AUTOMATED ARBITRAGE OPPORTUNITIES IN THE STOCK MARKET USING QUICK TEST PROFESSIONAL

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Computer Science

by
Gaurav Verma

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Automated Arbitrage Opportunities in the Stock Market Using Quick Test

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DEDICATION

I would like to dedicate this thesis to my parents who kept faith in me and provided that enthusiasm which was essential for the accomplishment of this project. I appreciate their support and patience during this period and I would have not made it this far without their inspiration.
ABSTRACT OF THE THESIS

Automated Arbitrage Opportunities in the Stock Market Using
Quick Test Professional
by
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Master of Science in Computer Science
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Automated arbitrage trading is aimed at computerizing arbitrage opportunities that exist in the stock market using Quick Test Professional (QTP). The developed software aims at obtaining a low cost model for arbitrage trading. The program makes price comparisons of 25 to 30 stocks every 30 seconds, which has a great advantage over manual arbitrage trading. The automated arbitrage trading developed in this thesis uses QTP and does not need any human intervention. It helps small traders take advantage of arbitrage opportunities that exist in different price segments of the stock market. The QTP tool compares prices of cash and future segments of the listed stocks to check if there is any arbitrage trading opportunity. It also checks prices of some pre-selected securities against preset conditions to determine if any of the securities pass the test. If the condition is satisfied, QTP initiates buying/selling on the arbitrage opportunity and thus helps make profit on the transaction. It uses Odin Diet trading platform to get updated price feeds of the securities. This procedure is executed after every 30 seconds by QTP.
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I would also like to thank my parents for the sacrifices they made to help me to attend graduate school.
CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

A stock market is a market in which company stocks are traded in the exchanges. Here, buyers and sellers trade a stock to find the equilibrium price every time. So it is basically demand supply equation that finds the future value of stock. It is a platform where investors can have a slice of company’s ownership by the buying the shares of the company. The investor can hence participate in the future growth performance of the company. If an investor owns some shares of a company, that does not mean he has a say in the company or he can make decisions for the company. He just owns a share in the company’s profit and assets. One needs to hold substantial amount of stake in a company to be the part of decision-making process. So, to make money in stocks you need to anticipate the future growth of the company or if the company is doing well, it pays you back in the form of dividends.

1.2 TYPES OF STOCK MARKET

There are basically two types of stock market as explained below.

1.2.1 Primary Market

Primary market is basically where a company gets listed in an exchange through an Initial Public Offering (IPO). So the company comes up with an IPO issue, then investors/traders subscribe to that issue if they believe that there is a potential for the IPO to move up in the future. The IPO gets listed in the exchange on a specified date and thereafter, it is traded as other stocks that are already listed. (See Appendix for a glossary of terms.)

1.2.2 Secondary Market

Secondary market is the place where the listed stocks are traded in the exchanges. We can say it is a place where existing products are traded. Most of the stocks listed in the
exchanges are liquid with the exception of few. So, an investor can buy or sell any of the listed stocks during stock market hours.

1.3 Different Types of Trading

The stock market participants trade in stock market with different time span and prospective. So we can broadly classify trading into the categories that follow [1, 2, 3, 4, 5, 6].

1.3.1 Intraday Trading

The most widely seen method in the exchanges is the one where people trade securities in couple of minutes or an hour or so to benefit from the short term price movements. The biggest advantage of Intraday Trading is the transaction costs are very low for intraday as compared to the delivery of the security.

1.3.2 Short Term Trading

The traders buy and sell securities in the exchanges with the holding period varying from a day to a week or so. The transaction costs are 6-7 times of the intraday trading, but the risk/reward is much more in the short term trading.

1.3.3 Swing Trading

The holding period for this trading is couple of weeks to months benefiting from the cycle change of the security.

1.3.4 Hedged Trading

Hedged Trading is like buying insurance for the life. So if we are making money in a trade we pay small amount of our profit to ensure that we do not lose the existing money we have made while keeping the upsides open. Good example of hedged trading is buying options of Indian currency at a small amount so that our worth does not lose value even if the currency appreciated while ensuring that we reap the benefits of its depreciation.

1.3.5 Arbitrage Trading

Arbitrage Trading has the least amount of risk in trading as the main purpose of trading is to benefit from difference in the prices of the security on different exchanges or
segments. The different segment can be futures, stock listed on a different exchange or options.

1.4 PURPOSE OF THE STUDY

Automated Arbitrage trading is aimed at automating arbitrage opportunities that exist in the stock market using Quick Test Professional (QTP) automated testing tool. The purpose of the study was to develop a low cost model that can help small traders to take advantage of arbitrage that exist in different price segments in the stock market. The goal of the study was to keep comparing prices of cash and future segment of some of the stocks every 30 seconds to check if we get profitable difference to do arbitrage.

1.5 LIMITATIONS OF THE STUDY

It was unknown at the beginning of this study that if QTP would be compatible with ODIN Diet trading platform. It was unknown at the beginning of this study if the factors that lead to its success were even possible like compatibility of application was even possible. The biggest threat to the application was if the random values of ODIN Diet trading platform could be recorded or not. So it was required to capture the changing values and compare to find if the required difference condition is satisfied or not. Lastly, it was required that if the listed security is trading at more than required difference then we should be able to execute the transaction automatically by buying the low value and selling the high value security.

Here is the short summary of chapters that explains the workflow of chapters:

- Chapter 2 is Arbitrage and Testing. It explains the definition of arbitrage with some examples and Introduction to testing with the methodology in the process of testing.
- Chapter 3 is Background and Literature. It introduces the automation testing tool QTP. The different functionalities of QTP are explained with the screenshots. Then I will explain different kinds of arbitrage opportunities along with the example.
- Chapter 4 contains the Code. It explains the actual implementation of the arbitrage with the code. There is a summary of each module that explains its functionality.
- Chapter 5 is a Results section which has a screenshot of actual arbitrage opportunities in the recent date and the screenshot of the implemented software.
- Chapter 6 is the Conclusion. It explains the reason behind the implementation of this software and its benefits.
Chapter 7 is the Future Recommendations and Feedback. It specifies the feedback from two highly reputed brokers. At the end some improvements are suggested that can be implemented to improve the efficiency of the software.
CHAPTER 2

ARBITRAGE AND TESTING

2.1 ARBITRAGE

Arbitrage is the practice of identifying the price differential of the same entity in different platforms or markets and executing it. So in this transaction the profit is the price difference between two exchanges. An arbitrage is a risk free opportunity as the trade is executed only when there is price difference in two exchanges. No doubt there are some risks in executing an arbitrage those will be discussed later.

2.1.1 Conditions for Arbitrage

The conditions for arbitrage are:

1. The entity should not be trading at the same price in different markets i.e., stock listed in US exchange trades at $3 and in India it trades at Rs150 which is equal because $1 = Rs50. So the entity is trading at same prices on different platforms which is not an arbitrage.

2. An asset with a known value in the future should not be trading at a discounted price to its future value at the risk free interest rate.

2.1.2 Example of Arbitrage

An example of arbitrage is:

A simple example of arbitrage is if rice grown in agricultural regions is bought from there and sold in cities where better can be realized is arbitrage keeping in mind the transportation, maintenance cost etc to be incurred. The ideal arbitrage is the one which does not involve any risk.

2.1.3 Price Convergence

The prices of an entity in different platforms tends to converge at some point of time like in futures instrument the prices of stocks and derivative instrument i.e., futures converge at the day of expiry. So the price differential is converged here and we cover our position. Factors to be kept in mind while executing arbitrage include [6, 7, 8, 9]:

- Liquidity – We need to ensure that there is good liquidity in that security to trade at any given time.
• ODIN Diet – ODIN software is trading software which is used to buy and sell securities in the exchange. We can buy, sell and put order limit for a security using ODIN Diet. It is developed by Financial Technologies. Also ODIN Diet is an application based internet trading, front end target at HNI clients. It ensures anywhere anytime trading through very low bandwidth. ODIN Diet is a widely used platform for trading because of its advanced features, great benefits and value proposition listed as follows [10]:

1. Features
   • Fast Order Entry
   • Bulk Order Entry
   • Integrated Market watch for multiple exchange and exchange segments
   • Basket Trading
   • Charting with Line tools and Indicators
   • Dynamic Portfolio
   • Customized Column Profiles
   • Derivatives Chain

2. Benefits
   • It ensures fast execution of orders.
   • It ensures stability and robustness of the system.
   • It helps in scalability.

3. Value Proposition
   • It offers real time connectivity to the exchange and back office system with faster inter segment trading.
   • It offers a complete trade and system audit trail, real time price and position information and real time risk monitoring at all levels.
   • Full customizable views at all levels besides extensive research and filtering options.

2.2 SOFTWARE TESTING

Software Testing is basically aimed to ensure following purpose:

1. The software developed meets all the requirements.
2. It does not have any bugs.
3. It is reliable, stable and functionality is as expected.
2.2.1 Functional and Non Functional Testing

We can broadly classify testing on two broad terms: functional and non functional, as explained below.

2.2.1.1 FUNCTIONAL TESTING

This testing is aimed to ensure that application meets all the requirements and customer needs. The tests are aimed at checking the functionality of the code. The types of Functional Testing include:

- **Black Box Testing** – The tester needs to consider the software as black box with no experience of data structure and algorithm of the software required to test the application. He just needs to test the application with the given inputs for different parameters and compare the output with the expected result.

- **White Box Testing** – It requires the tester to understand the data structure and algorithm of the functionality of each module to test the application.

- **Grey Box Testing** – It is an intermediate type of software testing where the knowledge of internal data structure is required for creating test plans and test cases but at the core testing level it is tested like a black box testing.

2.2.1.2 NON FUNCTIONAL TESTING

This testing is aimed at testing the non functional aspects of the software. It can be divided into following parts:

1. **Usability Testing** – It ensures the interface of the software is easy to use and understand.
2. **Load Testing** – It is used to check the performance.
3. **Stress Testing** – It ensures the reliability of the software.
4. **Volume Testing** – It ensures functionality of the software.

2.2.2 Software Testing Life Cycle

The software testing follows a set methodology from understanding requirements to defect analysis to complete the testing life cycle, as explained below [11, 12, 13].

1. **Requirement Analysis** – It requires understanding the design document and understanding each module to identify what test plans need to be developed for testing.
2. **Test Planning** – It involves creating a strategy for testing as large companies have already defined steps to identify the Test strategy for a new software product.
3. **Test Development** – It aims at identifying the test scenarios, description, expected results and all expected results from the test cases.
4. Test Execution – It follows the footsteps of test development to actually test the application and determine if it is performing as expected.

5. Defect Analysis – Here we analyze the results and discuss the defects with development team to analyze the functional code and rectify that. Also there is a traceability matrix which maps the requirements with test scenarios It helps in rectifying the test scenarios if the requirements are changed anytime.

6. Regression Testing – It is a part of software life cycle in every step as whenever a new module is added. Regression testing aims at testing the basic functionality of the application whenever a new module is integrated with the application to ensure it did not affected the basic functionality of the application.

7. Test Summary – It includes the feedback of the complete testing process, lessons learned and the back up of documents for further use.
CHAPTER 3

BACKGROUND AND LITERATURE

3.1 QUICK TEST PROFESSIONAL

Quick Test Professional (QTP) is basically a record and playback tool that records all the action and plays that every time when we are testing the application. QTP is basically a regression testing tool used to test the same features every time when a new build is released or there are any changes made to the software. The benefit of QTP is that tests can be recorded and saved and run anytime in the future by clicking the play button which saves lot of human time, improve accuracy and reliability. QTP is a product of Hewlett Packard. It was originally written by Mercury Interactive. Mercury Interactive was acquired by HP in 2006. The current version available for QTP is 11.

3.1.1 Benefits of Automated Testing

The wide range of benefits of automated testing are explained below.

- Fast – Automated Testing is much faster than human testing as it takes milliseconds to execute a test.
- Reliable – Once we have identified the parameters to test so we need to automate once to test every time when a new build is released as compared to manual testing which will test each parameter which is time consuming and does not ensure that each parameter is tested every time as there can be human negligence.
- Repeatable – As an automated test can be repeated n number of times without human intervention so the same test cases can be repeated saving time and ensuring accuracy.
- Programmable – We can program sophisticated tests to get the hidden information not visible to human eyes.
- Comprehensive – As the tests cover every feature required so automated testing ensures completeness.

3.1.2 Benefits of Quick Test Professional

QTP is one the most popular and widely used automated testing tool in software industry. It has wide range of enhanced features as explained below.
• Enhancing the Test – We can manually write the code to get the intermediate values or insert the different input values according to user preference.
• Debugging the Test – We can debug the test to ensure it runs smoothly
• Analyzing the Test – The test can be analyzed by going over the defects.
• Reporting Defects – If we have Mercury Quality Center then we can directly report defects we found in the testing.

3.1.3 About Quick Test Professional Automated Testing

QTP is used to test two types of application i.e., web based application and Windows based application. It has an important feature of checkpoints which is used to insert the action if a required condition is satisfied and then we can command a certain action to be executed at that given situation.

3.1.3.1 RECORDING A TEST

QTP provides a record and playback functionality which enables for beginners to learn the tool with an ease. Before we start recording a script we need to make initial settings for recording and then we record a test. See Figure 3.1 and Figure 3.2 for reference.

![Figure 3.1. Recording a test in QTP.](image-url)
3.1.3.2 ANALYZING A TEST

We can analyze a test by going through the test results and scrutinizing the reasons for fail. See Figure 3.3 and 3.4 for details.

3.1.3.3 CREATING CHECKPOINTS

We can define different types of checkpoints as seen in Table 3.1.

Some of them are explained in detail as follows [14]:

- **Object Checkpoint** – Checks the value of object properties. For example, a basic submit button. See Figure 3.5. Checkpoint Object properties can be seen in Figure 3.6.

- **Checking Images** – To check the different characteristics of image like to confirm if the source address is correct or not.

- **Checking Pages** – It is used to check the loading time of web page. It can be used to find if the webpage is taking much longer time to download or any broken link.
3.2 CASH AND FUTURES ARBITRAGE

Knowing when to trade is equally important as knowing when not to trade. If cash and futures arbitrage is done efficiently the return can be 10-14% risk free on the idle cash sitting. The future price of any stock or security is a combination of two factors the cash price of the asset and the cost of carry of remaining time period of the future instrument.

One month future price of Apple stock = Cash Price of “Apple” stock + Cost of carry for a period of one month.
3.2.1 Different Instances of Cash Future Arbitrage

The different instances of cash future arbitrage are explained below.

3.2.1.1 FUTURE PRICES HIGHER THAN CASH PRICE

As we know that future price closes at cash price of the security or index on the expiry day. So in the above case the future price of Apple is higher than cash price. Suppose the cash price of Apple is $250 and future price is $253. So we buy the Apple stock in cash market for $250 and sell the future for $253. Suppose on the expiry day the cash price of Apple stock is $280 so we can say that future price of Apple will be $280 too. Then we sell
Table 3.1. Checkpoint in QTP

<table>
<thead>
<tr>
<th>Checkpoint Type</th>
<th>Description</th>
<th>Example of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Checkpoint</td>
<td>Checks values of an object’s properties.</td>
<td>Check that a radio button is selected.</td>
</tr>
<tr>
<td>Image Checkpoint</td>
<td>Checks the property values of an image.</td>
<td>Check that the image source file is correct.</td>
</tr>
<tr>
<td>Table Checkpoint</td>
<td>Checks information in a table.</td>
<td>Check that the value in a table cell is correct.</td>
</tr>
<tr>
<td>Page Checkpoint</td>
<td>Checks the characteristics of a web page.</td>
<td>Check how long a Web page takes to load or if a web page contains Broken links.</td>
</tr>
<tr>
<td>Text/Text Area Checkpoint</td>
<td>Checks that a text string is displayed in the appropriate place in a web page or application window.</td>
<td>Check whether the expected text string is displayed in the expected location on a web page or dialog Box.</td>
</tr>
</tbody>
</table>

Figure 3.5. Example of Object Checkpoint.

the Apple stock at $280 and buy the Apple future at $280. The net profit in Apple cash stock is $280 - $250 = $30 and the loss in Apple future is $280 - $253 = $27. The net profit in this transaction is $30 - $27 = $30, if you take away $1 transaction cost the net profit of this transaction is $2 which 0.75% or 9.2% annualized.
3.2.1.2 Cash Prices Higher than Futures Price

In this Scenario cash prices are higher than future price so we need to borrow the stock for this transaction. So in this case we assume the future price is $250 and cash price is $253. We borrow the stock and sell at $253 and buy the future at $250. On the expiry day we reverse this transaction and cover our position. There is some cost of borrowing the stock so we need to encounter that transaction cost too. On the conservative basis the return comes about to be 8-8.5%. During bull markets these returns sometimes scale up to 12-13% per annum when the difference between cash and future price is more than 1.5%. In India large brokers like Kotak Securities let you lend the stock at a small cost. Classical example of Reverse arbitrage which is this one is Sesa Goa listed in Indian Stock Exchange. During last year it was giving a return of 3-4% per month i.e., 36-48% return annually before commissions, which is much more than bonds give. Most importantly these transactions are
risk free. So it does not lead you to have sleepless nights which are a common scenario in stock markets.

A list of arbitrage opportunities in Sensex in 2003-2004 is provided in Table 3.2.

Table 3.2. List of Arbitrage Opportunities in Sensex 2003-2004

<table>
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<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ACC</td>
<td>265.55</td>
<td>268</td>
<td>-2.45</td>
<td>13.47%</td>
</tr>
<tr>
<td>Bajaj Auto</td>
<td>1120</td>
<td>1137.90</td>
<td>-17.90</td>
<td>23.33%</td>
</tr>
<tr>
<td>BHEL</td>
<td>538.80</td>
<td>545</td>
<td>-6.20</td>
<td>16.80%</td>
</tr>
<tr>
<td>BPCL</td>
<td>479.15</td>
<td>1485</td>
<td>-5.85</td>
<td>17.83%</td>
</tr>
<tr>
<td>Canara Bank</td>
<td>141.10</td>
<td>143.20</td>
<td>-2.10</td>
<td>21.73%</td>
</tr>
<tr>
<td>Digital</td>
<td>749</td>
<td>758</td>
<td>-9</td>
<td>17.54%</td>
</tr>
<tr>
<td>Dr Reddy</td>
<td>1450</td>
<td>1468.75</td>
<td>-18.75</td>
<td>18.88%</td>
</tr>
<tr>
<td>HPCL</td>
<td>460</td>
<td>466.30</td>
<td>-6.30</td>
<td>20%</td>
</tr>
<tr>
<td>Infosys</td>
<td>5691</td>
<td>5755</td>
<td>-63.70</td>
<td>16.34%</td>
</tr>
<tr>
<td>Larsen</td>
<td>538</td>
<td>543.50</td>
<td>-5.50</td>
<td>14.93%</td>
</tr>
<tr>
<td>Maruti</td>
<td>381</td>
<td>385.50</td>
<td>-4.50</td>
<td>17.24%</td>
</tr>
<tr>
<td>National Alu</td>
<td>203</td>
<td>206.35</td>
<td>-3.35</td>
<td>24.09%</td>
</tr>
<tr>
<td>ONGC</td>
<td>916</td>
<td>926.60</td>
<td>-10.60</td>
<td>17.37%</td>
</tr>
<tr>
<td>PNB</td>
<td>239.50</td>
<td>242.50</td>
<td>-3</td>
<td>18.29%</td>
</tr>
<tr>
<td>Ranbaxy</td>
<td>1109.25</td>
<td>1123.40</td>
<td>-14.15</td>
<td>18.62%</td>
</tr>
<tr>
<td>Reliance</td>
<td>587.10</td>
<td>592.80</td>
<td>-5.70</td>
<td>14.17%</td>
</tr>
<tr>
<td>Satyam</td>
<td>375.75</td>
<td>381.50</td>
<td>-5.75</td>
<td>22.34%</td>
</tr>
<tr>
<td>State Bank</td>
<td>570</td>
<td>576.60</td>
<td>-6.40</td>
<td>16.34%</td>
</tr>
<tr>
<td>Tata Power</td>
<td>328.70</td>
<td>332.75</td>
<td>-4.05</td>
<td>17.99%</td>
</tr>
<tr>
<td>Telco</td>
<td>457.05</td>
<td>463</td>
<td>-5.95</td>
<td>19.01%</td>
</tr>
<tr>
<td>Tisco</td>
<td>451.70</td>
<td>458</td>
<td>-6.30</td>
<td>20.36%</td>
</tr>
</tbody>
</table>

3.2.2 Advantages of Using Cash and Future Arbritages

The different advantages of cash future arbitrage are explained below.

3.2.2.1 REASONABLE RETURNS WHEN NO TRADE IS AVAILABLE

As this strategy can offer more than 10% return annually when your cash is lying idle or when markets are in range bound mode and no good trade is available. This is a better
option when your funds are lying idle with the broker or in the savings account. Returns of around 10% may not excite stock market traders or punters but it can add your earnings during tough times as stock market trading is more of consistency returns rather than one time big returns. These extra returns can take off pressure of trading all times which is very good psychologically.

3.2.2.2 Perfect for Cash which You Cannot Risk

There is always some cash that you do not want to risk directly in market. So these cash future arbitrage is a good option for deploying that cash as the risks are not linked to market and most importantly it is risk free.

3.2.2.3 Perfect for Sideways Market

Markets are range bound 60% of the time and good trades are not available during this time so the alternate option is to utilize these opportunities. This helps in improving your returns and provides diversification to your portfolios and mitigating the risk in the market.

3.2.2.4 Reduces the Market Risk of a Portfolio

Many high net worth Individuals have high exposure to stock market so they need some means to mitigate there risks by utilizing cash in cash future arbitrage.

3.2.2.5 Returns Can Exceed in Negative Cost of Carry Scenarios

In same cases the returns can exceed from 10% to 15-17% annually. Suppose we take a cash future position and with positive cost of carry. Market crashes after that and futures go into a discount. So in this situation when we cover our position the difference in cash future will increase but in the positive side enabling us to square our position at a premium to what was able while taking the position. Consider an example when premium in cash future vanished after a couple of days after I have taken the position. Suppose we take a position in cash future of Apple and in couple of days the premium of future vanishes and future of Apple is trading at the same price of cash. So we can take the estimated return in couple of days of position. That provides us with same cash in couple of days which can be used to
take another position and enhancing our return. In some cases the return can shoot up to 20-22% if these opportunities remain available.

### 3.2.3 Factors to Keep in Mind while Doing Arbitrage

The main aim to be in stock market is the protection of capital along with the generation of returns with least risk possible. Cash future arbitrage is a great way to manage volatility in returns over a period of time and deploying the cash in cash future arbitrage when the market conditions are not favorable [15].

1. Cash future arbitrage should be traded in stocks that have high liquidity so we do not have any risks while covering our positions on the expiry day of the settlement.

2. High difference in the stock prices are only available when the markets are highly overbought or oversold which can provide extraordinary returns but in other time we need to satisfy ourselves with reasonable returns of 10% per annum.

3. You need to analyze the cost of carry while taking positions to make sure the returns available are worthwhile.

### 3.2.4 Different Types of Arbitrage Opportunities

The different types of arbitrage opportunities are explained below.

- **NSE BSE Arbitrage** – In this arbitrage opportunity we look for price differential in the 2 exchanges National stock exchange and Bombay stock exchange. Most of the stocks listed in exchanges are available for trading on NSE and BSE. So traders look for the price difference on both the exchange and buy from cheaper exchange and sell on the other exchange to lock in the profit. We need to make sure of the transaction costs before taking the trade. Normally more than 0.5% price difference yields positive return and we can set the criteria for taking only highly profitable trades.

- **Cash Future Arbitrage** – Cash future arbitrage is locking price difference in cash and future segment. If future prices are greater than cash prices then we have positive cost of carry and if cash prices are greater than future prices than we have negative cost of carry. If we are doing reverse arbitrage i.e., selling stock in cash market and buy near month future contract then we need to borrow the stock from the broker to complete the transaction.

- **Option Arbitrage** – Option arbitrage is similar to the above scenarios. In options arbitrage we look for same strike prices in the coming months to have more difference than the required time value.
CHAPTER 4

METHODOLOGY

4.1 SUMMARY

The code specified below explains the executing arbitrage opportunity in real time. QTP initializes its variables and browse into the ODIN Diet and stores the initial values. So when the market opens it start comparing the prices of stock in cash and future segment. So this iteration continues till it satisfy the condition of 1% difference in prices or if any condition that is specified in the loop. When it spots an opportunity i.e., 1% difference then it buy the stock in the cash market and sell the same quantity of stock in future market automatically and complete the transaction. It is explained with actual executed trade in results. The flow chart of complete process of cash future arbitrage using QTP is shown in Figure 4.1.

![Flow chart of cash future arbitrage algorithm.](image-url)

Figure 4.1. Flow chart of cash future arbitrage algorithm.
4.2 Code

This section explains the actual implemented code according to the flow chart explained in Figure 4.1.

4.2.1 Initialization

In the following code QTP and ODIN Diet are initialized and integrated.

```vbnet
Dim arr1()
Dim arr2()
Window("ODIN Diet Client Ver").Dialog("#32770").WinEdit("userName").Set "fs5456"
Window("ODIN Diet Client Ver").Dialog("#32770").WinEdit("Password").Set "aasdff"
wait(1)
Window("ODIN Diet Client Ver").Dialog("#32770").WinButton("Ok").Click
Do while (Window("ODIN Diet Client Ver").Dialog("Index View").Exist = True)
  Loop
  wait(40)
Window("ODIN Diet Client Ver").Db1Click 106,25
Window("ODIN Diet Client Ver").WinMenu("Menu").Select "Market; <Item 1>"
Wait(1)
Window("ODIN Diet Client Ver").WinEdit("Dropdown1").Set "RPOWER"
Window("ODIN Diet Client Ver").WinEdit("Dropdown2").Set "RELIANCE POWER LTD."
Window("ODIN Diet Client Ver").WinEdit("Dropdown2").Type micReturn
wait(2)
Set clipobj = createobject("mercury.clipboard")
clipobj.Clear
Window("ODIN Diet Client Ver").Window("Market Watch").WinListView("SysListView32").SetItemState 0, micClick
Window("ODIN Diet Client Ver").Window("Market Watch").WinListView("SysListView32").Type micCtrlDwn + "c" + micCtrlUp
Window("ODIN Diet Client Ver").Window("Market Watch").WinListView("SysListView32").Click 388,122
wait(1)
Window("ODIN Diet Client Ver").Window("Market Watch").WinListView("SysListView32").Click 388,122, micRightBtn
wait(1)
Window("ODIN Diet Client Ver").Window("Market Watch").WinListView("SysListView32").Click 388, 122, micRightBtn
wait(1)
pdftxt=clipobj.GetText
'msgbox pdftxt
```

arr1 = split(pdftxt,"NSE")
arr2 = split(arr1(Ubound(arr1))," ")
For i =0 to Ubound(arr2)
    msgbox arr2(i)
Next
wait(1)

4.2.2 Automated Comparison

The following code creates a file object in QTP and compares cash, future prices.

    wait(1)
    for_reading=1
    TestFilePath="C:\Users\Christa\Desktop\Gaurav_ODIN_DATA.txt"
    Set fso = CreateObject("Scripting.FileSystemObject")
    Set notepad = fso.OpenTextFile(TestFilePath,for_reading)
    pdftxt=notepad.ReadAll
    Dim arr_Result()
    arr_main = split (pdftxt,"NSE")
    ReDim arr_Result(Ubound(arr_main))
    For i=0 to Ubound(arr_main)
        arr_row=split(arr_main(i),"")
        For j=0 to Ubound(arr_row)
            If (Trim(arr_row(j)) <> " ") Then
                Result = Trim(arr_row(j))
                'msgbox arr_row(j)
                k=k+1
            End If
            'msgbox arr_RowVal(Ubound(arr_RowVal))
        Next
        'msgbox Result
        arr_Result(i) =Result
    j=0
    k=0
    Next
    For g=0 to ubound(arr_Result)
        msgbox arr_Result(g)
    Next

4.2.3 Automated Buying

The automated buying explains how QTP do automated buying and selling in ODIN Diet.

    Window("ODIN Diet Client Ver").Activate
4.2.4 Executed Trade

The executed code section explains how the final trades are executed when QTP identifies an arbitrage opportunity.

"Window("ODIN Diet Client Ver").WinMenu("Menu").Select "File;<Item 1>"' 'Dim arr1()
'Dim arr2()
'Window("ODIN Diet Client Ver").Dialog("#32770").WinEdit("userName").Set "sr9275"
'Window("ODIN Diet Client Ver").Dialog("#32770").WinEdit("Password").Set "sdsdsds"
'Wait(1)
'Window("ODIN Diet Client Ver").Dialog("#32770").WinButton("Ok").Click
'Do while (Window("ODIN Diet Client Ver").Dialog("Index View").Exist =True)
'Loop
'Wait(40)
'Window("ODIN Diet Client Ver").DbClick 106,25
'Window("ODIN Diet Client Ver").WinMenu("Menu").Select "Market;<Item 1>"
'Wait(1)
'Window("ODIN Diet Client Ver").WinEdit("Dropdown1").Set "RPOWER"
'Window("ODIN Diet Client Ver").WinEdit("Dropdown2").Set "RELIANCE POWER LTD."
'wait(2)
Set clipobj = createobject("mercury.clipboard")
clipobj.Clear
Window("ODIN Diet Client Ver").Activate
'Window("ODIN Diet Client Ver").Window("Market
Watch").WinListView("SysListView32").SetItemState 0, micClick
'Window("ODIN Diet Client Ver").Window("Market
Watch").WinListView("SysListView32").Type micCtrlDwn + "c" + micCtrlUp
Window("ODIN Diet Client
Ver").Window("TEST").WinListView("SysListView32").Click 373,219
wait(1)
Window("ODIN Diet Client Ver").Window("TEST").WinListView("SysListView32").Click 373, 219, micRightBtn
wait(1)
Window("ODIN Diet Client
Ver").Window("TEST").WinListView("SysListView32").WinMenu("ContextMenu").Select "<Item 4>"
'wait(1)
'Window("ODIN Diet Client Ver").Window("Market
Watch").WinListView("SysListView32").Click 388,122
'Window("ODIN Diet Client Ver").Window("Market
Watch").WinListView("SysListView32").Click 388, 122, micRightBtn
'Window("ODIN Diet Client Ver").Window("Market
Watch").WinListView("SysListView32").WinMenu("ContextMenu").Select
"<Item 4>"
pdftxt=clipobj.GetText
'wait(1)
'for_reading=1
'TestFilePath="C:\Documents and Settings\Administrator\Desktop\Sample Data.txt"
'Set fso = CreateObject("Scripting.FileSystemObject")
'Set notepad = fso.OpenTextFile(TestFilePath,for_reading)
'pdftxt=notepad.ReadAll
Dim arr_Result()
arr_main = split (pdftxt,"N")
ReDim arr_Result(Ubound(arr_main))
For i=0 to Ubound(arr_main)
arr_row=split(arr_main(i)," ")
For j=0 to Ubound(arr_row)
If (Trim(arr_row(j)) <> " " or Trim(arr_row(j)) <> Null or Len(Trim(arr_row(j)))
> 0 or Trim(arr_row(j)) <> " ") Then
Result = Trim(arr_row(j))
'msgbox arr_rowVal(Ubound(arr_rowVal))
k=k+1
End If
'msgbox arr_RowVal(Ubound(arr_RowVal))
`Next
'msgbox Result
arr_Result(i) =Result
j=0
k=0
Next
'For g=0 to ubound(arr_Result)
'msgbox arr_Result(g)
'msgbox g
'Next
y= (arr_Result(3) – arr_Result(6))
msgbox Csng(y)
z= (arr_Result(7) – arr_Result(9))
msgbox Csng(z)
w= (arr_Result(12) – arr_Result(16))
msgbox Csng(w)
'msgbox pdftxt
arr1 = split(pdftxt,"NSE")
arr2 =split( arr1(Ubound(arr1))," ")
For i =0 to Ubound(arr2)
msgbox arr2(i)
Next
wait(1)
If (y>0) Then
Window("ODIN Diet Client Ver").Activate
'Window("ODIN Diet Client
Ver").Window("TEST").WinListView("SysListView32").Select 1
'Window("ODIN Diet Client
Ver").Window("TEST").WinListView("SysListView32").Type micF1
Window("ODIN Diet Client
Ver").Window("TEST").WinListView("SysListView32").Select 1
Window("ODIN Diet Client
Ver").Window("TEST").WinListView("SysListView32").Type micF1
'Window("ODIN Diet Client Ver").Window("Order Entry").WinEdit("Total Qty").SetSelection 0,1
'wait(3)
Window("ODIN Diet Client Ver").Window("Order Entry").WinEdit("Total Qty").Set "3"
'wait(3)
Window("ODIN Diet Client Ver").Window("Order Entry").WinButton("Submit").Click
Window("ODIN Diet Client Ver").Dialog("dietodin").WinButton("Yes").Click
'wait(3)
Window("ODIN Diet Client Ver").Window("Order Entry").Close
'wait(3)
wait(1)"
Window("ODIN Diet Client Ver").Window("TEST").WinListView("SysListView32").Select 0
wait(1)
Window("ODIN Diet Client Ver").Window("TEST").WinListView("SysListView32").Type "micF2"
Window("ODIN Diet Client Ver").Window("Order Entry").WinEdit("Total Qty").Set "3"
Window("ODIN Diet Client Ver").Window("Order Entry").WinButton("Submit").Click
Window("ODIN Diet Client Ver").Dialog("dietodin").WinButton("Yes").Click
Window("ODIN Diet Client Ver").Window("Order Entry").Close
End If
x= Window("ODIN Diet Client Ver").WinStatusBar("msctls_statusbar32").GetVisibleText()
If Then
End If
msgbox x
CHAPTER 5

RESULTS

Summary of actual executed trades:

Cash required to execute this transaction = Quantity * Cash Price of the stock
= 4000 * 55
= Rs 220,000

Note there is no amount required to sell future in the market as the margin required for the future is compensated by the stock purchased in cash.

Trade 1 is detailed in Table 5.1 and the profit in Trade 1 was:

Suzlon Profit in Cash Segment = (Sell Price – Buy Price) * Qty
= (54.10 – 53.75) * 4000
= Rs 1400

Suzlon Profit in Future Segment = (Sell Price – Buy Price) * Qty
= (54.25 – 53.95) * 4000
= Rs 1200

The profit in Trade 1 listed transaction is Rs 2600 and if we exclude the expenses of around Rs1000 then Net profit for this transaction is Rs 1600.

Table 5.1. Details of Trade 1

<table>
<thead>
<tr>
<th>Date</th>
<th>Stock</th>
<th>Buy Qty</th>
<th>Buy Price</th>
<th>Sell Qty</th>
<th>Sell Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/17/2010</td>
<td>Suzlon</td>
<td>4000</td>
<td>53.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/17/2010</td>
<td>Suzlon Future</td>
<td></td>
<td></td>
<td>4000</td>
<td>54.25</td>
</tr>
<tr>
<td>9/27/2010</td>
<td>Suzlon</td>
<td></td>
<td></td>
<td>4000</td>
<td>54.10</td>
</tr>
<tr>
<td>9/27/2010</td>
<td>Suzlon Future</td>
<td>4000</td>
<td>53.95</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Trade 2 is detailed in Table 5.2. Profit in Trade 2 was:

GMR Infra Profit in Cash Segment = (Sell Price – Buy Price) * Qty
= (56.6 - 57.45) * 4000
= Rs – 3400

Profit in Future Segment = (Sell Price – Buy Price) * Qty
= (57.95 – 56.85) * 4000
= Rs 4400
Table 5.2. Details of Trade 2

<table>
<thead>
<tr>
<th>Date</th>
<th>Stock</th>
<th>Buy Qty</th>
<th>Buy Price</th>
<th>Sell Qty</th>
<th>Sell Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/30/2010</td>
<td>GMR Infra</td>
<td>4000</td>
<td>57.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/30/2010</td>
<td>GMR Infra Future</td>
<td></td>
<td></td>
<td>4000</td>
<td>57.95</td>
</tr>
<tr>
<td>9/30/2010</td>
<td>GMR Infra</td>
<td></td>
<td></td>
<td>4000</td>
<td>56.6</td>
</tr>
<tr>
<td>9/30/2010</td>
<td>GMR Infra Future</td>
<td>4000</td>
<td>56.85</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

So the net profit of this trade = 4400-3400
= 1000

If we exclude the expenses of around Rs 400 then Net profit for this transaction is Rs 600.

Trade 3 is detailed in Table 5.3. Trade 3 is still in execution and on the expiry day i.e., 28 Oct’2010 it will make a profit of difference in prices i.e., \((54.55-54.05)\times 4000=2000\). After reducing the expenses the net profit will be around 1200.

Table 5.3. Details of Trade 3

<table>
<thead>
<tr>
<th>Date</th>
<th>Stock</th>
<th>Buy Qty</th>
<th>Buy Price</th>
<th>Sell Qty</th>
<th>Sell Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/1/2010</td>
<td>Suzlon</td>
<td>4000</td>
<td>54.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/1/2010</td>
<td>Suzlon Future</td>
<td></td>
<td></td>
<td>4000</td>
<td>54.55</td>
</tr>
</tbody>
</table>

So, the Net return on all transactions is Rs\((1600+600+1200)\)= Rs 3400 which is 1.6% of Rs 2, 22,000 i.e., invested amount in approximately 40 days (17 Sep’2010-Oct 28’2010). So we can assume that we can achieve 13-14% return annually using automated arbitrage trading.

A list of stocks with arbitrage opportunities in NSE and BSE on 21 Sept 2010 is shown in Figure 5.1.
**5 Stocks To Buy Now**

These 5 Stocks Offer You The Chance To Make 300%... 500%... Or More!

www.tpapublishinggroup.com

![CNBC-TV18 Matrix](image)

**Arbitrage Opportunities**

<table>
<thead>
<tr>
<th>NSE &gt; BSE</th>
<th>BSE &gt; NSE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Company Name</strong></td>
<td><strong>NSE Close</strong></td>
</tr>
<tr>
<td>Harita Sealing</td>
<td>104.55</td>
</tr>
<tr>
<td>Ramsons Ind</td>
<td>25.15</td>
</tr>
<tr>
<td>Bell Ceramics</td>
<td>26.70</td>
</tr>
<tr>
<td>Keynote Corp Se</td>
<td>58.85</td>
</tr>
<tr>
<td>Salora Inter</td>
<td>53.60</td>
</tr>
<tr>
<td>Manjeera Const</td>
<td>96.65</td>
</tr>
<tr>
<td>Hang Seng BSE</td>
<td>1,306.11</td>
</tr>
<tr>
<td>Khandwala Se</td>
<td>22.50</td>
</tr>
<tr>
<td>Sree Rajalaxmiem</td>
<td>53.10</td>
</tr>
<tr>
<td>Kirloskar Bros</td>
<td>204.20</td>
</tr>
<tr>
<td>Surana Ind</td>
<td>204.65</td>
</tr>
<tr>
<td>AVT Natural</td>
<td>50.15</td>
</tr>
<tr>
<td>Nagreekta Export</td>
<td>32.50</td>
</tr>
</tbody>
</table>

**Figure 5.1. Arbitrage opportunities in NSE and BSE on 21 September 2010.**
CHAPTER 6

CONCLUSION

Automating Arbitrate Trading aimed at developing software that is cost effective and can be useful to small traders to make money from arbitrage opportunities in the stock market. As there are similar products in the market but they are very expensive and only big Mutual fund houses can afford to buy them because they are managing billions of dollars. More importantly if we price this software at 10% of the value of existing softwares then I believe this product can be a big success. So the innovative idea of finding arbitrage opportunity using QTP automation tool has paid up because it is implemented keeping in mind its cost effectiveness and its performance as compared to other available tools in market. I believe it can serve as a big booster in earnings of small traders that only rely on manual arbitrage to make money. This software will save lot of time and money with improving the productivity that will help in better output.

Before final conclusion I would like to relate with Wall Street article that explains the effects of automated and algorithmic trading.

Wall Street Flash crash of May 6’2010 was caused by computer algorithms on Dow Jones This article is related to Algorithmic Trading concept which we have used in our thesis. The security and exchange commission (SEC) and the commodity futures trading commission (CFTC) released a report explaining the May 6’2010 crash of Dow Jones as Flash Crash caused by automated sell algorithm. It was triggered by a trading firm and as the Dow Jones Index started falling the other algorithms also started selling as the sell off triggered there criteria too which led to a crash. As this crash was not triggered by a fundamental factor or any news so this fall was bought in a few minutes. In further reports it specified that the cause was speculated to be caused by human error, high frequency traders, large directional bets, change in market structure or Technical glitches.

Also a sell algorithm is a computer program used for trading contracts. In the case of the crash on May 6, 2010, 75,000 E-mini contracts were sold in 20 minutes. The speed of the
transaction was caused by High Frequency Traders to sell their contracts and computer generated algorithms which look for a particular condition to generate a sell trigger [16].

So the above specified article is another application of computer generated algorithm. Also currently 70% of the trading in U.S is done by algorithmic trading.

Now here I would specify the benefits of Arbitrage trading using QTP:

1. It makes the execution of overall process faster as the execution of trades by machine is much faster than humans.
2. It reduces the overall effort to find arbitrage opportunities as QTP keeps on comparing prices every 30 seconds.
3. The overall return on investment is much more as it saves human time and money that automatically adds to more output in long term.

So by the pricing structure and all the features in this product I believe it can be a big success in the market. But if we add some more features in the future as explained below we can improve this product more efficient. Following is the modification suggested for the future development:

While looking for arbitrage opportunities we look for difference in cash and future segment to trade. According to survey conducted in the market there is software that is getting developed by Master Mart broking house in India for the same functionality that our software uses but with different parameters. They scan the buy sell order in pipeline to determine the average buy price by using the average weighted price and in the same way they scan the sell orders to determine the average sell price as above. In this way they determine the price differentials in buy and sell side and the order is executed when the required difference in the buy and sell side is achieved.

So we can say keeping in mind the feedback that we received from the industry people I believe we can add some more features that fulfill customer needs and launch in the market with a very competitive price so that small traders can take advantage of arbitrage opportunities.
CHAPTER 7

FUTURE RECOMMENDATIONS AND FEEDBACK

7.1 IMPROVEMENTS

Quick Test Professional is an efficient tool for automating web and desktop applications.

So to improve the performance of our existing software following steps can be taken:

1. We can develop the existing code in Java which according to the feedback is faster so the execution time will reduce and that will help in improving the performance.

2. While looking for arbitrage opportunities we look for difference in cash and future segment to trade. According to the survey from the market there are software’s that are getting developed in India for the same functionality that our software uses but with different parameters. It scans the buy sell order in pipeline to determine the average buy price by using the average weighted price and in the same way it scans the sell orders to determine the average sell price as above. In this way it determine the price differentials in buy and sell side and the order is executed when the required difference in the buy and sell side is achieved.

7.2 FEEDBACK

Girish Malhotra, Stock Broker gave the following feedback:

I am Girish Malhotra and I am working as stock broker of Ludhiana Stock Exchange. We do arbitrage in National Stock Exchange (NSE) and Bombay Stock Exchange (BSE) or vice versa. We need to be very careful while arbitraging, because there is sharp rise or decline sometimes in the price of stocks. We gazed the screen to find out difference between the two Exchanges (NSE, BSE). It is really tough Job. There is lot of stress sometimes. Then I came to know about the Software Automated Arbitrage trading using Quick Test Professional. It automatically trades that is the good point. By using this software there is less possibility of losses. It means it only trades when there is difference between the prices of particular stock. But we manually trade sometimes with anticipation or take some risk to do arbitrage. Therefore this is the limitation it trade only when it finds difference. When I was introduced to the Quick Test Professional and I was really amazed by its functioning as it could really pop up the difference of 1% or more I a fraction of second which human eye cannot detect that. I would say this software can simplify our job in many ways by reducing the effort and time, thus improving the productivity. According to my knowledge only the big mutual fund houses and large institutions use this kind of software to make big bucks so if this
product can be introduced in the market with relatively low price then it can be big success as currently there is no product like this in the market at affordable cost for the individual. I am looking forward for this product to go live in the market and benefiting from this. Overall I would say it was great experience from me to be a part of this.

Vishal Sharma, Associate Manager in Religare Securities of Feroze Gandhi Branch, gave the following feedback:

I am in the stock market from last 7 years and I manage over 600 clients. I am executing arbitrage trades from last 5 years. In the year of 2004-2005 it was high margin business as one could easily get 25-28% of annual return through arbitrage. As the time passes by this business became very popular and many traders came into this trading and as the time went by the arbitrage returns start reducing with margins began to shrink. The overall returns got reduced to 16-18% within a year. Currently we need to work very hard to grab this opportunity and to achieve this return as keep on scan the numbers every 10th sec to see if there is opportunity. So the overall situation is that returns are much less and difficult to achieve. Few months back I met Gaurav and he gave a demo of doing arbitrage trading using Quick Test Professional. I was really amazed by its performance as it could scan all the stocks on the screen in a fraction of seconds and most importantly I would not be missing any opportunity. So in all I would say if I use this software it would make my tedious job much relaxing reducing my effort to 20% of the current one. Also I can expect much better returns too. So I recommend that this software should be launched in the market with the competitive price and by adding some more features so that small traders can benefit from this and I am sure because of its uniqueness it can be a big success in the market.

I would specify the benefits of Arbitrage trading using Quick Test Professional as:

1. It speeds up the overall process as the trades are automatically executed so the execution is much faster as its automated.

2. It reduces the tediousness of the job as it does 80% of the human’s work automatically.

3. It improves the efficiency of the work as it does not leave any opportunity which human eye is not able to spot sometimes.

4. The overall return on investment is much more it saves human time and money that automatically adds to more output in long term.

5. If the pricing is effective then one trader can do three man hours work at the same time which could be a big boost to the business.
**BIBLIOGRAPHY**


APPENDIX

GLOSSARY
IPO – Initial Public Offering

**Cash Segment** – Cash segment is a segment where we buy or sell security for delivery.

**Future Segment** – Future segment is a segment where we buy and sell security by paying only some percentage of transaction cost called as margin and this buying and selling comes with an expiry date.

NSE – National Stock Exchange

BSE – Bombay Stock Exchange

**ODIN Diet** – It is a trading platform where the buy sell orders are executed.

**Arbitrage** – Arbitrage is the practice of identifying the price differential of the same entity in different platforms or markets and profiting from it.

**Cash Segment** – The segment where stocks are purchased for delivery and complete value of transaction is to be provided to exchange.

**Primary Market** – Primary market is basically where a company gets listed in an exchange through an Initial Public Offering (IPO).

**Quick Test Professional** – Quick Test Professional (QTP) is basically record and playback tool that records all the action that we do in the recording and plays that every time when we are testing the application.

Rs – Rupees (Indian Currency)