	(0.07070)	(0.00156)
	[3.39119]	[-7.51687]	[-1.75314]
D(IMP_SHORTFAL(-2))	0.000289	-0.191184	0.000465
	(0.00097)	(0.05787)	(0.00127)
	[0.29752]	[-3.30351]	[0.36482]
D(VW AP(-1))	-0.002514	2.362512	-0.008101
	(0.02499)	(1.48839)	(0.03279)
	[-0.10061]	[1.58730]	[-0.24706]
D(VW AP(-2))	0.009438	1.210095	-0.005554
	(0.01373)	(0.81759)	(0.01801)
	[0.68747]	[1.48007]	[-0.30838]
C	0.838920	93.96702	-5.930280
	(1.19865)	(71.3878)	(1.57263)
	[0.69989]	[1.31629]	[-3.77094]
R-squared	0.528568	0.169577	0.664068
Adj. R-squared	0.518347	0.151573	0.656785
Sum sq. resids	174219.3	6.18E+08	299889.4
S.E. equation	21.72876	1294.093	28.50804
F-statistic	51.71523	9.418975	91.17966
Log likelihood	-1695.529	-3240.388	-1798.175
Akaike AIC	9.018672	17.19253	9.561771
Schwarz SC	9.112360	17.28622	9.655459
Mean dependent	0.675279	62.80178	-5.905813
S.D. dependent	31.30892	1404.942	48.66137
Determinant resid covariance (dof adj.)		6.22E+11	
Determinant resid covariance		5.79E+11	
Log likelihood		-6728.000	
Akaike information criterion		35.77248	
Schwarz criterion		36.11601	

Bound Testing

Before applying the method of bound testing for the Wald statistics the regression is run by taking the difference or the change in the variables, the change in the lag value and the lag value of the of all the variables, and keeping the difference of RPM as dependent variable. Then restriction on the coefficients of the lag values shown in Wald test is imposed. The results of the regression run for the purpose of bound testing are given in VECM model, while the Wald and the F-statistic for the VECM are given below. Through the results it is clear that both the statistics are significant and are no long run relationship in the model. VECM, F-statistics and Wald-statistics push to accept the hypothesis of Co-integration in the model.

Long run relationship association ship: In the VECM output co-integrating term (error correction term) one and two have negative value and statistically significant. It means that there is a long run **relationship** exist **among RPM (dependent variable), and IMP_SHORTFAL,VWAP (Independent variables).** Association ship is running from the independent variables to dependent variables and variables are reaching to the equilibrium.

Short run association ship: While co-integrating term explaining the long run equilibrium relationship, joint significance of coefficient of independent variable explains the short run relationship. In this case, standard Wald test statistics show that there is short run association ship exist between independent and dependent variable.

Table: 5.07.06.05.01 Wald Test

W ald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	3.167280	(4, 369)	0.0141
Chi-square	12.66912	4	0.0130

Null Hypothesis: C(5)=C(6)=C(7)=C(8)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(5)	0.004026	0.001187
C(6)	0.000289	0.000972
C(7)	-0.002514	0.024991
C(8)	0.009438	0.013728

Restrictions are linear in coefficients.

In the result of Wald test, the probability of F-statistic and Chi-square is significant at 5% level of significance. Therefore, the null hypothesis is rejected, i.e., there is a short run association ship exist between independent and dependent variable.

Granger causality test:

Table: 5.07.06.06.01 Pairwise Granger Causality Tests

Pairwise Granger Causality Tests
Date: 02/01/17 Time: 21:52
Sample: 1 734
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
IMP_SHORTFAL does not Granger Cause RPM	495	1.47536	0.2297
RPM does not Granger Cause IMP_SHORTFAL		0.24670	0.7815
VW AP does not Granger Cause RPM	495	0.00302	0.9970
RPM does not Granger Cause VW AP		1.65333	0.1925
VW AP does not Granger Cause IMP_SHORTFAL	495	1.44902	0.2358
IMP_SHORTFAL does not Granger Cause VW AP		1.43497	0.2391

Interpretation:

The Granger causality test is a statistical hypothesis test for determining whether one time series is useful in forecasting another, first proposed in 1969 by *Granger, C. W. J. (1969)*. Granger causality enables us to identify leading, lagging and coincidence microeconomic and macroeconomic variables for the stock market performance (Ahmed & Osman, 2007). It also measures the precedence and information content but does not itself causality in the more common use of the term (Ali M.B, 2011). Our estimates of bivariate Granger causality indicate that there exists no causal relation running from any variable among IMP_SHORTFAL, VWAP, RPM.

The impact of trade timing on performance

H07: There is no significant relation between performance and trade timing.

Next aspect is to test whether at any time of the day, trader can trade and perform better. Including pre-opening and post-closing trade period, the trading performance at various half an hour interval is reviewed. The results show that the best time to trade is between 9:30-10:00 am when it was found that out of the total of 734 trades during the whole day, 243 trades produced better RPM.

Table 5.07.07.01: Best trade timing in Half Hour Interval:

Best trade timing range	**Frequency**
Up to 09:30	71
09:30 – 10:00	**243**
10:00 – 10:30	61
10:30 – 11:00	43
11:00 – 11:30	35
11:30 – 12:00	35
12:00 – 12:30	23
12:30 – 13:00	17
13:00 – 13:30	24
13:30 – 14:00	34
14:00 – 14:30	27
14:30 – 15:00	31
15:00 – 15:30	37
15:30 – 16:00	52
16:00 and above	01
Total	**734**

Table 5.07.07.02: Best trade timing in 10 Minutes Interval:

Best trade timing range	**Frequency**
09:30 – 09:40	**186**
09:40 – 09:50	35
09:50 – 10:00	22
Total	**243**

The trades and timing of the best half hour is further investigated and it was observed in 10 minutes' interval. It was found that 9:30-9:40 am shows provides 186 RPM of 243 during that half hour. So, it indicates that for trader, the best trade timing is 09:30 to 09:40, i.e., first 10 minutes after the market open.

Table 5.07.07.03: Best trade timing in one Minute Interval:

Best trade timing range	**Frequency**
09:30 – 09:31	**88**
09:31 – 09:32	20
09:32 – 09:33	19
09:33 – 09:34	16
09:34 – 09:35	10
09:35 – 09:36	06
09:36 – 09:37	06
09:37 – 09:38	09
09:38 – 09:39	08
09:39 – 09:40	04
Total	**186**

A further look into the timing by separating the time difference to one minute to pin point the best time for trade is done. The data indicates that First minute of the market open offers the best trading opportunity.

Table 5.07.07.04: Best trade timing in 10 Seconds Interval:

Best trade timing range	**Frequency**
09:30:00 – 09:30:10	**56**
09:30:10 – 09:30:20	15
09:30:20 – 09:30:30	06
09:30:30 – 09:30:40	04
09:30:40 – 09:30:50	05
09:30:50 – 09:31:00	02
Total	**88**

So, the best trade timing is 09:30:00 to 09:30:10, i.e., first 10 seconds after the market open.

Table 5.07.07.05: Best trade timing in 2 Seconds Interval:

Best trade timing range	Frequency
09:30:00 – 09:30:02	**26**
09:30:02 – 09:30:04	18
09:30:04 – 09:30:06	03
09:30:06 – 09:30:08	07
09:30:08 – 09:30:10	02
Total	**56**

So, the best trade timing is 09:30:00 to 09:30:02, i.e., first two seconds after the market open.

Table 5.07.07.06: Best trade timing in 1/2 Seconds Interval:

Best trade timing range	Frequency
09:30:00:000 – 09:30:00:500	**13**
09:30:00:500 – 09:30:01:000	07
09:30:01:000 – 09:30:01:500	04
09:30:01:500 – 09:30:02:000	02
Total	**26**

So, for the buy side trader, aggressive trading in the market opening time may be get the best execution time.

Conclusion

To get the best price in transaction is very vital issue for every transection in Stock Exchange. Someone says it is not possible to identify the best time (e.g. best hour, minutes, and seconds) of transection because of invisible characteristics/nature of stock market. So the target was to find out the best time for transaction that leads to low transection cost and higher gain. Total 734 days transection data is considered. Based on the frequency of the transection if one transect between 9:00 am to 10:00 am it is possible to get the best price because in 243 days best traders got best price in that time. Further, it is desirable to know which 10 minutes within 9:30 am to 10:00 am is effective. So total 30 minutes are divided into three slots. Among 243 days 186 days, traders got best price between 9:30 am to 9:40 am. Similarly the minute when best time for transection is within 9:31 am and best seconds are the first 10 seconds. Finally, first half second is the ultimate time to transect at lowest cost. So based on the frequency one can infer that if anyone is able to execute within first half minutes s/he will be get best price.