Improving index fund implementation in India

Abstract

In an index fund world, every basis point of tracking error counts. While indexing may seem a simple strategy to adopt, replicating index performance may not be as easy as it seems. The central theme of the study is to understand the use of the index futures market for improving index fund implementation. We study *two* causes of tracking error, namely buffer cash held and dividend delays. Our findings show that the tracking error caused by these two factors can be significantly reduced by the use of index futures.

Contents

1 Introduction

While indexing may seem like an easy strategy to implement, in practice, fund managers often face problems in replicating the benchmark index returns. The index represents a mathematical calculation derived from a portfolio of securities that are not subject to the same market frictions as those faced by index mutual funds. Index funds incur transactions costs that are associated with portfolio implementation, re-balancing and capital flows.

The first index fund in India was launched in June 1999. While the index fund industry in India is still young, most major fund houses already have funds tracking an index. Index funds seek to deliver index returns. However, replicating index performance may not be as easy as it seems. In the developed markets, on a year–by–year basis, even the most established index funds have not been able to consistently match their benchmark index returns (Chiang 1998). In the Indian context, while some index funds have been able to consistently attain low levels of tracking error, there do seem to be periods where certain index funds incur unusually high tracking errors, and appear to depart from the discipline of indexation (Fernandes 2003). Even if we focus only on the best–performing funds, i.e. those incurring the lowest tracking error, the magnitude of the tracking error that we see in India is considerably in excess of the best values seen worldwide.

In this chapter we focus on issues concerning implementation of index funds. We seek to offer some ideas on how index funds can be managed better. We seek to gain insights into how these funds can use index futures to reduce tracking error. We also hope to get a sense of how much reduction in tracking error can be obtained by the use of index futures. To study the effectiveness of using Nifty futures for index replication, we study the correlation between Nifty spot and one–month Nifty futures. We use rolling window estimates of the correlation to see how it has changed over a period. We find that the one–month Nifty futures are highly correlated with the Nifty spot and hence would prove to be effective in replicating the index. The rolling window correlations since inception of the futures market show values between 0.93 and 0.97.

Index funds incur tracking error for a variety of reasons. Factors driving tracking error include transactions costs, fund cash flows, uninvested/buffer cash, treatment of dividends by the index, corporate actions, and index composition changes. The liquidity of the underlying index securities also has implications for transaction costs (in terms of impact cost) and in turn the tracking error incurred by funds. We focus on tracking error arising out of

uninvested/buffer cash and delays in dividend receipts. These are obvious sources of tracking error and both can be addressed using the futures market implementation that we suggest in this study.

Open ended index funds are faced with subscriptions and redemptions. When subscriptions happen, the fund is required to invest the money across index stocks and when redemptions happen, the fund is required to sell part of its index portfolio to generate cash. In order to handle redemptions, index funds usually maintain buffer cash. This buffer cash is typically invested into liquid instruments which lie at the near–end of the zero coupon yield curve. To the extent of buffer cash held, the fund has a $\beta < 1$, which in turn results in tracking error.

Using the single market model framework, we expect an index fund to normally suffer only the variance of errors as the tracking error. However, to the extent that $\beta \neq 1$, the index fund additionally suffers tracking error. For example, if the market has a daily volatility of 1.4 and the beta of the index fund is 0.98, this suggests that the index fund would incur an additional daily tracking error of 0.028 or 0.44% annualised. If a fund holds a fixed fraction of cash and does perfect indexation with the remainder, we would observe the following observable effects: (a) a highly stable beta which is less than one, (b) alpha of roughly 0 and (c) an error variance of roughly 0.

We simulate two funds, one naively holds buffer cash while the other holds buffer cash and uses index futures to bring it beta back to one. We study the extent to which the use of index futures reduces the tracking error of the fund. We also study index funds in India which exhibit the above symptoms of tracking error arising due to buffer cash, namely the IDBI Index I-Nit'99 fund and the Templeton Franklin India index fund, both tracking the Nifty. We assume that fund beta falls short of one solely due to reasons of buffer cash held by the fund. For these funds, we calculate the actual tracking error incurred and compare it with the tracking error that the funds would incur had they to readjust their betas using Nifty futures. Our findings show significant reductions in tracking error are possible by using index futures. Across the funds under study, we see a reduction in tracking error in the range of about 50 to 68 basis points.

Most equity indexes assume that dividends are paid on the ex–date and are reinvested immediately. In the real world however, index funds receive money well after ex–date. Often it could take several weeks before the dividends come in the hands of the fund. Due to this delay in receipt of dividend, in a rising market, the fund suffers cash drag and will lag the market. In a falling market, the reverse is true. To study the magnitude of tracking

error incurred due to dividend delays and the extent to which this can be avoided, we simulate a 50 crore fund indexed to the Nifty. We assume that the fund perfectly tracks the index, and that tracking error comes purely out of dividend delays. The index incorporates dividends on ex–dividend date, but the fund receives dividends three weeks later. We calculate the tracking error for the fund under the following situations: (a) Index stocks go ex–dividend, the fund does nothing and suffers tracking error due to delays in dividend receipts. (b) Index stocks go ex–dividend, the fund takes a long position in one month Nifty futures contracts to the extent of dividend declared. Our findings show that delays in dividend receipts add significantly to tracking error. The use of the index futures market can reduce this tracking error by about 30–35 basis points.

In summary, our study shows that significant improvements in index fund performance are possible by using index futures. The high correlation between the Nifty spot and one–month futures suggests that these could be effectively used for reducing tracking error caused both due to buffer cash held and due to delays in dividend receipts. While implementing index funds using index futures, the fund would have to bear in mind the existence of factors such as impact costs, rollover costs and margins to be paid on the futures positions. To the extent these exist, the benefits of using the futures market would reduce. However our findings suggest that the magnitude of reduction in tracking error obtained by futures usage far outweighs the costs involved.

The remainder of this study is organised as follows. Section 2 is a survey of literature on index fund implementation. Section 3 outlines the motivation and goals of the study. Section 4 describes the methodology that is used in this paper. Section 5 highlights some implementation issues. Section 6 documents the findings of the study. Finally, Section 7 concludes.

2 Issues

The main challenge in managing an index fund is to minimise the tracking error. Most fund managers are subject to a limit on ex–ante tracking error (C.Blitz & Hottinga 2001). In the index world every basis point counts. To track the index closely, the fund manager must choose the right approach to index fund implementation. An equity index portfolio can be established either by purchasing equities directly, or by getting exposure to a particular index by using derivatives. The most straightforward approach is to purchase a full set of the index stocks in the exact proportions as they exist in the index.

This is called full replication and is the most appropriate implementation strategy when all the stocks in the index are liquid. When an index contains stocks that are less liquid, optimisation may be used, but this method requires good historical data for the stocks in the index. Sampling is typically used when the stocks in the index are not liquid and historical data is insufficient to be able to properly develop a good factor model.

In a frictionless world, constructing index funds is a simple task. However, in the real world, index fund implementation involves transactions costs that are associated with portfolio implementation, re–balancing and capital flows either due to additions or deletions of constituents or due to corporate restructuring. The index assumes that the theoretical portfolio's new weights to each security can be achieved automatically. However, for the index fund, realigning the portfolio to mimic the underlying benchmarks involves physical trading in stocks and the transactions costs incurred thereby.

The other approach to indexing is a derivatives based approach. In this, the exposure to the underlying index is obtained through the purchase of futures contracts Mason et al. (1995). The dynamics of a derivatives–based strategy is as follows. Instead of buying physical securities to replicate the index, futures contracts are purchased, with cash invested to yield a short–term interest rate. The arbitrage relationship between the spot and the futures will ensure that the profits/losses on the futures and the interest earned on the invested cash will closely track the total return on the index. Miller & Meckel (1999) focus on the use of derivatives contracts to index a portfolio and generate enhanced returns in the process. In most markets, where the rates of return embedded in index futures prices are slightly in excess of the riskless rate of return, the *synthetic index fund* can systematically earn slightly higher returns than the index. While derivatives–based indexing is increasingly becoming popular (Miller & Meckel 1999), in this study we do not look at the implementation of this strategy. We seek to understand how a cash–based full replication index fund can make use of index futures to reduce tracking error.

3 Motivation and goals of the study

While some index funds in India appear to have obtained consistently low levels of tracking error, the magnitude of tracking error obtained by these funds in India is far greater than that exhibited by the best performing funds worldwide. Since the goal of an index fund is to minimise tracking error, even a few basis points of savings in tracking error directly contributes

to the funds performance. While funds could incur tracking error due to numerous reasons, in this study we seek to measure the impact of two factors on tracking error, buffer cash held and delays in dividend receipts.

These two issues are directly relevant insofar as they appear to be prominent sources of index fund tracking error. In addition, the ideas used in addressing these problems may pave the way for other innovations in index fund management in India. This study seeks to answer the following questions

Q1 How can index funds achieve their target levels of buffer cash, in order to cope with most redemptions, but obtain lower levels of tracking error while doing so? In other words, how best can buffer cash be implemented?

Q2 How can index funds reduce tracking error which results from delays in receipts of dividends?

The main idea in the study is to use the index futures to reduce this tracking error. We seek some ideas on how index funds could be implemented using index futures and to what extent their usage would reduce the fund tracking error.

4 Methodology

4.1 Measuring Nifty basis risk

The Nifty futures market is a fairly young market that commenced in 2000. To study the effectiveness of Nifty futures for index replication, we examine the correlation between Nifty spot and one–month Nifty futures. To the extent that the correlation is imperfect, the Nifty futures would fail to track the Nifty spot, and prove to be a flawed instrument for obtaining index tracking. We use rolling window estimates of the correlation to see how it has changed over time.

We also calculate rolling window hedge ratio, the ratio of the size of position to be taken in the index futures contracts to the size of the exposure in the spot market. Equation 1 gives the optimal hedge ratio.

$$h = \rho \frac{\sigma_S}{\sigma_F} \tag{1}$$

where:

- ΔS: Change in the spot index, S
- ΔF: Change in index futures, F
- σ_S: Standard deviation of ΔS
- σ_F: Standard deviation of ΔF
- ρ: Coefficient of correlation between ΔS and ΔF
- h: Hedge ratio

4.2 Uninvested/buffer cash

As a result of ongoing subscriptions and redemptions, open–ended index mutual funds engage in trading. Upon subscriptions, they are required to rapidly invest the cash flow across index securities, and upon redemptions, to sell securities to generate cash. Index funds often maintain buffer–cash to meet redemptions. This gives $\beta < 1$ and innately yields tracking error.

In the market model

$$r_j = \alpha + \beta r_M + \epsilon \tag{2}$$

where $r_M \sim N(0, \sigma_M^2)$. The index fund normally needs to only suffer $\text{Var}(\epsilon)$ as the tracking error. However, to the extent that $\beta \neq 1$, the index fund additionally suffers tracking error to the tune of $(1-\beta)^2\sigma_M^2$.

For example, if $\sigma_M = 1.4$ and $\beta = 0.98$, this suggests that the additional tracking error incurred by the fund, $\sigma_{e_p} = 0.028$ or 0.44% annualised. The variance of Nifty is higher as compared to the variance of indexes in most countries. Hence handling the buffer cash problem becomes an important issue in the Indian setting.

Assume a fund holds a particular level of buffer cash, and does perfect indexing with the non–buffer amount. Under the single market model framework, we expect to observe the following effects in the data:

1. A highly stable $\beta = 1 - \lambda$,
2. We should not get $\beta > 1$.
3. $\text{Var}(\epsilon) \approx 0$.
4. $\alpha \approx 0$.
5. $R^2 \approx 1$.

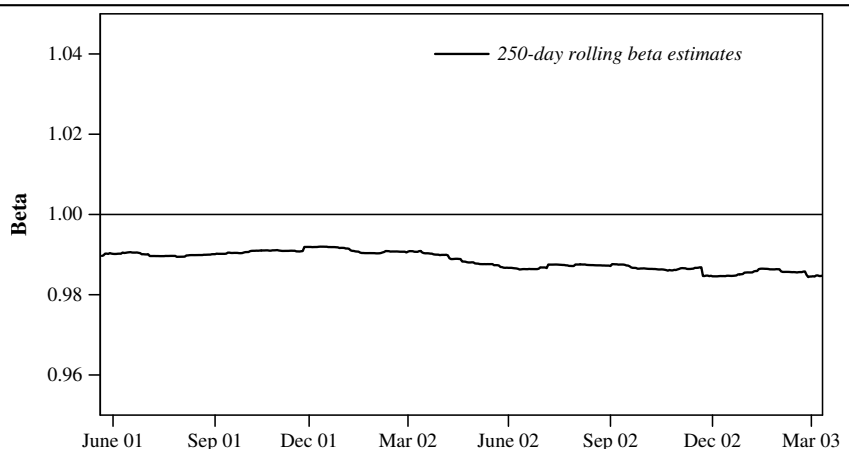

Figure 1: Rolling β estimates: IDBI I-Nit'99

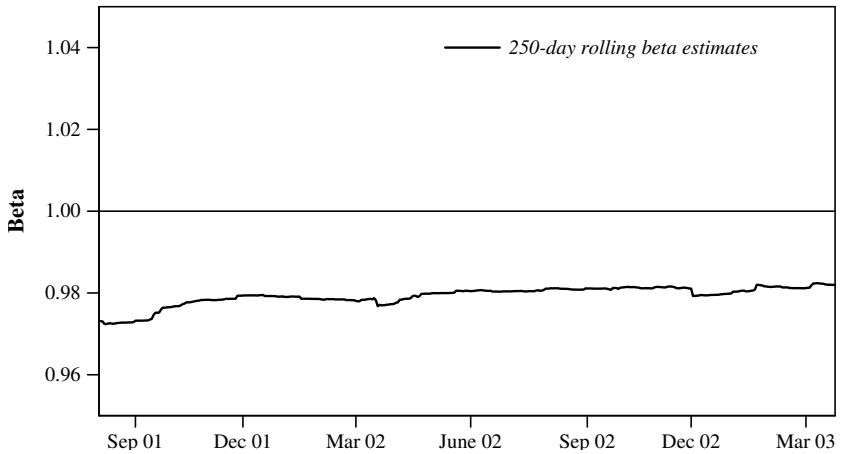

Figure 2: Rolling β estimates: Templeton Franklin index fund

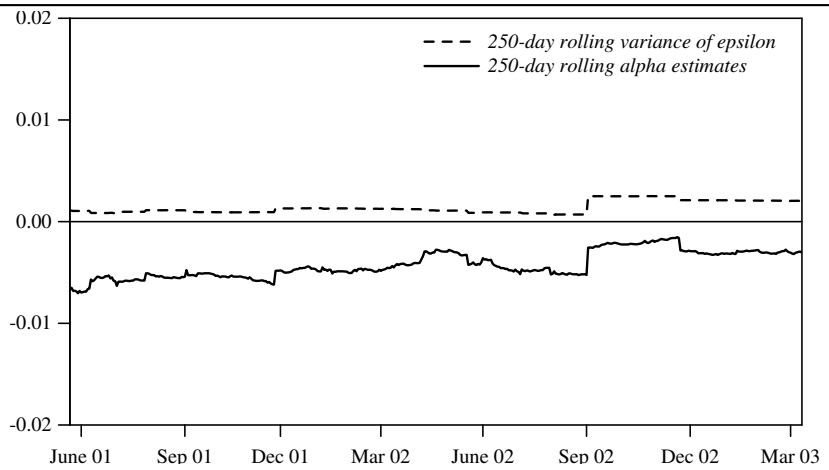

Figure 3: Rolling $Var(\epsilon)$ and α: IDBI I-Nit'99

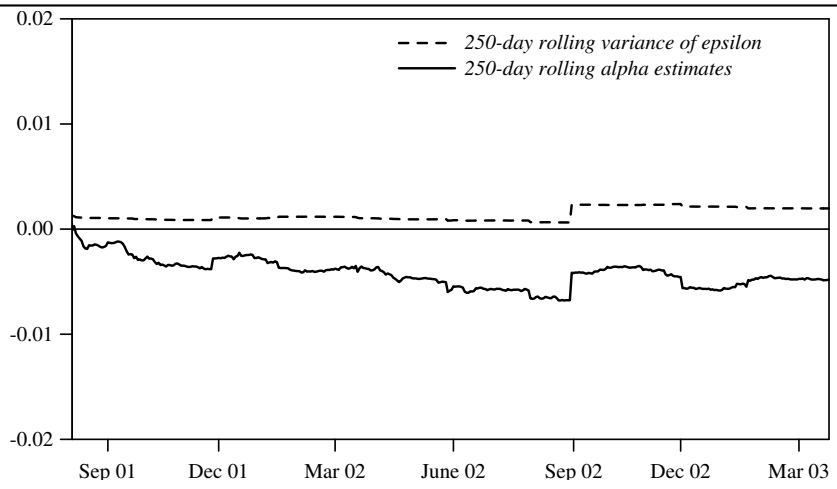

Figure 4: Rolling $Var(\epsilon)$ and α estimates: Templeton Franklin

In a study on evaluation of index fund performance in India, Fernandes (2003) looks at buffer cash as a source of tracking error. Under the single market model framework, the β, α and ϵ for the various funds are estimated. Findings of this study show some funds having a highly stable beta with the R^2 of the regression almost equal to one. These findings suggest that the funds seem to exhibit strong symptoms of holding 1% to 3% buffer cash. We use these Nifty–based index funds for the present study, namely the IDBI I-Nit'99 index fund and the Templeton Franklin index funds. Figure 1 to Figure 4 show the above parameters for the two funds under study.

We assume that the fund does perfect indexation with a fraction λ of its corpus and maintains a buffer cash of $(1 - \lambda)$. The fund has $\beta < 1$. We propose that to the extent of buffer cash held, the fund takes a long index futures position. This pushes the beta of the fund back to 1.0. Index futures are particularly appealing because futures enable replication using a single contract. If the prices on the index futures market are purely determined by the *cost of carry* model, the basis risk on the futures will be zero and the long futures position will perfectly track the index. The spot plus futures positions together will yield zero tracking error. In the real world however, basis risk exists. To the extent of basis risk on the futures market, the index fund would obtain imperfect tracking. So the issue is about which is the lesser evil – holding buffer cash and suffering tracking error or taking position in an imperfectly correlated futures contract and suffering basis risk of the index futures.

To study the magnitude of error caused by buffer cash and the extent to which use of futures can reduce this error, we do the following:

1. *Simulation using fixed buffer cash*: To study the impact of using index futures to realign the fund β (which we assume is different from the index β only for buffer cash reasons), we simulate two hypothetical funds which follow different approaches to index fund implementation. This simulation uses the historical experience of returns on the Nifty futures.

    - Naive implementation: Fund A buys the spot index using fraction $(1-\lambda)$ of its funds, maintains λ as buffer cash and has $\beta = 1-\lambda$ which is < 1.

    - Index futures implementation: Fund B buys spot index using fraction $(1 - \lambda)$ of its funds, maintains λ as buffer cash, buys one month Nifty index futures to the extent of buffer cash maintained and has $\beta = 1$.

2. *Simulation using time–varying buffer cash*: In our empirical work, we know how β varies through time for certain funds(e.g. IDBI I-Nit'99). These are rolling window estimates: at each time t, they show the average that

prevailed over the last one year.

For these funds that exhibit strong symptoms of holding buffer cash, given the daily β estimates, we can simulate implementation of buffer cash using index futures. We calculate the following:

- Actual tracking error incurred.
- Tracking error that would be incurred had the funds to readjust their betas using Nifty futures.

4.3 Delays in dividend receipts

The index computation assumes that dividends are paid on the ex–date and are reinvested immediately. In most cases however, index funds receive dividend money well after ex–date. Often it could take several weeks before the dividend comes in the hands of the fund. These delays in dividend receipt have the following consequences.

1. Wrong β
   - These delays in receipt of dividend makes the index fund $\beta < 1$ and results in tracking error.
   - In a rising market, the fund suffers cash drag and will lag the market. In a falling market, the reverse is true.
2. Errors on ex–dividend date and on dividend–receipt date
   - On ex-dividend date, the index incorporates the dividend, the fund NAV shows a lower return.
   - When the fund receives dividend in hand, the fund NAV shows a jump. This gives two errors between fund returns and index returns.

Table 1 and Table 2 presents some evidence on the delay in dividend receipts observed in India. While the delay in recent periods has reduced, it is still significant enough to add to tracking error. This delay innately introduces tracking error.

At every instance of dividend declaration, the return on the fund deviates from return on the index. On ex-dividend date, the index incorporates the dividend, but the fund does not actually receive the cash, hence its return lags behind the return shown by the index. When the fund receives dividend in hand, the fund NAV suddenly shows a jump, and there is a spike in the fund return. Figure 5 shows the daily returns on the Nifty and the simulated fund for a one–year period. On all three days where the fund received a

Company	Ex-dividend date	Dividend receipt date	Delay (days)
VESUVIUS INDIA LTD	26/07/99	12/10/99	79
DR REDDY'S LAB	12/07/99	27/10/99	77
DABUR INDIA LTD	2/08/99	15/10/99	74
TVS SUZUKI LTD	16/08/99	27/10/99	73
APOLLO TYRES LTD	9/08/99	18/10/99	70
PUNJAB TRACTORS	16/08/99	20/10/99	66
GUJARAT AMBUJA CEMENT	23/08/99	25/10/99	64
THERMAX LTD	16/08/99	15/10/99	61
HLL	30/08/99	21/10/99	53
RHONE POULENC (I) LTD	16/08/99	6/10/99	52

Table 1: Some evidence on dividend delays in India: 1999

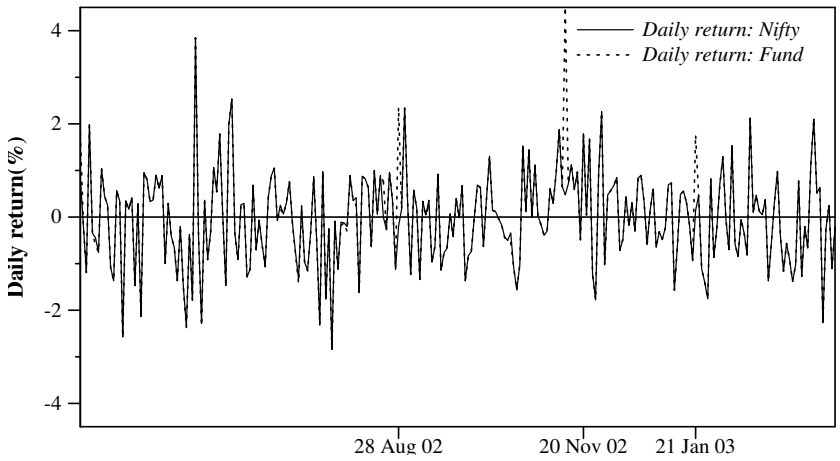

Figure 5: Spike in fund returns observed on dividend receipt date

dividend, we see a spike in daily returns. Fernandes (2003) shows how a single day of large error can throw off the full years tracking error budget of the fund. Figure 6 and Figure 7 give the rolling tracking error for the IDBI I'Nit'99 fund and the Templeton Franklin index fund for a one year period ending March 2003. We see a sharp rise in tracking error across the funds around end of August 2002. This coincides with several ex–dividend dates for large stocks like HLL, HPCL and Dr.Reddy's Laboratories lying around this period. Index funds need to be very careful in terms of consistently tracking the index.

To show how an index fund can handle the dividend delay problem, we assume that with its existing corpus, the fund does perfect indexation. When

Company	Ex-dividend date	Dividend receipt date	Delay (days)
ABB LTD	27/03/03	1/07/03	96
SBI	4/07/03	23/07/03	50
ORIENTAL BANK	19/06/03	7/08/03	49
SATYAM COMPUTERS	14/07/03	29/08/03	46
TISCO LTD	9/06/03	25/07/03	46
BPCL LTD	16/07/03	26/08/03	41
HCI TECHNOLOGIES	15/05/03	9/06/03	40
ZEE TELEFILMS	27/10/03	27/11/03	37
MAHINDRA & MAHINDRA	26/06/03	31/07/03	35
TATA POWER	4/07/03	7/08/03	34
NIIT LTD	27/01/03	26/02/03	30
WIPRO LTD	1/09/03	31/09/03	30
BAJAJ AUTO	10/07/03	7/08/03	28
DABUR INDIA LTD	14/09/03	11/08/03	28
HINDALCO LTD	14/7/03	11/08/03	28
TATA TEA LTD	14/08/03	11/07/03	28
INDIAN HOTELS	12/08/03	8/09/03	27
VSNL LTD	13/08/03	8/09/03	26
ASSOCIATED CEMENT	30/06/03	25/09/03	25
DR REDDY'S LAB	8/08/03	4/09/03	25
RELIANCE IND LTD	23/05/03	17/06/03	25
SMITHKLINE CONS	29/07/03	23/08/03	25
HERO HONDA LTD	16/07/03	9/08/03	24
INDIAN PETRO	23/05/03	16/06/03	24
RANBAXY LABS	10/06/03	4/07/03	24
ICICI BANK	4/08/03	27/08/03	23
TATA MOTORS LTD	30/06/03	23/07/03	23
INFOSYS TECH	28/03/03	19/06/03	22
ITC LTD	14/7/03	5/08/03	22
HLL	14/08/03	4/09/03	21
L&T	11/08/03	1/09/03	21
BRITANNIA INDIA	23/07/03	12/08/03	20
SUN PHARMA	20/08/03	19/06/03	15
TATA CHEMICALS	29/05/03	12/06/03	14
BSES LTD	28/08/03	9/09/03	12
COLGATE PALMOLIVE	17/06/03	27/06/03	10
SHIPPING CORPORATION	19/03/03	28/03/03	9

Table 2: Some evidence on dividend delays in India: 2003

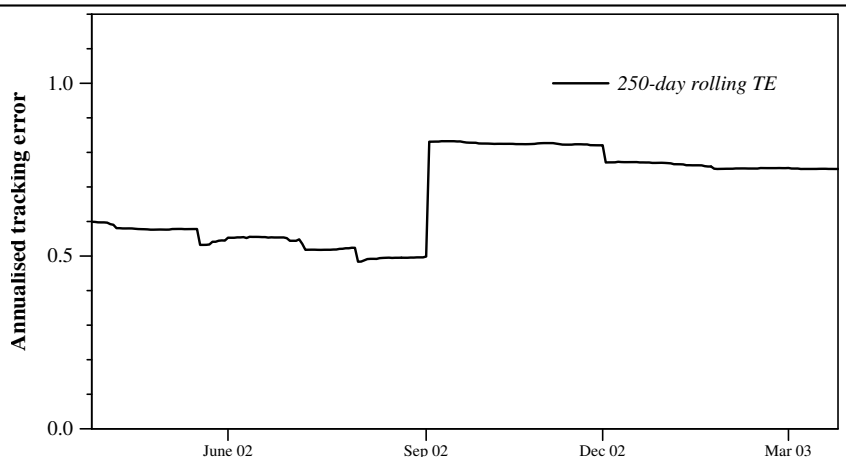

Figure 6: IDBI I-Nit'99 : Effect of dividend

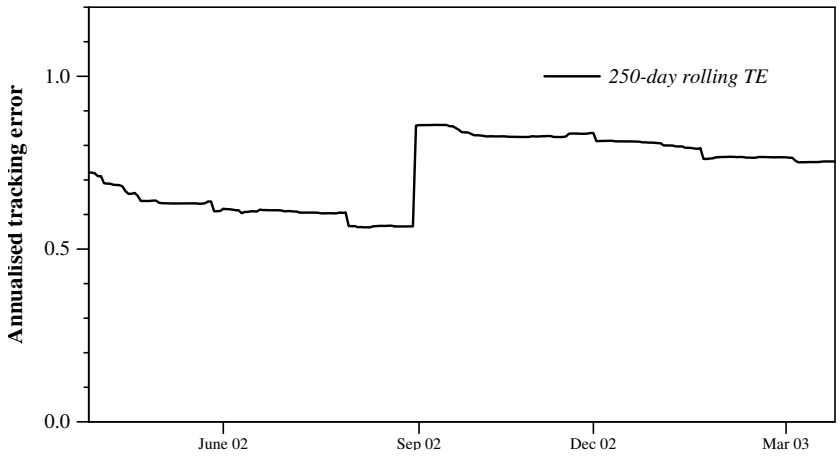

Figure 7: Templeton Franklin index fund : Effect of dividend

an index stock goes ex–dividend, to the extent of dividend to be received, the fund buys index futures. Number of index contracts to be purchased is given by:

$$N = \frac{\text{Dividend amount to be received}}{\text{Level of index} \times \text{Index multiplier}} \times \text{Hedge ratio} \tag{3}$$

This brings the fund β back to 1. Upon actual receipt of dividend, the fund buys the underlying portfolio and unwinds the position it has taken on the futures market. For the purpose of this study, we assume the hedge ratio to be one.

To study the magnitude of tracking error caused by delays in dividend receipts and the extent to which use of futures can reduce this error, we do the following:

1. We simulate a 50 crore fund indexed to the Nifty.
2. We assume that the fund perfectly tracks the index, and that tracking error comes purely out of dividend delays.
3. Beginning 12th June 2000, we calculate the tracking error for the fund under the following situations:
   (a) Naive implementation: Index stocks go ex–dividend. The fund does nothing and suffers tracking error due to delays in dividend receipts.
   (b) Index futures implementation: Index stocks go ex–dividend. The fund takes a long position in one month Nifty futures contracts to the extent of dividend declared, and closes position upon the receipt of dividend.
4. We examine delays of one, three, five and eight weeks.

We find that during the period of our study, there have been about 200 ex-dividend dates for Nifty securities. The dividend amount received by the fund ranges from about Rs.600 to Rs.15,75,000. We only work with instances of dividends where the dividend amount received by the fund is in excess of one Lakh. This leaves us with 9 ex–dividend dates. Ignoring the remaining dividends *understates* the extent of tracking error caused due to delays in dividend receipts.

For the purpose of this study, we assume that funds take position in the futures market to the extent of buffer cash/dividend expected. When buffer cash increases, the funds buy futures, when buffer cash falls, the funds sell futures. Similarly when an index stock goes ex–dividend, the fund buys futures. When dividends come in hand, the fund invests in the index and closes out the futures positions.

By definition, the performance of a futures contract should closely approximate the performance of the underlying asset. If bought at fair value and held to expiration, a futures contract should have a return equal to the cash instrument – assuming that the cash component is invested in instruments at the near–end of the zero coupon yield curve. However there a few issues that need to be borne in mind before index fund managers begin adopting the futures strategies we mention. A variety of factors determine how successfully these strategies can be implemented.

5.1 Futures mispricing(Basis risk)

Basis risk on a futures contract is the mispricing of the contract relative to its fair value. Depending on the demand/supply in the market at any given point in time, futures contracts will trade cheap or expensive. Buying futures when they are expensive would lead to underperformance, while buying futures when they are cheap would lead to overperformance. Either way, this would result in imperfect tracking of the index.

5.2 Impact cost and futures rollover

Futures contracts have a finite life. In India, futures contracts expire every three months. At any point in time, there are one–month, two–month and three-month futures contracts on the Nifty available for trading. The futures implementation suggested by us in this study, uses the most liquid contract, i.e. the one–month futures contract.

Costs incurred in trading futures would result in underperformance of the index fund vis–a-vis the index. Globally, stock index futures markets are more liquid than their stock counterparts. Futures have lower transaction costs in the form of lower brokerage, tighter spreads, and smaller market impact costs. Estimates of the ratio of transaction costs for stock index futures

versus the costs of an equivalent stock transaction range from about 7% for the U.K. to 17% in Hong Kong (Shalen 2000). An important component of transactions cost is the impact cost. In most markets, the impact costs of doing a futures trade are much less than the impact costs of doing a trade in the cash market. To test if these costs significantly effect the outcome of the futures implementation strategy suggested by us, we incorporate various levels of impact cost into the above dividend simulation and study its impact on the reduction in tracking error. While we do not have access to impact cost numbers on the Nifty futures market, as a rule of thumb, the costs of trading on the futures market are one–tenth the cost of trading on the spot market. The impact cost for trading a Rs.5 million Nifty basket on the spot market is around 0.10%. Taking cue from the impact cost on the spot market, we use three levels of impact cost on the futures market, namely 0.05%, 0.025% and 0.01%.

Both in the case of buffer cash and dividend handling, funds may require to take futures positions for more than a month at a time. In such situations, they will have to go in for a futures rollover, which results due to expiration of one contract(near term) and the purchase of another contract(the next one–month contract). In the dividend handling implementation, impact costs are incurred when the fund undertakes the following trades in the futures market:

1. Buys futures when an index stock goes ex–dividend.
2. Closes the futures position when dividends are received.
3. Buys futures during the rollover, i.e. when a futures contract entered into expires before the receipt of dividends by the fund.

5.3 Margins

Buying futures contracts involves posting margins. Funds would need to post initial margins while entering into the contract and maintain mark–to–market margins upon incurring losses. So long as the amount of loss is small, these margins could be paid out of the buffer cash held. Large losses on the futures position may require selling securities to generate cash.

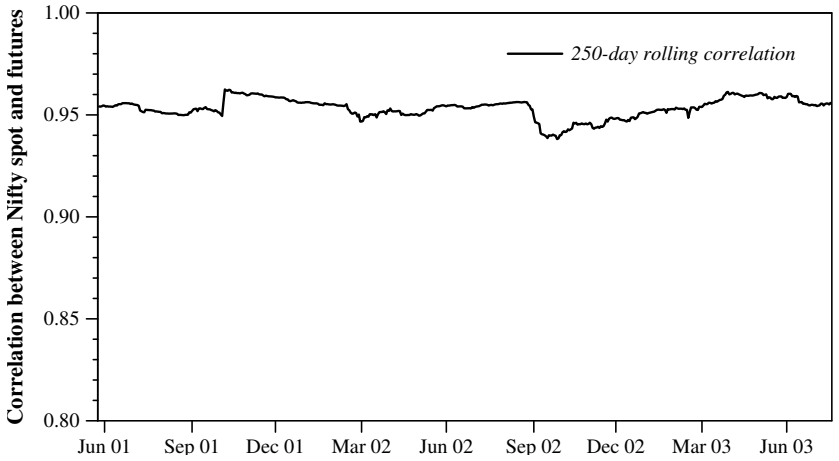

Figure 8: Correlation between Nifty spot and futures

6 Findings

6.1 Effectiveness of one–month Nifty futures contract

To study the effectiveness of using Nifty futures for index replication, we study the correlation between Nifty spot and one–month Nifty futures. We use rolling window estimates of the correlation to see how it has changed over a period. We find the correlation to be fairly stable around 0.95. Over the period 2001-2003, the liquidity of the futures market has grown tremendously, however the basis risk on the index futures does not seem to have dropped. Figure 8 gives the 250–day rolling correlation between the Nifty spot and one–month Nifty futures. Though not perfect, the correlation is high enough to enable the usage of the futures contract for the purpose of tracking the spot.

In our study of index fund implementation using one–month Nifty futures to reduce tracking error, both due to buffer cash held and due to delays in dividend receipts, we have assumed the hedge ratio to be one. Figure 9 gives the 250–day rolling window hedge ratio. For the period of the study, the mean hedge ratio has been 0.98.

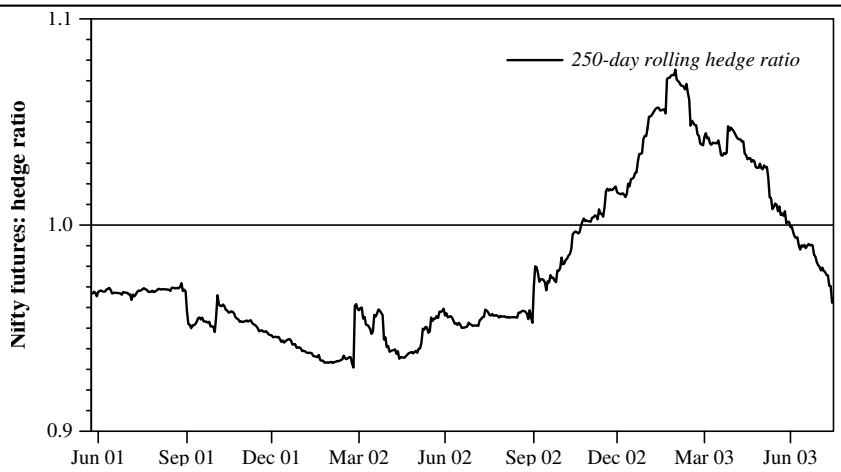

Figure 9: Hedge ratio for one–month Nifty futures

6.2 Using futures to handle the buffer cash problem

We study the magnitude of error caused by buffer cash and the extent to which use of futures can reduce this error by a simulation using: (a) fixed buffer cash, and (b) time varying buffer cash.

Fixed buffer cash

We simulate two index funds which follow different strategies. Fund A buys the spot index and naively holds a fraction of its corpus as buffer cash. Fund B buys spot index. Assuming a hedge ratio of one, it buys one month Nifty index futures to the extent of buffer cash maintained and brings its beta back to one. We calculate the tracking error incurred by both the funds for various levels of buffer cash held. Figure 10 shows the tracking error incurred by the two funds. While the basis risk of the Nifty futures does not permit perfect replication by Fund B, the reduction in tracking error for Fund B is significant.

Time–varying buffer cash

We study the IDBI Index I-Nit fund and the Templeton index fund, both of which exhibit strong symptoms of tracking error arising out of buffer cash held. For the purpose of knowing how much position to take in the futures market, we assume that the funds hold buffer cash to the extent of $(1 - \beta)$.

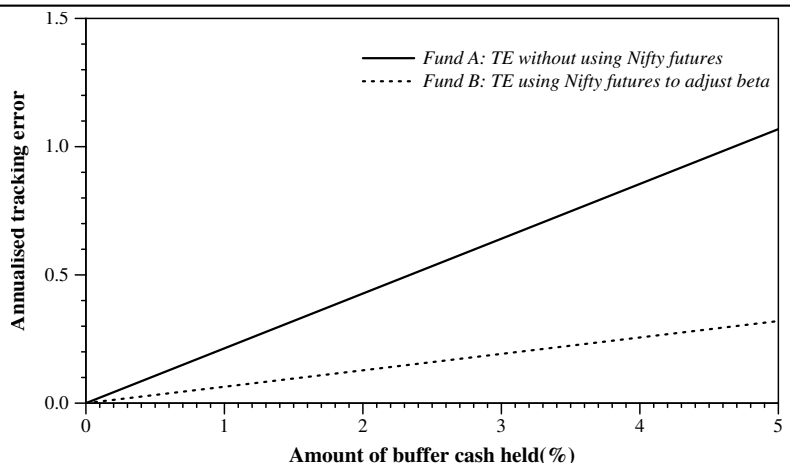

Figure 10: Tracking error incurred under different implementation strategies

Fund	TE without using futures	TE using futures
IDBI I-Nit'99 Index Fund	0.65	0.1434
Templeton Franklin India Index Fund	0.71	0.1212
Templeton Franklin India Tax Fund	0.77	0.0965

Table 3: Reduction obtained in tracking error

In real life, the fund would know how much buffer cash it actually holds and would simply take a futures position to that extent. We calculate the actual tracking error incurred by these two funds and the tracking error that they would have incurred, had they to readjust their betas using one–month Nifty futures.

Table 4 gives the tracking error incurred by the funds with and without the use of index futures. Across the funds, we see a reduction in tracking error to the extent of 50 to 68 basis points. In an index world where every basis point counts, this reduction in tracking error is significant. Figure 11 and Figure 12 give the 250–day rolling window tracking error for the IDBI I-Nit'99 and Templeton Franklin India index funds under the two methods of implementation. The gains from using index futures are large and consistent over both the funds.

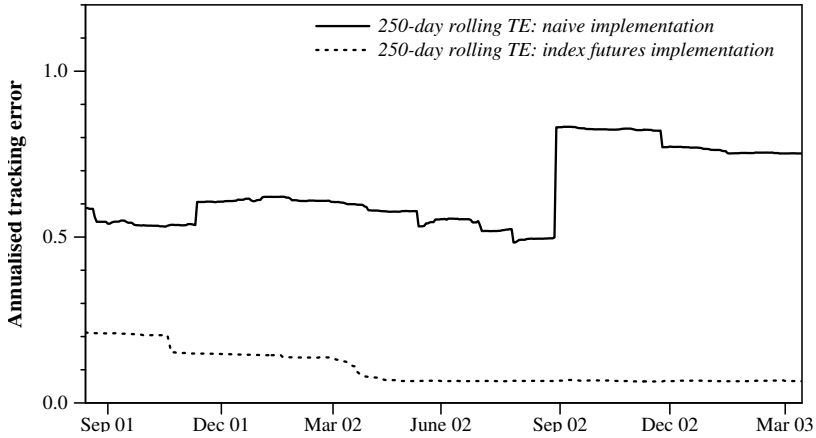

Figure 11: IDBI I-Nit'99 Index fund: buffer cash implementation

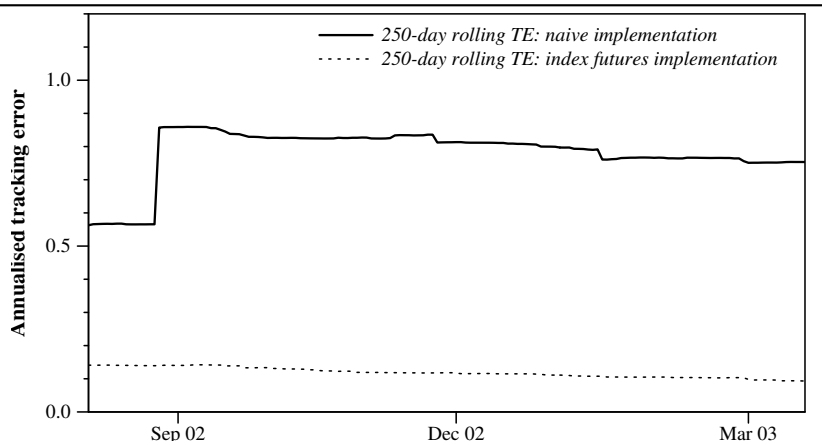

Figure 12: Templeton Franklin India Index Fund: buffer cash implementation

6.3 Using futures to handle the dividend delay problem

To study the magnitude of tracking error caused by delays in dividend receipts and the extent to which use of futures can reduce this error, we simulate an index fund. The fund has a corpus of Rs.50 Crore and an NAV of Rs.10 on 12th June 2000, day one of the fund. For different dividend delays, we calculate the TE incurred by the fund under the following situations:

1. The fund does not take any futures positions and incurs tracking error.
2. The fund takes long futures position on ex-dividend date to correct for tracking error due to the delayed receipts of dividend.

Our findings show that dividend delays contribute significantly to tracking error. A fund that takes a long futures position on the ex-dividend day, can avoid sudden deviations from index returns and hence obtain large reductions in tracking error as compared to a fund that does not use futures.

For various periods of delay in dividend receipt, we calculate the tracking error obtained by the simulated index fund in two situations. One, where the fund does nothing as stocks go ex–dividend, and two, where on the day an index stock goes ex–dividend, the fund takes a long position in one month Nifty futures contracts to the extent of dividend it will receive. Figure 13 to Figure 16 show the rolling tracking error incurred by the fund for one week, three weeks, five weeks and eight weeks delay in receiving dividends. The figures show that the increase in tracking error caused due to a single instance of a delayed receipt of dividend, has a prolonged impact on the tracking error of the fund. The jumps in levels of tracking error in the figures show that higher the dividend amount received, higher is its continued impact on tracking error. Whatever be the delay in receipt of dividends, use of index futures contracts, can significantly reduce the tracking error.

Table 4 gives the annualised tracking error that the fund would incur with and without the use of the index futures market. We have assumed uniform levels of delays in dividend receipts, that is, one week, three, five weeks and eight weeks, whereas in the real world, these delays would be non–uniform. The tracking error numbers obtained suggest that when there is a delay in receipt of big dividend amounts, its impact on tracking error is much higher than when small dividend amounts are delayed. The surge in tracking error that we see between September 2002 to December 2002 in Figure 13 to Figure 16 is due to a number of large dividends coming in around this period. Using futures could reduce tracking error by about 20–60 basis points. Figure 17 gives the reduction in tracking error obtained across the various period of

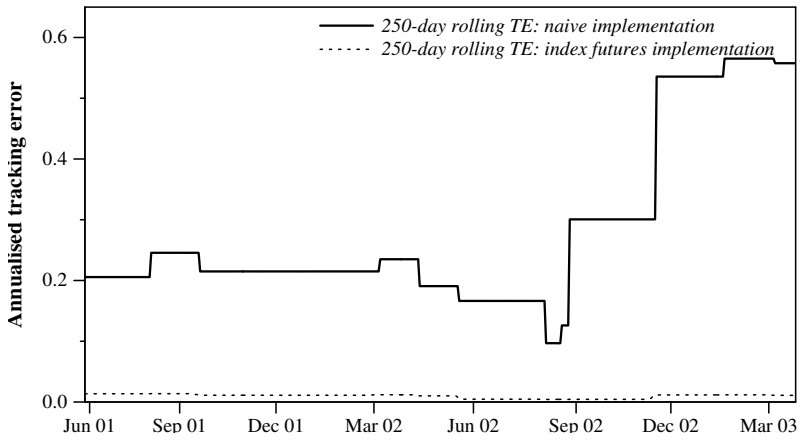

Figure 13: Rolling tracking error: one week delay in dividend receipt

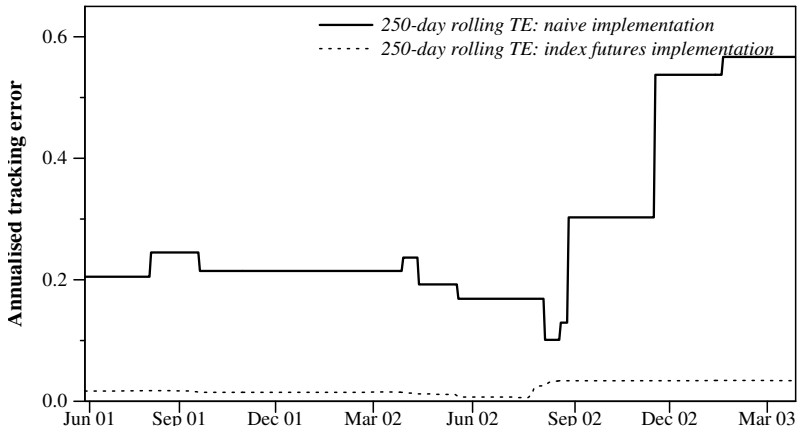

Figure 14: Rolling tracking error: three weeks delay in dividend receipt

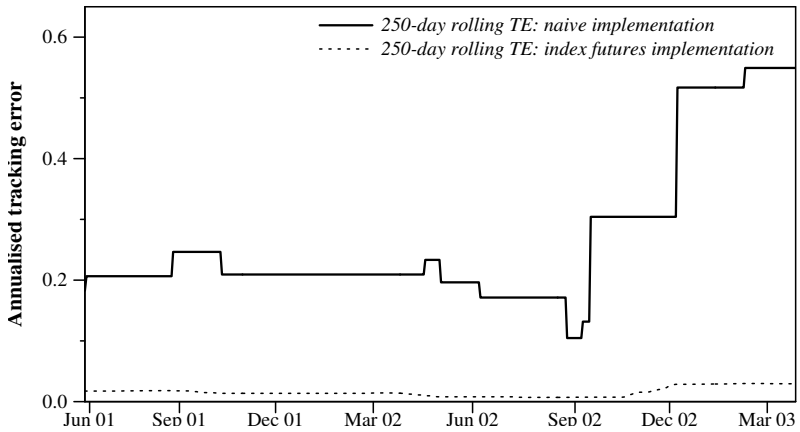

Figure 15: Rolling tracking error: five weeks delay in dividend receipt

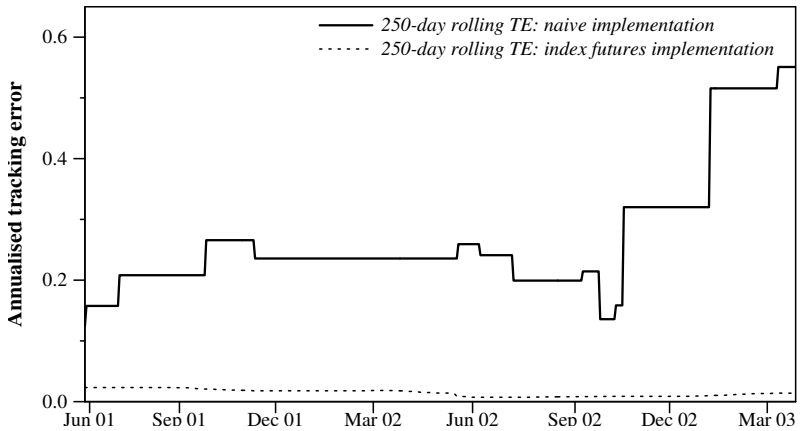

Figure 16: Rolling tracking error: eight weeks delay in dividend receipt

Delay in dividend receipt	TE: naive implementation	TE: index futures implementation
One week	0.3683	0.0198
Three weeks	0.3690	0.0229
Five weeks	0.3598	0.0208
Eight weeks	0.3657	0.0164

Table 4: Reduction in tracking error obtained

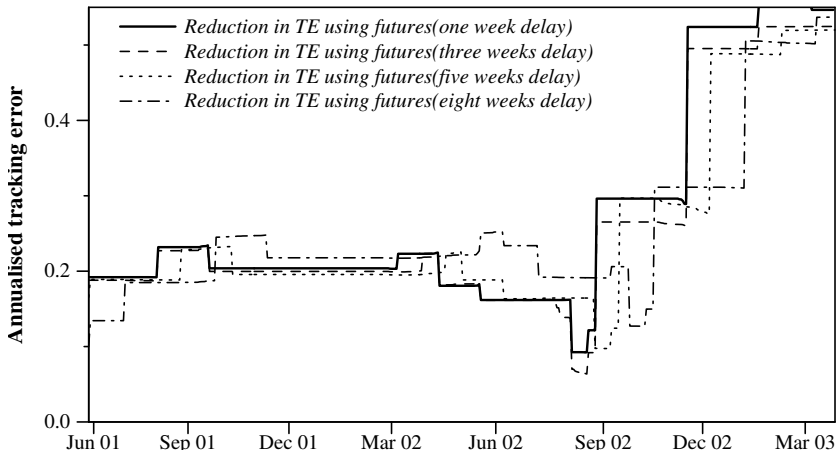

Figure 17: Reduction in tracking error using futures

delays.

Figure 17 gives the tracking error obtained by the fund by taking a long futures position to the extent of dividends to be received. In this study we are using the one–month futures contract for obtaining index exposure. Longer dividend delays would involve going in for futures rollovers. However, it seems very clear that the use of futures can significantly reduce tracking error due to delayed receipts of dividends.

6.4 Effect of impact cost and futures rollover

Figure 19 gives the monthly average impact cost for trading a Rs.5 million Nifty portfolio. Over the last two years, the impact cost for a portfolio this size has been around 0.10%. As a rule of thumb, costs of trading on the futures market are one–tenth the costs of trading on the cash market. The turnover of Nifty futures vis–a–vis the underlying cash has also been increasing steadily. While we do not have exact impact cost numbers for the

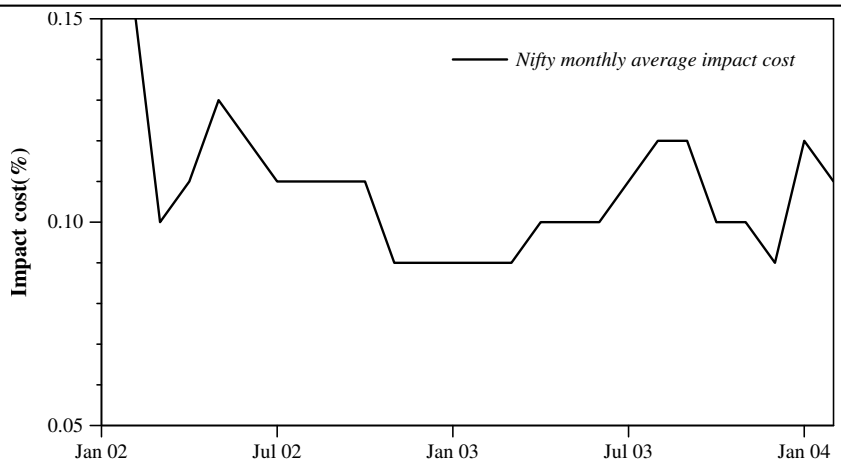

Figure 18: Nifty impact cost for a portfolio size of Rs.5 million

Turnover	Sep–03	Oct–03	Nov–03	Dec–03	Jan–04	Feb–04
F&O segment	185152	230364	192171	238907	324063	272839
Futures on indices	45861	56435	49486	65378	99878	86359
Underlying cash segment	103345	115595	92866	110373	134268	108718
% of F&O to underlying	179.16	199.29	206.89	216.45	241.35	250.96

Table 5: Index futures turnover (Rs.Crores)

futures market, the increasing volumes suggest low impact costs. Table 5 gives a comparison of the turnover on the cash versus index futures markets in India.

To test the effect of impact costs and rollover costs on the outcome of the futures implementation strategy, we incorporate various levels of impact cost into the earlier simulation using an eight weeks delay in dividend receipt. An eight week delay would typically involve three futures rollovers. Figure 19 shows tracking error incurred at various levels of impact cost. The impact cost levels that we have used on the futures market have been deduced from a Rs.5 million Nifty portfolio traded on the cash market. Dividends receipts by the 50 crore fund in the simulation vary from Rs.0.1 million to Rs.1.5 million. For each instance of futures trade, we have used a uniform level of impact cost (0.05%,0.025% and 0.01%). In reality, smaller size trades on the futures market would suffer lower impact costs. The liquidity on the Nifty futures market suggests that a Rs. 5–10 Lakh trade on this market would go through at near–zero impact cost. Figure 19 exaggerates the effect of impact costs and rollover costs. Our findings suggest that inspite of suffering these

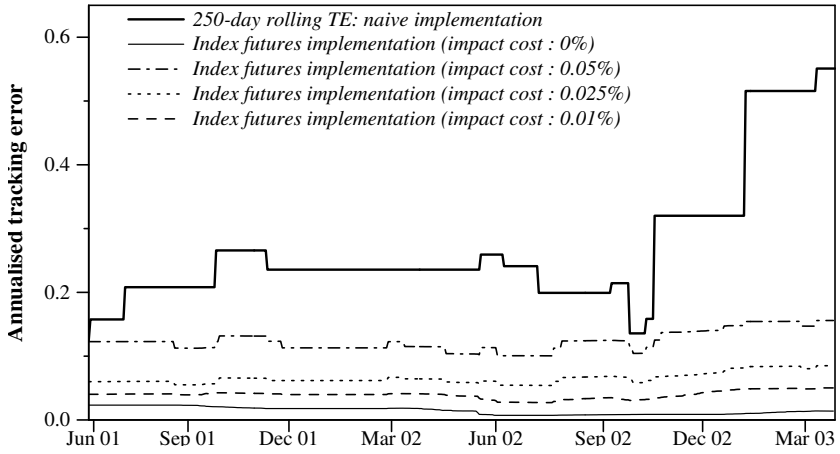

Figure 19: Tracking error for different levels of futures impact cost

costs, the index fund will show improvements in tracking error by using the futures implementation suggested by us.

7 Conclusion

In this study, we look at the use of futures markets for improving index fund implementation in India. We do not look at the use of index futures in terms of creating a synthetic index fund, but in terms of its use as an adjunct to trading in stocks. Index funds incur tracking error on account of the buffer cash they hold. To the extent of buffer cash held, the beta of the index fund is less than that of the index. Similarly index funds incur tracking error due to delays in dividend receipts. We use index futures to reduce the tracking error due to these two causes. Trading in index futures provides a number of advantages. Use of futures enable index replication using a single contract. Another advantage is the relatively low transactions cost as measured by market impact cost. As a rule of thumb, trading in futures involves one–tenth the transactions costs of trading in stocks.

To find out the effectiveness of using index futures for index fund implementation, we study the correlation between Nifty spot and one–month Nifty futures. The average correlation works out to be about 0.95. Using a 250–day rolling window we find the correlation since inception of the index futures market to be between 0.93 and 0.97. The imperfect yet high correlation suggests that index futures could be effectively used for replicating the spot. We also calculate the rolling window hedge ratio for one–month Nifty futures.

The average hedge ratio for the period of our study is about 0.98.

We use the futures market to tackle the buffer cash problem. Both in case of the simulated funds as well as in the case of real world index funds in India, we find that use of futures significantly reduces tracking error. We see a reduction in tracking error to the extent of 50 to 68 basis points across the funds under study.

Delays in dividend receipts result in increased tracking error. We simulate an index fund to study the impact of this. Our findings suggest that dividend delays add significantly to the funds tracking error. The use of index futures market can correct most of the tracking error that the fund would incur on account of dividend delays.

Our findings show that index funds can effectively use the index futures market to reduce tracking error arising out of buffer cash and delays in dividend receipts. Due to basis risk of the index futures, funds would not be able to obtain perfect replication and zero tracking error. Impact costs and rollover costs would also reduce the effectiveness of the futures implementation strategy. However, as against taking no action and suffering tracking error, the benefits of using this strategy are clearly evident.

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