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Arbitrage in India: past, present and future

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1 Introduction

A central idea in modern finance is the *law of one price*. This states that in a competitive market, if two assets are equivalent from the point of view of risk and return, they should sell at the same price. If the price of the same asset is different in two markets, there will be operators who will buy in the market where the asset sells cheap and sell in the market where it is costly. This activity termed as *arbitrage*, involves the simultaneous purchase and sale of the same or essentially similar security in two different markets for advantageously different prices (Sharpe & Alexander 1990). The buying cheap and selling expensive continues till prices in the two markets reach an equilibrium. Hence, arbitrage helps to equalize prices and restore market efficiency.

Theoretical arbitrage requires no capital, entails no risk and appears to be an easy way of earning profits. However, real–world arbitrage calls for large outlay of capital, entails some risk and is a lot more complex than the textbook definition suggests. A major weak link in India's financial sector today is inadequate knowledge about arbitrage. This explains the low levels of financial capital deployed in it.

In this chapter we begin with a discussion on the theoretical concept of arbitrage. We then go on to discuss some existing arbitrage opportunities in India. We particularly focus on arbitrage across the spot and derivatives market and explain how these opportunities can be translated into profits. We also look at markets which could present potential arbitrage opportunities in the future. Finally we identify the risks associated with arbitrage and the factors which act as impediments to arbitrage in India.

2 The science of arbitrage

The origins of arbitrage pricing lie in the efficient market hypothesis (EMH). In this section we take a look at some literature on arbitrage and discuss the theory, operational aspects and impediments to arbitrage.

2.1 Efficient markets hypothesis

EMH states that the price of a security must be equal to the expected present value of the future cash flows on that security. In other words, it states that the price of a security must be equal to its fundamental value. The two central assumptions of the efficient market hypothesis are:

1. Investors hold rational expectations
2. Arbitrage brings prices towards fundamentals

In an efficient market there are no profitable arbitrage opportunities. Proponents of EMH (like Fama (1965) and Ross (2001)) maintain that rational arbitrageurs will undo any mispricings in the market, by buying underpriced securities and selling overpriced ones. Thus, arbitrageurs ensure that security prices converge to their fundamental values thereby restoring market efficiency. However, EMH assumes that arbitrage strategies are riskless and do not involve capital outlay. Hence professional arbitrageurs are willing to take unbounded positions in the market.

In reality however, arbitrage involves risk. An arbitrage strategy is risky even if rational traders care only about the final payoff of the arbitrage strategy. In other words, an arbitrage trade is riskless only if a perfect substitute for the mispriced asset exists. Arbitrageurs can rarely fully hedge their arbitrage strategies. Recent literature on the limits to arbitrage has identified two broad categories of risk: *fundamental risk* and *noise trader risk*.

An arbitrage strategy can be risky because the fundamental value of a partially hedged portfolio might change over time. Alternatively, the arbitrageur's model may often not coincide with the true data–generating process. Thus, arbitrageurs have to bear *fundamental risk* even if they can sustain the arbitrage strategy until the final payoff is realized. In addition to this, the activity of noise traders might lead to temporary price movements. These price changes temporarily reduce the value of the arbitrage portfolio as prices move even further from fundamental values. If arbitrageurs are compelled to liquidate their positions in the intermediate term, they are forced to take losses when the arbitrage opportunity is greatest. This is called the *noise trader risk*. In Shleifer & Vishny (1997), fund managers limit their arbitrage out of fear of a drawdown. Fund managers are afraid that investors will withdraw their money if they suffer intermediate short–term losses even though the arbitrage provides a riskless positive payoff in the long–run. This paper builds on the insight that distorted prices might become even more distorted in the short run before eventually returning to their normal long run values.

2.2 Impediments to arbitrage

In its purest form, arbitrage requires no capital and is riskfree (Dybvig & Ross 1992). By simultaneously selling and purchasing identical assets at different prices, the arbitrageur captures a profit with no upfront capital. Unfortunately, pure arbitrage exists only in perfect capital markets. In the real world, imperfect information and market frictions make arbitrage both capital intensive and risky. They impede arbitrage in two ways:

1. When there is uncertainty over the nature of an apparent mispricing, and additional learning involves a cost, arbitrageurs may be reluctant to incur the potentially large fixed costs of entering the business of exploiting the arbitrage opportunity (Merton 1987). Uncertainty over the distribution of arbitrage returns, especially over the mean, will deter arbitrage activity until would–be arbitrageurs learn enough about the distribution to decide whether the expected payoff from the arbitrage is large enough to cover the fixed costs of implementing arbitrage strategies. Even with active arbitrageurs, opportunities may persist while the arbitrageur learns how to exploit them.

2. Once the fixed costs of implementing the arbitrage strategy are borne, imperfect information and market frictions often encourage specialization. Specialization limits the degree of diversification in the arbitrageur's portfolio and causes him to bear idiosyncratic risks for which he must be rewarded.

   For instance, if there is a purely random chance that prices will not converge to fundamental value, a highly specialized arbitrageur who cannot diversify away this risk will invest less than one who can. Even if prices eventually converge to fundamental values, the path to convergence may be long and bumpy. While waiting for the prices of the mispriced securities to converge, they may temporarily diverge. If the arbitrageur does not have access to additional capital when the security prices diverge, he may be forced to prematurely unwind the position and incur a loss (DeLong et al. 1990, Shleifer & Summers 1990, Shleifer & Vishny 1997). This is a risk in arbitrage strategies that will limit the amount that a specialized arbitrageur is willing to invest.

2.3 Operational issues

In situations where it is possible to exploit mispricing risklessly by generating perfectly hedged positions and holding on to them till the final payoff, the following operational aspects need be noted before implementing arbitrage strategies:

1. For the arbitrage to be a risk–free process, the arbitrageur must trade *simultaneously* in two markets. In efficient markets, arbitrage opportunities last for very short periods. As arbitrageurs spot these opportunities and act upon them, the arbitrage gets wiped out. The fastest instances of arbitrage opportunities being wiped out, are those seen in the foreign exchange market. This market trades currency in large volumes, so what seems like a small mispricing can often translate into huge profits.

   Take the case of a trader at a trading terminal of a bank in Mumbai. He sees that Bank A quotes the US dollar at 48.55–60 (i.e. it will buy dollars at Rs.48.55 and sell dollars at Rs.48.60). At the same instant, Bank B offers a quote of 48.65–70 (i.e. it will buy dollars at Rs.48.65 and sell dollars at Rs.48.70). The trader spots an arbitrage

opportunity in two trades: he can buy dollars at 48.60 from Bank A and sell them at 48.65 to Bank B, making a profit of Rs.0.05 per dollar of trade.

However, prices on the foreign exchange market change continuously. He would face the risk of price movements, if he does not place the trades simultaneously. We assume that he places the orders with a small lag, i.e. he first buys dollars at Rs.48.60 from Bank A and a few seconds later, sells them at Bank B. However when he approaches Bank B, he realizes that in those few seconds, Bank B has revised its quotes to 48.50–55. The arbitrage has already been wiped out. He is now stuck with dollars bought at Rs.48.60 and faces the risk of a further loss on the transaction.

2. All trading involves transactions costs. These transactions costs and other market imperfections create a no–arbitrage band around the fair value of an asset. Hence the arbitrage opportunity must be sizeable enough to generate a profit over and above the costs involved. Not all mispricings are profitable arbitrage opportunities.

   Consider the case of hike in onion prices seen in India a few years ago. Onions traded at about Rs.60,000/ton in Delhi and at Rs.58,000/ton in Nashik. An arbitrageur could have earned a profit of Rs.2,000/ton by buying onions in Nashik and selling them in Delhi. However the potential returns net of transportation costs and other overheads were clearly not attractive enough for arbitrageurs to step in.

3 History of arbitrage in India

Arbitrage is not a new concept in India. Although the level of activity was not significant, market players have engaged in inter–market arbitrage for a long time.

3.1 Line operators (Inter city)

In India, we've had over a decade of experience with multiple stock exchanges and line operators arbitraging between these markets. This has been a fairly well accepted idea. These arbitrageurs mostly operated between Bombay, Ahmedabad, Calcutta and Delhi. They used telephone

lines and PTI screens to locate the difference in prices. The main centers for arbitrage though were Bombay and Calcutta. Here is how the arbitrage happened.

There were brokers who either had cards on both the exchanges, or alliances with members of the other exchanges. By calling up the other exchange, the rates for a stock (for example, Reliance or ACC) were determined. Typically, the difference in prices across exchanges would be about one to two percent. The stock would be purchased on the exchange where it quoted at a cheaper price and sold on the exchange where it traded at a higher price. The settlement cycles of the exchanges were different so the delivery that was received from one exchange could be given to the other exchange. If there was short delivery, the transaction would be carried forward.

However, these operators suffered risks of settlement due to movement of stocks and funds across the country. The stocks had to be moved in the physical form between the two markets and, amongst other risks, there was the risk of *bad delivery*. Due to the high risk involved in this operation, the returns were also high, with the activity limited to a few brokerage houses.

3.2 NSE–BSE (Intra–city manual traders)

In the mid 90's, the National Stock Exchange (NSE) and the Bombay Stock Exchange (BSE) went electronic and moved over to screen based trading. The period witnessed huge volumes due to arbitrage between these exchanges. The arbitrage process involved two people working as pairs. The pairs concentrated on one or two scrips at a time. This process generated high returns, typically around 1–1.5 percent per week. Here is how the arbitrage worked.

The settlement cycle at NSE was Wednesday to Tuesday and that at BSE was Monday to Friday. Positions could be built up during the entire week, and unwound on the last day. The residual or the portion that was not unwound would go for delivery. Since most of the traders did not have the funds or stocks to take or give delivery, there would be a mad scramble to square off the transactions on Tuesday and on Friday, the last date of settlement on the NSE and the BSE, respectively. During a typical week, traders would mostly have buy positions which they would want to square off at the end of the cycle. This would result in depressed prices at NSE.

At the same time, the trader would want to maintain the buy position, so he would buy the same stock on the BSE. This would result in inflated prices on the BSE. The gap in prices of the same stock across NSE and BSE would be between half percent to two percent.

The arbitrageur would now enter the scene. He would buy the stock where it traded cheap, i.e. on the NSE, and sell it where it was more expensive, i.e. on the BSE. On Wednesday, the arbitrageur would sell it on the NSE and buy the same stock on the BSE for a modest return. The effect of this trade was that the long position was squared off on the BSE and no cross delivery of stock was required. (This mattered because of *bad* delivery problems which were rampant then). On Friday the entire process was repeated: the arbitrageur bought stocks on the BSE and sold them on the NSE. On Monday, he would again buy at NSE and sell at BSE. Table 4.1 shows the cycle as it typically happened. The net returns in a week would be between one to three percent.

Table 4.1 BSE–NSE arbitrage trades

Trading days	NSE	BSE
Tuesday	Buy Reliance	Sell Reliance
Wednesday	Sell Reliance	Buy Reliance
Friday	Sell ACC	Buy ACC
Monday	Buy ACC	Sell ACC

Initially, the returns on the arbitrage across NSE and BSE were very high. These returns attracted more participants. Competition led to more humans and capital being deployed into arbitrage. As the number of players in the game increased, the arbitrage was gradually wiped away and returns fell. The arbitrage activity across NSE and BSE is a classic example of how arbitrage helps to restore market efficiency.

With rolling settlement, this activity has lost its charm and the returns are very poor. In the absence of a weekly settlement period, only intra day arbitrage is possible. Sometimes the difference at the end of day is around one percent. The difficulty in arbitrage lies in competition. When NSE first began its operations, the differences in prices between NSE and BSE were embarrassingly large – price differences as large as Rs.10 were occasionally seen on Reliance at a base price of Rs.300. Today, it is rare to earn more than Rs.0.25 on Reliance. This has happened because many now understand the tricks of the trade for the NSE/BSE arbitrage, and the

competition has eliminated the best opportunities. The game is now poised to shift to a higher and different level. The arbitrageurs who were previously employed in this field have started to look at new areas where they can deploy their existing domain knowledge.

4 Existing arbitrage opportunities

The launch of the equity derivative markets in India has given rise to a whole new world of arbitrage. Multiple products with the same underlying asset are now available for trading. Mispricings across the spot, futures and options markets can led to profitable arbitrage opportunities.

4.1 Nifty spot – Nifty futures

By definition, a derivative is derived from some underlying. The Nifty futures are derived from Nifty. It is the *cost of carry* that binds the value of the Nifty futures to the underlying Nifty portfolio. When the two go out of sync, there are arbitrage opportunities.

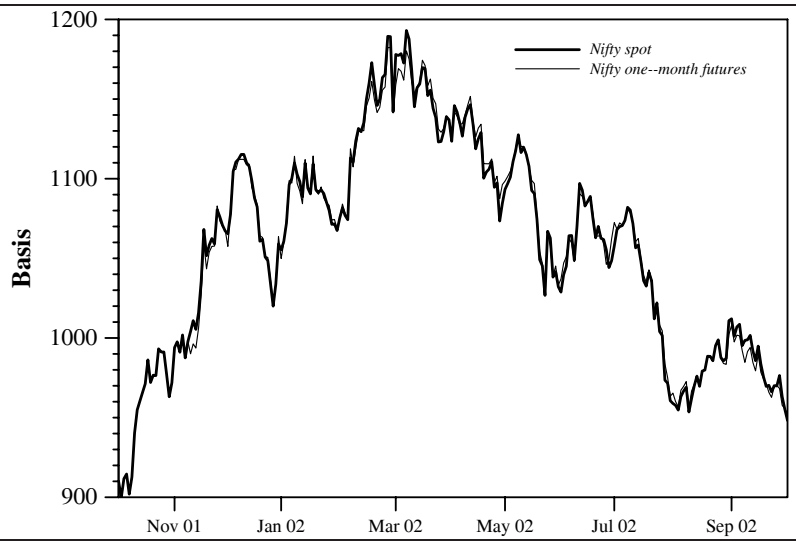
There are several ways to arbitrage between the cash and the index futures market. The cost–of–carry binds the futures price to the price of the underlying asset. The price of Nifty futures at any given instance should typically be more than the level of Nifty at that point. Investors identify arbitrage opportunities by watching the difference between the spot and the futures price. This is called the basis. Theoretically, the fair value of Nifty futures is equal to the level of Nifty plus the cost of carry, which is roughly one percent for one–month futures contract. In other words, typically the basis must be negative. When the basis turns positive, arbitrageurs can exploit this opportunity by buying the underpriced index futures and selling the index portfolio comprising 50 index stocks. The cash received upon the sale is reinvested at the risk–free rate of return till the expiration of the futures contract. This is called *reverse cash and carry*. The arbitrage profits come in at the expiration of the futures contract when the position is unwound by buying back the 50 index stocks.

Reverse cash and carry is done when the futures are underpriced, i.e. when the observed basis is less than the fair basis. Overpriced futures also result in arbitrage. This is called *cash and carry* arbitrage. It involves buying the underlying index portfolio and selling the overpriced futures.

At maturity of the futures contract, the spot and futures prices converge. This is when the arbitrage profits come in.

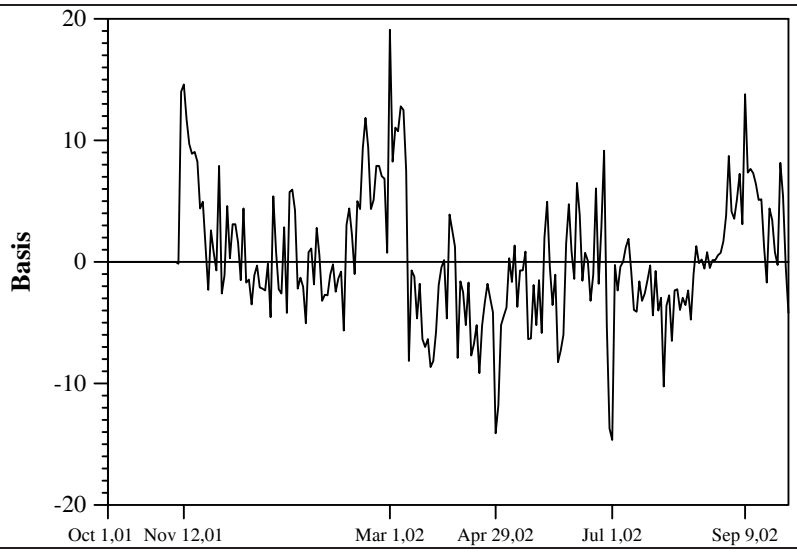
Figure 4.1 shows the movements in the Nifty spot and one–month futures. For almost all of March, April and September 2002, the futures traded at a discount to the spot. For investors holding a well diversified portfolio, this was an ideal opportunity for a *reverse cash and carry*. Figure 4.2 shows how the the basis for the one–month Nifty futures contract has been widening and narrowing over time. Over a period of two months, beginning March 2002, the basis went from being large and positive (19.10 percent on 1st March 2002), to being large and negative (-14.10 percent on April 2002). Fluctuations in the basis enable continuous arbitrage.

Figure 4.1 Movements in the Nifty spot and futures



Cash and carry and *reverse cash and carry* can also be implemented across stock futures and the underlying stock when the futures move away from their fair values. Figure 4.3 shows the change in basis for the one–month Infosys futures over the last one year. It also gives an idea about the kind of returns that can be obtained on arbitrage in India in recent times. In absolute terms, the basis was maximum on 19th November 2001 (-57.65). Executing *reverse cash and carry* at this point would have resulted in a return of 79.29 percent. A steep drop in basis was seen in September 2002.

Figure 4.2 Basis for Nifty



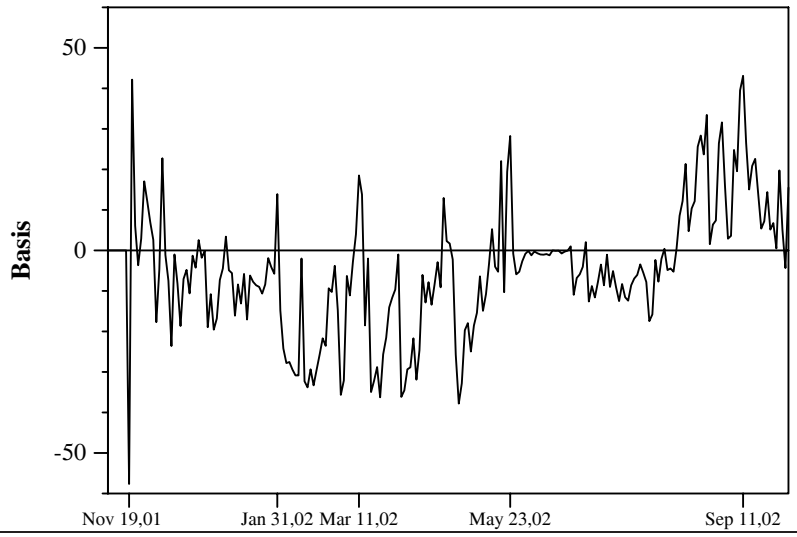
Entering into a *cash and carry* position on the 11th September could have generated a return of 86 percent.

The most inexplicable thing about the index futures market in India so far, is the lack of a clear relationship between the cost of carry on the index futures market and *normal* interest rates in the economy. This suggests that speculators and hedgers now dominate the ecosystem, and that arbitrageurs have not yet understood how to trade on this new market. The most common pricing error observed is very low futures prices. This suggests that the mutual funds have not yet figured out how to do *reverse cash and carry arbitrage*. This is an extremely simple trading strategy, which is like a *stock repo*. The index is sold off today and bought back at a locked–in price at a future date. The funds are deployed into the fixed income market. The fact that these opportunities have not been exploited shows that arbitrage knowledge and expertise is as yet unavailable in India's mutual fund industry.

4.2 Nifty futures – SGX

In September 2000, Nifty futures started trading in Singapore. While the trading activity in Singapore has been erratic, there have been times when the trading volumes and open interest for the Nifty futures contract trading

Figure 4.3 Basis for Infosys



in Singapore were higher than those on the NSE. In an ideal world, there could exist arbitrage opportunities across these markets. For example, if the Nifty futures trading on the the SGX were quoted at a price lower than those on the NSE, a global arbitrage firm could easily capture the opportunity by trading on both these markets simultaneously, buying Nifty futures on the SGX and selling them on NSE. The arbitrage profits would come in on the last day of trading of the contracts, when the Nifty futures price on both these markets would converge to the Nifty spot price, or the Nifty index level. A note of caution however, the contract size on the Singapore market is roughly five times larger than that on NSE, and the NSE contract is roughly 30 percent larger than that on BSE. Hence comparisons of the *number* of contracts traded or *number* of contracts outstanding often gives a misleading picture.

Three exchanges compete in the index futures market – NSE, SGX and BSE. However, NSE holds roughly 90 percent of the market share. It would be possible for Indian players to arbitrage across these different markets, buying futures where they trade cheap and selling them where they trade expensive. To enable this, we will have to have convertibility on the capital account. A number of issues like transaction costs, forex exposure, availability of capital, different settlement cycles etc., prevent this from happening at the moment.

Box 4.1: Commission arbitrage in Japan

In a keynote address given at the Fourth Annual Pacific–Basin Capital Market Research Conference, Merton Miller spoke of the commission arbitrage that existed in Japan after the launch of cash–settled stock index futures contracts in 1988. As the share prices declined in 1989, the Japanese Ministry of Finance worried that the foreign arbitrageurs had something to do with it. But strangely enough, the foreign arbitrageurs were *buying* shares and selling futures. The MOF had an informal agreement with the foreign arbitrageurs that they would keep rolling over those positions – a policy that the foreign firms were most happy to follow. The MOF just couldn't figure out how the arbitrageurs were making money in a falling market. When the MOF consulted their own academic experts, there were told that the arbitrageurs made money by exploiting small differences in prices between the two markets. A small difference between the Tokyo spot prices and Osaka futures prices didn't seem to be a good enough explanation for the millions of dollars in profits that were being taken out of Japan's capital markets month after month.

MOF's thrashing around to explain the huge arbitrage profits being sucked out of the market by foreigners was like the story of a farmer who rode up to the customs toll booth at the Dutch border carrying a bag of sand in the basket on his bicycle. The first day he did this, the customs officers stopped him, checked his bag and let him cross. The next week he did the same thing. They emptied and checked his bag of sand and found nothing suspicious. He kept doing this for a long time till the Dutch customs officers could stand it no more. They told him that they *knew* he was smuggling something, and promised him immunity if he told them what it was. "Its obvious", the farmer answered. "I'm smuggling bicycles!."

What was happening in the Japanese market was similar. It took a while for the MOF to realize that the foreign firms were arbitraging commissions. Brokerage commissions on common stocks are usually higher than those on index futures on all markets. However, in Japan, the cost to the customer for establishing or adjusting a diversified portfolio of equities was thirty to forty times higher than the futures. This was a high cost to outside customers, but not for any foreign arbitrage firm with a membership on the Tokyo Stock Exchange. Members could buy stocks directly without paying commissions, and then hedge by selling futures to Japanese investors. The futures contracts though quoted at a substantial premium to theoretical value, were still preferable over doing direct stock purchases at full retail commissions! The Japanese Ministry of Finance finally figured this out by 1992 and reacted by taking frantic measures to counter this back door under-cutting of its retail commission structure.

4.3 Spot – Futures – Options

The launch of options on the equity derivatives markets in India has seen the growth of a new area for arbitrage in the equity markets. Arbitrage strategies can now be created between the spot, futures and options market. Using options one can create synthetic futures, which can be compared to the prevailing futures. The synthetic futures can also be used in any of the thirty stocks where options are allowed. Let us see how we can accomplish this on the index derivatives market.

The peculiar symptom found on this market so far is extremely low futures prices coupled with reasonably fair Black/Scholes option prices. Everybody is keen to know how to exploit these extremely cheap index futures. We have already discussed one way to do this, i.e. *reverse cash and carry* – sell shares, buy them back at a future date, and deploy the money raised through sale of shares in the money market.

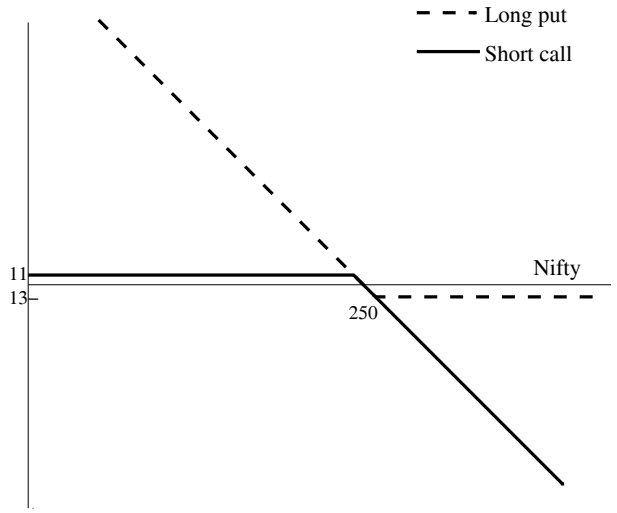
In order to do *reverse cash and carry* one would need to have the underlying index shares. While we wait for arbitrageurs who have the shares to wake up and do this, let us look at a strategy by which we can exploit the underpriced futures without having the underlying portfolio. Suppose call and put options on the index are available at fair prices. They can be used in arbitrage. The futures trade cheap, so buy futures. Hedge using a synthetic futures contract. This can be generated by selling a call option and buying a put option. Figure 4.4 shows a synthetically generated short futures position.

This hedge eliminates price risk. Let us have a closer look at how this strategy works. To generate the risk–free 'long futures + synthetic short futures' position, we need to: buy futures, buy put options and sell call options. Our initial investment would work out as follows:

$$
\begin{aligned}
\text{Initial investment} &= M_1 + M_2 + (P - C) \\
\text{where } M_1 &= \text{Margin paid on long futures position} \\
M_2 &= \text{Margin paid on short call} \\
P &= \text{Premium paid for put option bought} \\
\text{and } C &= \text{Premium received on call option sold}
\end{aligned}
$$

Figure 4.4 Payoff of synthetic short futures position

The figure shows the payoff for a synthetically created short futures position. This position is created by selling a call option with a strike 250 at a premium of Rs.11, and buying a put option with the same strike at a premium of Rs.13. The cost of setting up this position works out to be Rs.2.



Assuming that margins are paid purely in interest–free cash, the riskfree return that we get on this strategy works out as follows:

$$\begin{aligned}
\text{Riskfree return} &= (S-F)+(X-S)+M_1+M_2 \\
\text{where } S &= \text{Spot price of index(index level)} \\
F &= \text{Index futures buy price} \\
X &= \text{Strike price of the call and put options} \\
M_1 &= \text{Margin paid on long futures position} \\
\text{and } M_2 &= \text{Margin paid on short call}
\end{aligned}$$

So the percentage return obtained on the deal is:

$$\begin{aligned}
\text{Percentage return} &= \frac{\text{Riskfree return}}{\text{Initial investment}} \times 100 \\
&= \frac{(S-F)+(X-S)+M_1+M_2}{M_1+M_2+(P-C)} \times 100
\end{aligned}$$

Let us work the same example with some numbers.

$$
\begin{aligned}
S &= 1100 \\
F &= 1100 \text{ (zero basis, this happens quite often)} \\
(X - S) &= 0 \text{ (i.e. we are dealing with ATM options)} \\
M_1 &= 150 \\
M_2 &= 150 \\
T &= \frac{2}{12} \\
C &= 56 \\
P &= 34 \text{ (Options are Black/Scholes prices)} \\
\text{and } r &= 0 \text{ (i.e. margin paid in cash)}
\end{aligned}
$$

Box 4.2: Role of arbitrageurs in the market

The S&P index futures contracts introduced by the Chicago Mercantile Exchange in 1982 were a success from the very beginning. Within three years, the share–equivalent volumes on the Chicago Mercantile Exchange (CME) surpassed the the volumes on the New York Stock Exchange (NYSE). Clearly, the market seemed to love the futures contracts. However, they faced a strong opposition from the brokerage community who believed that the futures market had caused a diversion in their business. "Index arbitrageurs" and "program traders" were the villains in the game. John Dingell, whose committee was then the overseer for the Securities and Exchange Commission (SEC) which regulated the stock and options markets but *not* the futures markets, was a follower of the anti–arbitrage movement. On one occasion when an academic witness before his committee expressed his opinion that arbitrageurs too played a role and hence had a place in the market, he is known to have remarked – "Yes. About the same place as cockroaches in a kitchen"!
Over the years, economic logic and empirical research have conclusively found index arbitrage not guilty of increasing market volatility or of causing market crashes. The two equal and off–setting legs of an inter-market arbitrage move the cash index and the futures price closer together and help in the price discovery mechanism. Arbitrageurs do not and cannot effect the net level of share prices in the market.

If this be the case, we make an initial investment of Rs.278 (i.e.300+34-56) and towards the end, we get back Rs.300, the margin money we put in. This is a return of 7.9 percent in two months, or 58 percent annualized.

A few points to note – the margin money that we put in, namely $M_1 + M_2$, is fixed. This capital goes in at entry and comes back at exit. So the arbitrage trick is really about comparing $[(S - F) + (X - S)]$ versus $(P - C)$. The capital invested depends on $(P - C)$ – this should be as small as possible. The riskfree return at expiration depends on $[(S-F)+(X-S)]$ which should be as large as possible. An electronic arbitrage system would be able to constantly scan all strikes, all expirations looking for favorable situations. The futures are quite liquid and won't be a bottleneck. However, at the moment, the options market has fairly wide spreads, so we would need to carefully look at the execution obtained on the options leg. As knowledge and expertise on the options market improves, there will be more people exploiting this arbitrage which would in turn bring the low basis to normal.

4.4 Dividend arbitrage

Around dividend declaration time, the stock options market can sometimes pose a profitable arbitrage opportunity. Let us look at how this works.

We know that the stock price should decline by the dividend amount when the stock goes ex–dividend. In the following tables, we illustrate dividend arbitrage using the spot and options market on Reliance.

Table 4.2 Details of Reliance stock and puts

Particulars	(Rs.)
Reliance price	238
Reliance 240 put option premium	9
Next dividend net of tax	4.75

Reliance has declared a dividend of 47.50 percent for the year. Assume that on 22nd October, just prior to the ex–dividend date, the stock trades at Rs.238. 31st October 240 puts trade at Rs.9. When the stock goes ex–dividend, the price of Reliance should drop by Rs.4.75 to Rs.233.25. Puts will now be worth at least Rs.6.75 (in addition to any remaining time value). A trader could exploit this situation by buying the stock and buying put options at Rs.9. Table 4.3 gives the traders position *before* the stock

goes ex–dividend and Table 4.4 gives his position *after* the stock goes ex–dividend.

Table 4.3 Position of trader on Reliance before the stock goes ex–dividend

Position	(Rs.)
Long Reliance	238
Long Reliance 240 Put option	9
Total outlay	247

Table 4.4 Position of trader on Reliance after the stock goes ex–dividend

Position	(Rs.)
Long Reliance	233.25
Long Reliance 240 Put option	11.25
Dividend received	4.75

After the stock goes ex–dividend, he sells the put option and the stock. He has received a dividend of Rs.4.75. Thus his total revenue works out to be Rs.249.25. Table 4.5 gives the cashflows from his transactions. He makes arbitrage profit of Rs.2.25 on the initial outlay of Rs.247. This works out to a return of nearly one percent over one day.

Table 4.5 Cashflows of dividend arbitrage

Activity	(Rs.)
Buys Reliance	(238)
Buys Reliance Puts	(9)
Sells Reliance	233.25
Receives dividends	4.75
Sells ABC puts	11.25
Total Profit	2.25

5 Potential arbitrage opportunities

5.1 Index – Exchange Traded Funds

Exchange traded funds (ETFs) are innovative mutual fund products that provide exposure to an index or a basket of securities that trades on the exchange like a single stock. They have a number of advantages over traditional open–ended funds as they can be bought and sold on the exchange

at prices that are usually close to the actual intra–day NAV of the scheme. They are an innovation to traditional mutual funds as they provide investors with a fund that closely tracks the performance of an index with the ability to buy/sell on an intra–day basis. Unlike listed closed–ended funds that trade at substantial premia or more frequently at discounts to NAV, ETFs are structured in a manner which allows to create new units and redeem outstanding units directly with the fund, thereby ensuring that ETFs trade close to their actual NAVs.

ETF's came into existence in the US in 1993. Over $70 billion is invested in the ETF market today. They have gained prominence over the last few years with over $100 billion invested as of end 2001 in about 200 ETFs globally. About 60 percent of trading volumes on the American stock exchanges are from ETFs. Among the popular ones are **SPDRs** (Spiders) based on the S&P 500 Index, **QQQs** (Cubes) based on the Nasdaq-100 Index, **iSHARES** based on MSI Indices and **TRAHK** (Tracks) based on the Hang Seng Index. Since the product underlying them is the same, i.e., the index portfolio, this permits arbitrage between spot, futures and ETF's. The same position can then be rolled over from one product to another in order to maximize profits. All this requires robust IT systems and trained man power. The human arbitrageur will find himself hopelessly out of depth if he has to continuously monitor a number of parameters.

At the moment however, both the index fund and the ETF market in India is very young. We have a long way to go before arbitrageurs can actively enter this market and make profits. But nonetheless it is a potentially promising market. The first ETF in India, "Nifty BeES" (Nifty Benchmark Exchange Traded Scheme) based on S&P CNX Nifty, was launched in December 2001 by Benchmark Mutual Fund. It can be bought and sold like any other stock on NSE and has all characteristics of an index fund.

5.2 ADR/GDR – underlying shares

In February 2001, the government allowed two–way fungibility of global depository receipts (GDRs) or American Depository Receipts (ADRs). It took a full year for Reserve Bank of India to come out with guidelines on this issue. On August 5th 2002, the first two–way fungibility deal was struck in India. With fungibility now functional, it opens new opportunities for arbitrage in the global equity arena.

In two–way fungibility, depository receipts can be converted into underlying domestic shares and local shares can be re–converted into depository receipts. The depository receipts could either be ADRs or GDRs. GDRs are listed on the London or the Luxembourg stock exchange, while ADRs are listed on the US exchanges like the NYSE or the Nasdaq. Since every GDR/ADR has a given number of underlying shares, the number of shares qualifying for re–conversion into GDRs/ADRs is limited to the number of shares which were converted into local shares.

How can two–way fungibility help exploit equity arbitrage opportunities? Say, for instance, that the ADR/GDR price is at a discount to the price of the underlying share. Converting the ADR/GDRs into the underlying shares can now result in a gain. If the ADR/GDR price is at a premium to the price of the underlying shares, then it makes sense to re–convert the underlying shares into depository receipts. All this is subject to headroom or the availability of shares for re–conversion.

Say, for example, that a particular company has issued 10 million ADRs with one underlying share per ADR. Two million ADRs have been re–converted into local shares. The outstanding number of ADRs are now 8 million. However, the two million ADRs, which were cancelled and converted to shares in the domestic market, can be re–converted to ADRs. Two–way fungibility is the first step towards a truly global equity market for Indian equity. The final step would be a free flow of equities between domestic and oversees exchanges.

5.3 Globally listed stocks

With the globalisation of capital markets, increasing number of companies over the world have chosen to raise capital through global equity issues or are in the process for raising future capital by way of cross–listings on foreign exchanges. The cross–listings on exchanges across the world has opened new avenues for arbitrage. Table 4.6 summaries findings on arbitrage opportunities in multiple listed stocks.

Just as Indian stocks get listed overseas, in the future, we will find foreign companies seeking listings in India. This will allow arbitrage between the two markets. This arbitrage could begin as a manual process, but overtime this process will inevitably be automated. Issues of FERA, settlement and counterparty risk will have to be addressed. When we move to cap-

ital account convertibility, Indian brokerage houses will have the option of starting overseas operations which will enable them to arbitrage in the international markets.

5.4 Quantitative trading

The world of quantitative trading is enveloped in secrecy with few having access to it. Unlike fundamental analysis, which relies largely on subjective or qualitative data (such as the skill of a company's management), quantitative trading is based on the study of the company (or a sector) using quantifiable data. Key ratios such as price–to–sales, along with average analyst rankings are used for shortlisting stocks. A quantitative analysis model might also throw in economic data, or compare how interest rates have affected a particular company or its sector in the past. These techniques aim to capture the massive amounts of financial information flowing through our systems on a daily basis, analyzing and transforming it to develop a disciplined, rigorous approach to portfolio investing. Quantitative techniques apply the latest tools and techniques in investment management and information technology to identify and exploit arbitrage arising out of mispriced securities.

Brokerages and institutions have used quantitative modeling for years. There has always been a mystique surrounding it. The actual inputs into the model tend to be closely guarded secrets. The models have been called black boxes, while the models' programmers have often been dubbed "quants" or "rocket scientists", and kept holed up in back rooms. With the rapidly increasing availability of online information and growing computational power, quantitative trading is already a significant phenomenon globally.

6 Risks in arbitrage in India

The basic principles of an arbitrage strategy are straightforward – if an asset trades at two different prices across two markets, buy where it trades cheap and sell where it trades expensive. This textbook arbitrage assumes a frictionless world where arbitrage profits can be made without putting up capital and without bearing any risk. In reality however, almost all arbitrage requires capital and carries some risk.

Table 4.6 Arbitrage opportunities on cross–listed stocks

Study	Sample	Findings
Eun & Sabherwal (2001)	Canadian stocks listed in US	Arbitrage leading to price–discovery
Ding et al. (1999)	Stocks listed in Malaysia and Singapore	Significant price discovery in both markets
Ben-Zion et al. (1996)	five Israeli stocks listed on the Tel Aviv stock exchange and US OTC market	Arbitrage opportunities are generally not available
Domowitz et al. (1995)	four Mexican firm stocks listed also as US ADRs	The average return in both markets are very similar, suggesting existence of arbitrage
Froot & Dabora (1995)	three Siamese twin stocks, multiple listed on the NYSE and the LSE	Each company's stock obeys the law of one price indicating the existence of cross–border arbitrage
Pagano & Roell (1993)	16 stocks dually listed on London's SEAQ-I and the Paris Bourse	Markets are perfectly arbitraged: in a sample of 380 perfectly time matched observations, not a single unexploited arbitrage opportunity was found.
Kato et al. (1991)	23 stocks listed in England, Japan and Australia and also as US ADRs	No arbitrage opportunities
Jorion & Schwartz (1986)	98 Canadian stocks multiple listed on various US markets	Few arbitrage opportunities

Shleifer & Vishny (1997) argue that the textbook notion of arbitrage does not describe realistic arbitrage trades. These discrepancies become particularly important when arbitrageurs manage other people's money. In India, the risks become even more pronounced due to existing market frictions. In this section we look at some of the risks associated with arbitrage.

6.1 Execution lags

In the ideal world, trades placed to capture an arbitrage opportunity would be instantaneously executed. However, in the real world, execution takes time. Very often, there can be variations in price between the time an arbitrage opportunity is entered into and the time the trade is actually executed on the market.

Take, for instance, the *reverse–cash–and–carry* index arbitrage. This involves buying the underpriced index futures and selling the overpriced index basket. Typically, the futures market is more liquid than the spot and hence the trade on the futures market would get executed instantly. However, the trades involving the selling of the index basket on the cash market may not happen instantly. There could be a slow down or halt in trading due to illiquidity or market congestion.

This slippage naturally increases when markets are volatile. A highly volatile market would result in the index stocks being traded at different levels of the index. Hence, there is always some risk that the cash and futures legs of the arbitrage strategy may not be executed simultaneously. The risk is compounded when the arbitrageur starts *legging*, that is when he starts taking a view on the market in an effort to maximize the returns.

6.2 Interest rate uncertainty

An arbitrageur who enters into an arbitrage trade assumes that a particular level of interest rate will remain constant. In the *cash–and–carry* strategy, the arbitrageur assumes that he will be able to borrow at a certain rate till the expiration of the futures contract. Similarly, in the *reverse–cash–and–carry* strategy, he assumes that he will be able to invest the proceeds from the sale of stocks at a particular rate of interest. However, the uncertainty about the interest rate that will be charged on the capital that is deployed and the returns that would be generated from the free funds deployed in the

money market, have a direct bearing on the profits generated from arbitrage positions undertaken.

6.3 Trading restrictions

When the markets are very volatile, the stock exchange imposes a *circuit breaker* on the stocks. On NSE's market, whenever the index moves by 10, 15 or 20 percent in one day, NSE's rule number 26528-6-2001 comes into play which halts trading. These trading halts are coordinated by SEBI. At this point all trading on the exchange is stopped. The exchange allows the markets to process all the relevant information and come to an equilibrium. A halt in trading can result in a loss for an index arbitrageur who, as a part of his arbitrage strategy, is in the process of buying or selling the index stocks.

7 Impediments to arbitrage in India

7.1 Short sales constraints

Stock index futures normally trade at a premium to the cash index. The appearance of a discount sends a strong signal that the futures may be underpriced. When a stock index futures price is considered low relative to the stock index, arbitrageurs buy futures and short the stocks in the index. A high futures price triggers the reverse program, to short the futures and buy the stocks in the index. When one shorts the stock it is required that shares be available for delivery on the settlement date. If one does not have the shares, a strong borrowing/lending mechanism should allow for delivery using borrowed shares. This is absent in India at the moment. This makes *reverse cash and carry* difficult.

Moreover, when intra–day arbitrageurs forcibly close down their position in the evening, they further force the futures into large discount. To strengthen arbitrage in the equity futures market, proper lending/borrowing mechanism should be evolved which can help in reducing the arbitrage gap.

7.2 Lack of liquidity and depth in the spot market

Index arbitrage involves the buying or selling of all the index stocks in the cash market. This can be done by placing program trades. Although

the constituent stocks of most indexes are typically liquid, liquidity differs across stocks. Due to the heterogeneity in liquidity in the capital market segment, trades on this segment do not get implemented instantly. This often makes arbitrage expensive, risky and difficult to implement.

- Many stocks within an index have small share price values. When purchasing an index, the goal is to obtain a Rupee amount of investment. Small price stocks require more individual shares to be purchased for a given Rupee value of index exposure. This increases the execution costs.
- The mandate to buy all stocks within the index creates an inefficient pool of stocks, because some stocks in an index are less liquid than others. Stocks with less liquidity create higher invisible trading costs (bid–ask spreads).

7.3 Capital intensive nature of arbitrage

Real–world arbitrage requires putting up substantial capital for a short period of time. Take the case of *cash and carry arbitrage*. In order to capture the mispricing, the arbitrageur sells the overpriced futures, buys the underlying stocks and holds them till the maturity of the futures contract. Buying the underlying stock requires significant amount of capital. Very often, it is not possible for the arbitrageur to take delivery and hold stocks, due to the lack of capital. Hence, small arbitrageurs are forced into intra-day arbitrage.

Arbitrage hinges on capturing profits due to mispricing on the market. The underlying assumptions is that, the mispricing will be wiped out, at some stage, and prices will return to their fair value. This is when the arbitrageur receives his profits. However it may often happen that prices do not correct themselves immediately. There could be situations where the mispricing worsens, in which case the arbitrageur would be required to bring in more capital for margins. Even if, the prices of the two contracts converge eventually and the arbitrageur makes money, he loses money, in the short run, and needs more capital. Arbitrageurs face difficulties in raising funds at short notice. Very often, an arbitrage strategy that is entered into is reversed before the end of the contract. This is known as *early unwind*.

7.4 Anomalies in regulation and taxation of arbitrage trades

In India, from the regulatory and taxation point of view, trades undertaken to exploit arbitrage are still regarded as speculative trades. This increases transactions cost on arbitrage and impedes the development of arbitrage in India.

7.5 Absence of hedge funds

Hedge funds are among the most active participants in the arbitrage game. Most hedge funds have schemes which involve engaging in purely arbitrage transactions. In the absence of proper hedge funds regulations in India, there is very little hedge fund activity in India.

7.6 Inadequate IT infrastructure

Capturing an arbitrage opportunity involves following prices in two markets and entering into trades simultaneously on both these markets. Successful arbitrage depends on obtaining the correct prices across the two market and trading accordingly. Due to the lack of adequate IT infrastructure, prices from various agencies are often received with a time lag. The delay can sometimes be as long as 30 seconds. This implies that what may appear like a potential arbitrage opportunity at time T may actually have existed at time $(T - t)$ and may or may not exist anymore. Proper decision support systems will help to correctly identify and exploit arbitrage across markets.

7.7 Lack of knowledge

Arbitrage requires an understanding of the price mechanisms across markets. Most market players in India are not yet comfortable with trading on the derivatives market. Even those acquainted with derivatives market do not understand the intricacies of arbitrage. This lack of knowledge results in sustained mispricings on the market.

8 Conclusion

Arbitrage is a fascinating process. Theoretically, an arbitrage opportunity is like money lying on the road waiting to be picked. The trick of the trade is in being able to spot the opportunity quickly.

Besides an understanding of the markets, the processes and the risks involved, exploiting arbitrage also requires capital and infrastructure. In some markets, it is possible to detect and capture arbitrage profits manually. The execution of an arbitrage trade today is fairly simple. However, as derivatives get more complicated, the procedures employed for doing arbitrage will steadily get more complex. This will require new skills to be developed and new processes to be formulated.

With the introduction of multiple new products, faster trading mechanisms and more efficient markets, it may prove to be impossible for the human eye to detect or act upon arbitrage. We would then have to rely on computers. As computers get into the game, arbitrage opportunities would be quickly wiped out. There would however always be smart operators who would find ways to use new products and new markets in order to continue the arbitrage game.

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