Chapter 6

Investment Risk in the Indian Pension Sector and the Role for Pension Guarantees

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6.1 Introduction

The central distinguishing feature of pension fund investment is the multi-decade horizons involved. Over these horizons, small improvements in the rate of return generate a magnified impact upon pension wealth on retirement date, through the 'power of compounding'.

Basic economic arguments suggest that the return on government bonds cannot exceed the rate of wage growth, but the return on private corporate bonds and equities would be the marginal product of capital. The marginal product of capital is generally likely to be higher than the rate of wage growth. Hence, individuals can obtain substantially higher pension wealth, on average, by utilising securities issued by private firms in their pension portfolios.

A difficulty that flows from this approach is that of investment risk. In a world where individuals include risky assets in pension portfolios, there is greater uncertainty about post-retirement consumption. One important mechanism that has often been proposed in containing this uncertainty is guarantees. These guarantees can be offered "for free" by the State, as part of a public pension system, or they can be purchased on financial markets. It is also possible to envision hybrid approaches where the State supplies

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certain minimal guarantees, and individuals voluntarily purchase supplements.

In this paper, we try to obtain numerical values for the value of certain guarantee structures. We deal with three guarantee structures. The first is a guarantee that post-retirement consumption will be above $1/day. The second is a guarantee that real returns on the pension portfolio would not prove to be negative (over the life). The third is a guarantee that the first monthly pension would be better than half of the last monthly wage.

In order to obtain concrete numerical values for the cost of these guarantees, we analyse them in the context of a simplified model, with certain assumptions about parameters which characterise the risk and return on asset markets in India.

For each guarantee structure, we compute three summary statistics. First, we compute the probability that the worker ends up in poverty in old age. Second, we compute a measure of the ex-ante variability of post-retirement consumption. Third, we compute the price of the guarantee. This is done using the idea of 'risk-neutral valuation', whereby all contingent claims can be priced under the assumption of complete markets. We implement this using a computer simulation, that allows us to price fairly general guarantee structures.

In all cases, there are two fundamental parameters which influence the outcome: (a) the initial wage and (b) the equity fraction. Different values of the initial wage and different assumptions about the fraction invested in equities can generate extremely different results for the three summary statistics we seek. Hence, all our calculations are done for a grid of values ranging from an initial income of Rs.10/day to Rs.200/day, and ranging over values of the equity fraction from 0 to 1.

Equity investment induces an enormous upside, where there is a possibility of ending up with extremely high returns. We focus on the downside, or scenarios where the terminal pension wealth is not able to buy an annuity of even $1/day. We find that without any guarantees, there is an interesting "plateau of poverty" where individuals with a low income and a low equity fraction are very likely to end up in poverty. For the poor, equity investment offers a hope of escaping poverty, while investing in government bonds generates a certainty of being in poverty. This relationship changes for the rich, who can avoid poverty for sure using government bonds, but run a risk of encountering poverty when investment in equity is done.

Guarantee structure 1 involves a guarantee that post-retirement consumption would exceed $1/day. This guarantee turns out to cost as much as Rs.60,000 per person for the poor. It costs very little for the rich. It is costlier for individuals who invest more in equities. It succeeds in eliminating ex-ante uncertainty about old-age consumption for the poor, while being irrelevant for the rich.

Guarantee structure 2 can be visualised as a 'capital preservation guarantee'. We add up the contributions over life, and if the terminal wealth is below this sum, it is topped off to be the sum. The guarantee that we analyse is stronger than the conventional notion of a capital preservation guarantee in that it ensures returns above 0 percent in *real* terms, i.e. after inflation. We find that it is relatively inexpensive, since the probability of obtaining a negative real return in fund management, over multi-decade horizons, is rather low. It is more precious for individuals who have a larger equity fraction.

Guarantee structure 3 ensures that the first monthly pension is above 50 percent of the last monthly wage. It is highly effective in eliminating poverty amongst all but the poorest workers. However, it is an extremely expensive guarantee, with much higher prices being associated with richer workers.

Our calculations suggest that even though these guarantee structures may appear somewhat similar to each other, the are extremely dissimilar in their consequences and in the valuation. This suggests that such computations should be done as part of any policy effort in thinking about guarantees.

These calculations suggest that if any of these three guarantee structures were supplied by the State, this would involve a significant fiscal impact. A guarantee costing Rs.5,000 per person implies a notional cost to the State of Rs.0.5 trillion in extending it to 100 million workers. Going beyond the fiscal costs, these guarantees have significant incentive implications for the behaviour of workers, and have serious distributional implications.

If guarantees had to be produced using private financial markets, we encounter the hurdle that as of today, equity index option markets are generally fairly illiquid when compared with the demands made in the context of a pension system. This is particularly true in India, where the options market has been hindered by financial sector regulation.

The paper ends with some modest "feasible policy choices". We suggest that it is prudent to emphasise 100 percent self-funding of guarantees: workers should make choices about the guarantee structure they desire, and they should pay the full price of buying such a guarantee from financial markets. This would necessarily imply that we would initially have access only to short-dated guarantees. In parallel, the policy impediments which are holding back the index option market can be addressed, so as to obtain greater liquidity in long-dated index options. Such an approach would gradually open up a larger scope for guarantees in the pension sector.

The diversification of portfolios across countries has long been viewed as a key tool for reducing investment risk. This reduction in risk makes international diversification attractive in its own right. Since option prices are lower when portfolio volatility is smaller, comparable guarantees are cheaper when implemented on an internationally diversified portfolio. In addition, we argue that international diversification is particularly attractive since financial markets abroad offer more liquid index options, and can hence support real-world implementation of more sophisticated guarantee structures.

6.2 Investment Risk in Pensions and the Role for Guarantees

In recent decades, pension systems have increasingly moved towards defined contribution programs, and investment policies which harness risk factors. The equity premium (Siegel 1998) has come to prominence in thinking about policies followed by pension funds.

The major difficulty with DC pension systems is the problem of investment risk. The participant in a DC pension system is given no guarantee about the value of pension assets, and hence the stream of annuities, faced upon retirement. This exposure to uncertainty reduces the welfare of risk-averse workers.

This has generated heightened interest in the questions of risk management for pension investments. There are many mechanisms of risk management which can be adopted. At the simplest, participants can voluntarily modify their exposure to high-volatility asset factors depending upon their age profile and their risk preferences. Such individual risk management efforts could be supplemented by *guarantees*, where there may be a role for public policy. In this paper, we focus upon the valuation and consequences of pension guarantees in the Indian pension system.

In order to do this, we will explicitly articulate certain guarantee structures, and seek to obtain numerical values for the price profile of these guarantees in an idealised complete-markets setting, under certain assumptions about the parameters which characterise price processes in India.

This paper is not primarily focused on the question of *whether* there is a role for equity investment in pension fund management. Several simplifying assumptions made in this paper, in order to obtain concrete answers on questions of guarantees, bias the outcomes in favour of or against equity investment. This paper should best be utilised in better understanding the *consequences* of envisioning guarantee structures in a world where pension funds invest in the equity index.

6.3 Modelling Assumptions

We will focus upon investment risk and the valuation of guarantees in a simplified setting, which is described here.

- **Timeframe** A worker embarks on pension contributions at time 0, and retires at age T.
- **Income** We assume that his wage starts off at W_0, and grows at a fixed rate of w percent per year. We assume that there is no uncertainty about future wages.
- **Contribution rate** We assume a fixed contribution rate c for life, whereby cW_t is accreted into the pension account in each time period.
- **Inflation** All our analysis is conducted in real terms. This has the strong advantage that all numerical values seen in this paper, whether

they pertain to contributions at age 20 or benefits at age 60, are interpretable in terms of price levels prevalent in 2002.

- **Equity versus government bonds** We assume a fraction λ of the portfolio is always invested in equities. That is, we assume that the portfolio at time t consists of λV_t equity and $(1-\lambda)V_t$ in debt. We assume that all equity investments are implemented through an index fund (Shah & Fernandes 2001).

- **Asset market assumptions** We assume that daily log returns on the equity index are drawn from $N(\mu, \sigma_M^2)$, and that government bonds risklessly yield a non-stochastic return r_f.

  In recent years, r_f in India has exhibited high volatility. To a significant extent, this volatility can be attributed to the initial effects associated with a secular drop to modest inflation, the easing of financial repression, and the move to a floating exchange rate. In coming decades, we may expect a more normal r_f, based on low inflation rates, and reduced State involvement in determining interest rates and exchange rates.

  The assumptions of deterministic general inflation and wage-rate inflation generate a bias in this analysis, against equities. For example, in a pension program where benefits are linked to terminal wages, the risks associated with investment in government bonds are those of shocks to inflation and shocks to productivity. Equity investment is attractive in that it provides partial protection against inflation risk and stronger protection against positive productivity shocks.

- **Annuity market assumptions** We assume there is a market for annuities, where a worker of age T can convert a stock of assets A into a flow of Rs.1 per day until death. We assume complete annuitisation, i.e. on date T, the entire stock of pension wealth V_T is used to buy an annuity. We assume that consumption in old age is solely based on this annuity.

  In the future, improvements in mortality (and fluctuations of interest rates) could yield different values for A. However, in this paper, we assume that A is a constant.

- **Poverty** We assume that consumption below Rs.$\bar{C}$ per day constitutes a state of poverty. In other words, an outcome $V_T/A < \bar{C}$ is synonymous with ending up in poverty in old age. Hence, we use the symbol $\bar{V}_T = \bar{C}A$.

The model works using iterations in time through the equations –

$$\begin{aligned} r_{Mt} &\sim N(\mu, \sigma_M^2) \\ V_{t+1} &= e^{r_{Mt}}\lambda V_t + (1+r_f)(1-\lambda)V_t + cW_t \\ W_{t+1} &= (1+w)W_t \end{aligned}$$

These iterations proceed, one day at a time, from time 0 till T. At date T, the stock of assets V_T is used in buying an annuity V_T/A giving a replacement rate $V_T/(AW_T)$.

The numerical values that we use in this paper, which appear to be plausible in an Indian setting, are:

T We assume $T = 40$, which may be roughly equivalent to a labour market career which runs from age 20 to age 60. This implies simulating over 10,000 days in one trajectory.

w Wage growth is assumed to be 3 percent per annum.

c The contribution rate is assumed to be 8.33 percent.

r_f We assume that the real return on government bonds will prove to be 3 percent per year.

r_M We assume the daily returns on the index has volatility 1.3 percent (per day). We assume that the equity premium will prove to be 7 percentage points. These values are plausible estimates for the NSE-50 index (Shah & Thomas 1998), which is the dominant index used with index derivatives and index funds in India.

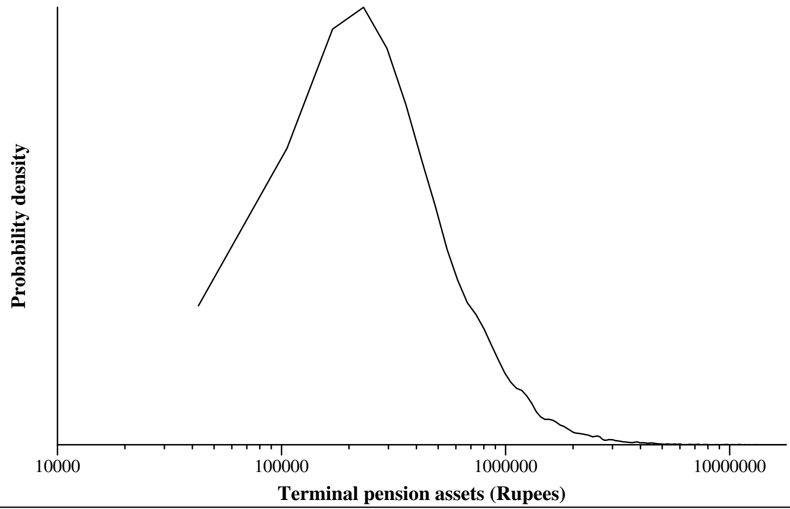
A We assume that the market for annuities sells an annuity for a price of Rs.3,842 which yields a flow of Rs.1/day. This is drawn from the price of annuities sold by the Life Insurance Corporation (LIC), as of 2002.

$\bar{C}$ We assume that the threshold of poverty is $\bar{C} = 50$, which is roughly equivalent to consumption of a dollar a day. Conversely, the worker needs $\bar{V}_T = 192,100$ in order to avoid poverty in old age.

There are two key parameters which have a major impact upon the analysis. These are the initial wage W_0, and the fraction of equity investment λ. The choice of these two parameters has a profound impact upon the valuation and the consequences of guarantees. In order to explore these relationships, we work with a two–dimensional grid of values for these two parameters, with W_0 ranging from Rs.10 per day to Rs.200 per day, and the fraction in equities ranging from 0 to 1.

In order to assist intuition, Figure 6.1 shows the kernel density plot of V_T obtained using $W_0 = 50$ and $\lambda = 1$. It highlights the enormous dispersion in the upper tail of the distribution of pension assets. The median of the distribution is Rs.406,950, and the 99th percentile is over ten times that. This serves to remind us that equity investment is a powerful tool for obtaining low-probability events of extremely high returns. At the same time, there is a class of events in the lower tails, i.e. outcomes involving extremely poor equity returns. The focus of guarantees would be on eliminating the lower tail of this distribution, while continuing to give workers the upside (i.e. the upper tail).

Figure 6.1 Distribution of V_T: One example ($W_0 = 50$ and $\lambda = 1$)



6.4 Alternative Guarantee Structures

In this paper, we analyse four structures:

0 *No guarantee.* At the simplest, we analyse the consequence of an investment strategy which is purely driven by asset pricing outcomes.

1 *Guarantee that avoids poverty*. In this structure, if the worker finds himself in poverty at time T, the pension system tops off the terminal pension assets in order to ensure that $V_T/A > \bar{C}$. This constitutes a transfer of $V_T - \bar{V}_T$ to the worker.

2 *Guarantee that returns will beat inflation*. In this structure, if the real rate of return obtained by the participant on his entire lifetime of pension contributions drops below 0 percent, the pension system will top off terminal pension assets so as to atleast reach this 0 percent level. While this may also be called a "preservation of capital guarantee", it is stronger than the conventional interpretation of capital–preservation guarantees in that the guarantee is invoked when returns drop below 0 percent in *real* terms.

3 *Minimum replacement rate*. In this structure, if the replacement rate drops below 50 percent, the pension system will top off terminal pension assets to as to reach a replacement rate of 50 percent. In other words, if $V_T < \frac{1}{2}AW_T$, V_T is topped off to $\frac{1}{2}AW_T$.

There is always room for other, innovative mechanisms through which guarantees can be supplied. However, these four structures are important and plausible alternatives which merit careful analysis.

Some countries, like Chile, have created guarantee structures which deal with the *relative* performance of one pension fund manager when compared with other pension fund managers (Turner & Rajnes 2002). The relative returns guarantee addresses the risk that a given worker will have hired a fund manager who turns out to do much worse than other fund managers. It does not address the underlying and fundamental source of investment risk, the fluctuations in asset markets, which would affect all fund managers.

We assume that all equity investment is implemented using index funds, which essentially eliminates the risk of a malfunctioning fund manager, and then focus on risk management issues associated with the irreducible risk that is then faced by all fund managers: the fluctuations of the equity index.

6.5 Understanding Alternative Guarantee Structures

For a range of assumptions about initial income W_0, and for a range of assumptions about the fraction invested in equities λ, we seek to quantitatively understand these four alternative guarantee structures.

There are three numerical values, about each guarantee structure, which will shed much light in understanding it:

- **The probability of poverty in old age** In each scenario, we seek to know the probability that $V_T > \bar{V}_T$. What is the probability that when the terminal pension wealth V_T is annuitised, the worker is in a state of poverty, with consumption below $\bar{C}$?
- **A measure of investment risk** In our model, future income is deterministic, and the equity market is the sole source of uncertainty. When $\lambda > 0$, there is an ex-ante probability distribution of the replacement rate that a given worker will obtain.

  In a defined contribution pension system with individual accounts, each worker would control his own λ. Each guarantee structure then induces a probability distribution of the replacement rate $V_T/(AW_T)$. There is a welfare loss associated with the ex-ante uncertainty in the replacement rate.

  We use the the difference between the 75th and 25th percentile of the replacement rate, i.e. the interquartile range, as a metric of the investment risk.
- **Cost** We measure the cost of the stated guarantee structure, under certain assumptions.

6.5.1 Measuring the Cost of a given Guarantee Structure

Each guarantee structure corresponds to certain contingent payoffs. These can be valued using the general methods of the option pricing literature

(Black & Scholes 1973, Merton 1973), which have been extensively used in research on pensions (Lachance & Mitchell 2002, Pennacchi 1998, Smetters 2000).

These approaches to pricing critically rely on the assumption of complete markets, i.e. the assumption that financial markets offer trading opportunities for all states of nature. This assumption is clearly violated in the real world. Yet, pricing guarantees through this approach does constitute a useful benchmark for the price that would prevail in a certain idealised setting.

The key result of the option pricing literature is a concept called *risk neutral valuation*, which asserts that when markets are complete, the valuation of contingent claims can be done without reference to preference parameters. In the Black-Scholes world, the fair value of a contingent claim is the present value of payoffs under a risk-neutral random walk of underlying asset prices. The general approach to using simulation for measuring the value of the contingent claim is as follows:

1. Using the risk-free measure, we simulate sample paths of the underlying state variables over the relevant time horizon,
2. We estimate the discounted cashflows of a contingent claim on each sample path, as determined by the structure of the contingent claim in question, and
3. We average the discounted cashflows over sample paths.

In this paper, we simulate 10,000 trajectories through time, while assuming that there is no equity premium.[2] The NPV of the payout for each guarantee structure, in this 'risk neutral world', is the fair value of the guarantee.[3]

[2]It is important to distinguish between the 'real world' and the 'risk neutral world'. When we seek to understand issues like the probability of encountering poverty in old age, or the inter-quartile range of the replacement rate, we need to conduct simulations in the real world, where the magnitude of the equity premium matters. For the limited purpose of computing the value of contingent claims, we work in the risk-neutral world, where our assumption about the equity premium is irrelevant.

[3]As an example, consider a scenario where the pension wealth is initialised to $V_0 = 200,000$, and we set $T = 1$ (i.e. one year to retirement). Let $\lambda = 1$, $W_0 = 120$ and $c = 0$. This is a setting with an all-equity portfolio where there are no incremental contributions going into pension assets.

Guarantee structure 1 now constitutes a put option on the index which ensures that V_T does not drop below Rs.192,100. It proves to have a price of Rs.9964. Guarantee structure

Our analysis is a partial equilibrium analysis, in the sense that we do not consider the consequences upon equilibrium rates of return of a large volume put-protected equity investments by the pension system (Constantinides et al. 2002). We return to this issue in Section 6.7.

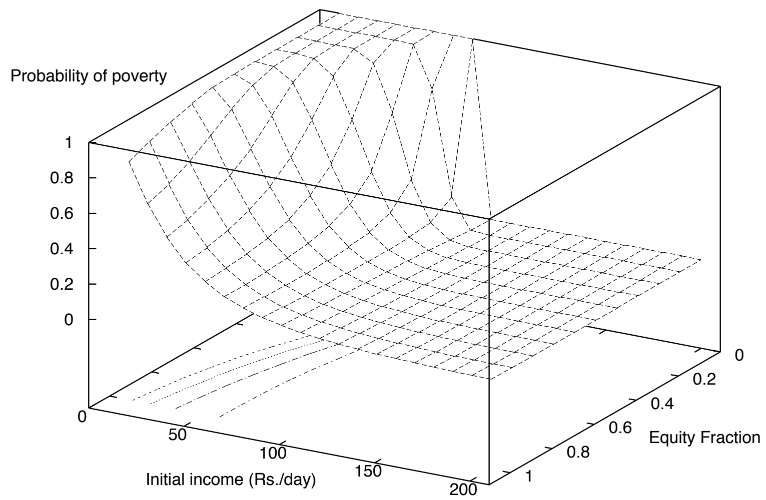
6.6 Results

6.6.1 Structure 0 – No Guarantees

At the simplest, we analyse the consequence of an investment strategy which is purely driven by asset pricing outcomes, i.e. no guarantees.

Figure 6.2 shows the probability of facing poverty in old age. Some numerical values out of this figure are shown in Table 6.1.

Figure 6.2 Probability of falling into poverty (no guarantees)



The remarkable feature of this graph is the interplay between initial income and the equity fraction. For the poor, investment in government bonds generates a certainty of poverty, but equity investment offers some hope of

3 sets a target of terminal consumption of Rs.60, i.e. a target $V_T = 230,520$. This proves to have a price of Rs.31,607.

Table 6.1 Probability of falling into poverty (no guarantees)

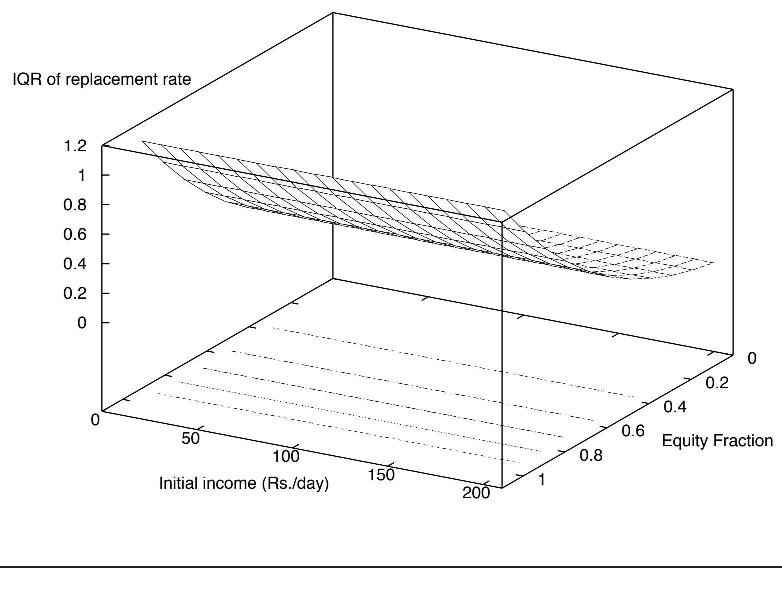
W_0	Equity fraction λ		
	0	0.5	1.0
10	1.000	0.999	0.844
50	1.000	0.394	0.248
100	0.000	0.025	0.064

escaping poverty. Thus we get a 'plateau' in Figure 6.2, where low W_0 and low λ generates a near-certainty of ending up in poverty.

In contrast, for the rich, investment in government bonds offers a certainty of escaping poverty, while equity investment generates some possibility of suffering from it.

Figure 6.3 shows the inter-quartile range of the replacement rate for different values of W_0 and λ. We see that higher fractions of equity investment generates a larger dispersion of outcomes, and that altering W_0 does not influence this dispersion.

Figure 6.3 Inter-quartile range of the replacement rate (no guarantees)

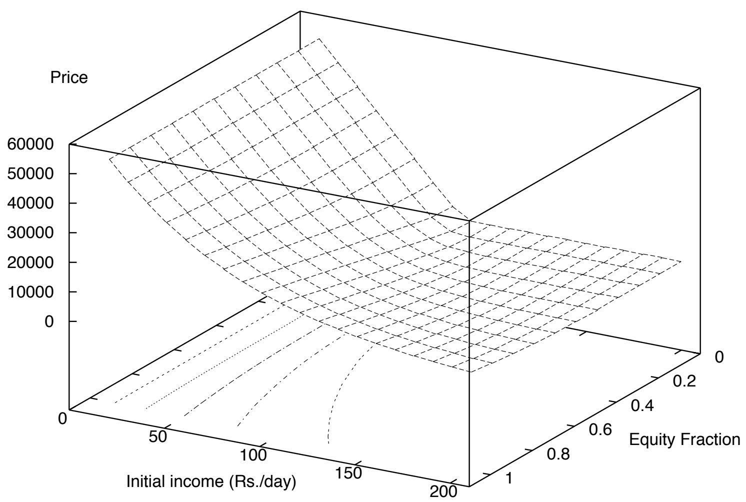


6.6.2 Structure 1 – Avoiding Poverty

In this structure, if the worker finds himself in poverty at time T, the pension system tops off the terminal pension assets in order to ensure that $V_T/A > \bar{C}$. This constitutes a transfer of $V_T - \bar{V}_T$ to the worker. Once this guarantee structure is in place, all workers have a certainty of avoiding poverty, in contrast with the un-guaranteed outcome (seen in Figure 6.2).

Figure 6.4 shows the price of this guarantee. All the values are expressed in rupees on date 0. That is, if a price of Rs.10,000 is seen, then this is the price that has to be paid for the guarantee (in a Black/Scholes world) on date 0.

Figure 6.4 Cost of guarantee (structure 1)



The first order regularity here concerns income. The cost of guaranteeing that a low-income worker will avoid poverty in old age is higher than that seen for the rich.

Less strikingly, there is an impact of the equity fraction also. For the rich, this guarantee structure implies insuring them against low-probability events where extremely negative outcomes on the equity market force them into poverty. Figure 6.5 shows how the value of the guarantee varies with the equity fraction for a person where $W_0 = 90$: it is a slice of Figure 6.4 for the value $W_0 = 90$. This level of initial income happens to be the lowest point at which $\lambda = 0$ is sufficient to stave off poverty. For these individuals, as the equity fraction is increased, the worker keeps the upside, but the value of the guarantee goes up.

Figure 6.5 Value of Guarantee 1 for a person with $W_0 = 90$

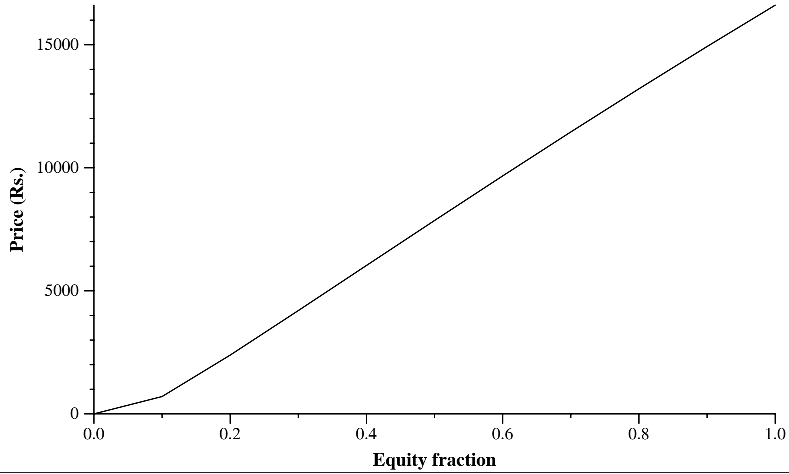


Figure 6.6 shows the inter-quartile range of the replacement rate for different values of W_0 and λ. We see that for the poor, this guarantee structure generates a certainty of getting to a certain consumption (Rs.50/day), and there is no dispersion for these values.

6.6.3 Structure 2 – Beating Inflation

In this structure, if the real rate of return obtained by the participant on his entire lifetime of pension contributions drops below 0 percent, the pension system will top off terminal pension assets so as to atleast reach this 0 percent level. While this may also be called a "preservation of capital guarantee", it is stronger than the conventional interpretation of capital–preservation guarantees in that the guarantee is invoked when returns drop below 0 percent in *real* terms.

Figure 6.7 shows the value of this guarantee. We see that the prices faced here are substantially smaller than those seen for the guarantee that poverty

Figure 6.6 Inter-quartile range of the replacement rate (Guarantee 1)

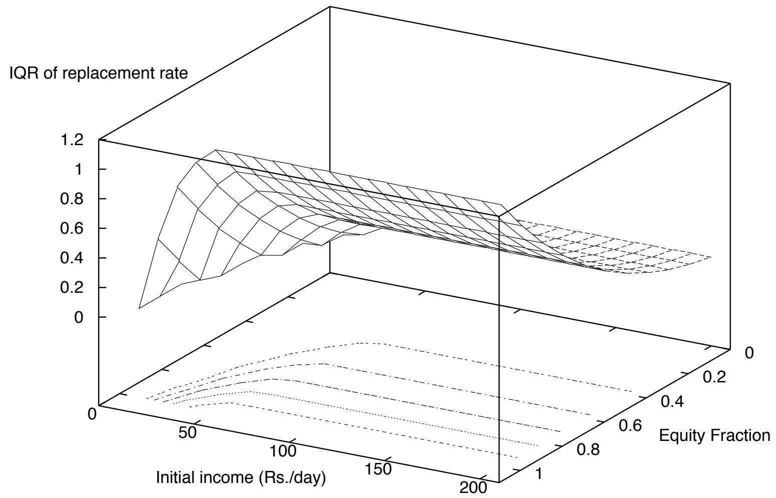
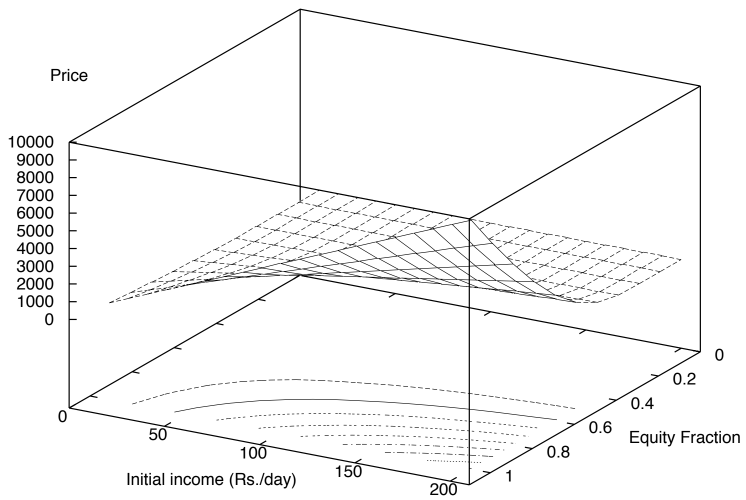


Figure 6.7 Cost of guarantee (structure 2)



will not occur. Conceptually, over these long investment horizons, it is extremely unlikely that a series of negative equity returns will be encountered, thus generating an overall negative real return. Hence, this guarantee is relatively unlikely to be exercised, and costs little.

As expected, we see that the price of this guarantee is higher for the rich, and for those who invest more in equities.

6.6.4 Structure 3 – Replacement Rate Above 50 percent

In this structure, if the replacement rate drops below 50 percent, the pension system will top off terminal pension assets to as to reach a replacement rate of 50 percent. Figure 6.8 shows the impact of this guarantee structure upon the probability of encountering poverty in old age. We see that for sufficiently high values of W_0, it is tantamount to having a certainty of avoiding poverty (given the growth of wages that takes place over the T years).

Figure 6.8 Probability of falling into poverty (Guarantee 3)

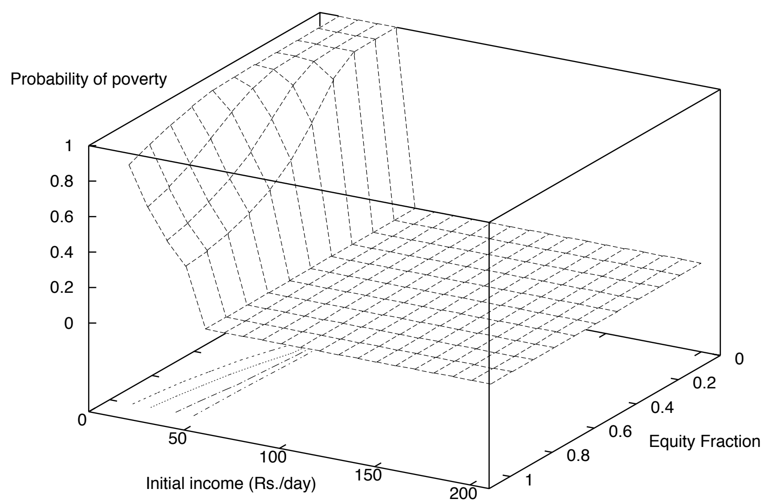
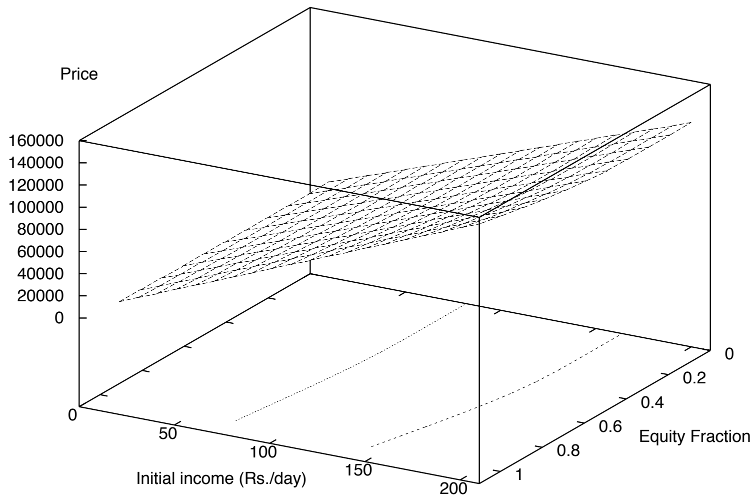


Figure 6.9 shows that it is an extremely expensive guarantee to offer. The price of this guarantee reflects the relationship between our assumptions for

wage growth, contribution rate and the riskless rate of return. It is possible to obtain lower estimates for the price of this guarantee by assuming low rates of wage growth, high contribution rates, and high rates of return.

Figure 6.9 Cost of guarantee (structure 3)



This structure leads to particularly high prices of the guarantee for the rich (who end up with a large value for W_T), and for those investing in equities (who keep the upside of the equity market, but pass on the downside risk to the provider of the guarantee).

6.6.5 Summarising Valuation of Guarantees

Table 6.2 shows a few numerical values for the prices obtained for the three guaranteed structures, for a 3×3 grid of W_0 and λ. The highlights of this table are as follows:

- Capital protection is the cheapest of these guarantees.
- Guarantee 1 (no–poverty guarantee) is expensive for the poor, and cheap for the rich (who are likely to escape poverty based on their

own contributions). In contrast, the replacement rate guarantee is very expensive for the rich.

- All guarantees are costlier with high λ, since they involve options on a more volatile portfolio.
- Most of the values seen here are enormous when scaled up into the Indian economy. A guarantee costing Rs.5,000 per worker maps to a overall cost of Rs.0.5 trillion for 100 million workers.

Table 6.2 Summarising the valuation of guarantees (prices in rupees)

	Equity fraction λ		
	0	0.5	1.0
1: Avoiding poverty			
$W_0 = 10$	51,992	51,992	52,042
$W_0 = 50$	24,407	25,229	29,712
$W_0 = 100$	0	5,541	14,383
2: Capital protection			
$W_0 = 10$	0	50	452
$W_0 = 50$	0	248	2262
$W_0 = 100$	0	496	4525
3: Replacement above 50%			
$W_0 = 10$	6,105	6,210	7,026
$W_0 = 50$	30,533	31,051	35,134
$W_0 = 100$	61,067	62,102	70,269

6.7 Public Policy Questions Associated with Guarantees

6.7.1 Who Pays for the Guarantee?

At the simplest, these calculations suggest that if a pension system seeks to offer assured returns to participants, then these assurances have a considerable economic cost, even in an ideal world where markets are complete and adequately liquid.

In debates on pensions, it is often assumed that the State would fund guarantees using general tax revenues. This approach suffers from several weaknesses:

- **Fiscal impact** There are two aspects of the fiscal impact of guarantees.

First, if the State undertakes guarantees, but does not hedge its exposure using derivatives markets, then the stock of outstanding guarantees constitute off-balance sheet contingent liabilities for the State. This introduces non-transparency and risk in public finance.

Further, even if the State engages in sound risk management and reporting, where guarantees are implemented using private markets, our calculations suggest that giving free guarantees to workers is extremely expensive. A pension system with 100 million participants, and a guarantee worth Rs.5,000 per person, constitutes a transfer of Rs.0.5 trillion.

- **Incentive implications** The behaviour of pension participants would not be unchanged when a guarantee program is announced. As highlighted above, in a DC pension system, guarantees could generate actions which generate lower contributions and/or a higher fraction of assets invested in equities. For example, under guarantee structure 3, workers have an incentive to work for fewer years, and concentrate on only having a high terminal wage rate.[4]

  The moral hazard induced by pension guarantees is also closely linked to population-wide anti-poverty programs. If there is a safety net, then individuals are more likely to engage in high risk bets, where they keep the upside, but can fall back upon State support in the event that low returns materialise. This suggests that the poor are particularly likely to exploit investment strategies with high equity investment and low expenditure on guarantees, if there is a credible assurance of a safety net from the State.

- **Political economy** Guarantees raise concerns about fiscal prudence, and fiscal non transparency.

  The governance capacity in the Indian pension sector is, as yet, highly limited. For example, there is a large mandatory DC pensions

[4] In an extreme scenario, under guarantee structure 3, a worker who choose to be unemployed for life, but only works at a high wage for one month at age 60, would get an attractive pension for life. It may be assumed that in the real world, if such a guarantee structure is used, there would be safeguards against such behaviour. However, more modest versions of distorted behaviour would surely arise, such as efforts to work for fewer years and ensure a high terminal wage.

system which substantially invests in government bonds, does not as yet engage in daily marking to market, and believes that the rate of return obtained in the past is a policy variable. In such an environment, if pension guarantees were a tool of public policy, there are concerns about imprudent guarantees being announced without corresponding risk management strategies and transparency about the fiscal implications.

- **Distributional implications** Our results show that alternative guarantee structures have very different distributional consequences. This is clearly seen in Table 6.2. If a government announces a free guarantee of the replacement rate (which would be analogous to EPS or the Civil Servants), this sharply favours the rich. Conversely, a free guarantee of avoiding poverty largely favours the poor.

These arguments suggest that a desirable course is one where each worker is charged the full price of the guarantees consumed by him; where guarantees are produced by firms in the private sector and sold to the worker at a market price.

6.7.2 Implementation Difficulties in the Real World

If there was an attempt at creating these guarantees purely using private markets, the major constraint faced is that of a lack of liquidity on the index options market. There is no country in the world where index options have significant liquidity for horizons exceeding a few years.[5]

There may be a role for the State to be a market maker in overcoming this 'missing markets' problem (Moss 2002). This could take the form of a government selling put options to pension fund managers, or the government putting out two-way quotes on options markets. These ideas need further thought in order to fully comprehend their consequences. They also assume considerable governance capacity and technical capabilities on the part of the State.

[5] If a liquid index options market came about, there may be concerns about credit risk. If an economic agent X has sold an index put option with a ten-year maturity, this implies that the pension system customer is exposed to the credit risk of X for the next ten years. In practice, this is not a problem as long as the transaction enjoys the credit enhancement services of the futures clearing corporation.

6.7.3 Ramifications in General Equilibrium

This analysis has been conducted in partial equilibrium. We assume that the data generating process for stock prices, and the fair value of option prices, is unaffected by the design of the pension system. However, it is extremely likely that when the pension system enables large-scale purchases of the index spot and of index put options, these markets will be affected.

The Black/Scholes model, and modern ideas on the pricing of derivatives, are founded on the no-arbitrage principle. The model implies certain links between the spot and the derivatives markets. If a high volume of buying of put options makes them ‘too costly’, this will throw up arbitrage opportunities, and private traders will exploit these arbitrage opportunities, so as to bring the spot price and volatility in line with the option prices.

In India today, the regulatory framework does not recognise the concept of a hedge fund, and financial regulation inhibits arbitrage activities of banks, insurance companies and pension funds. However, assuming these problems will be addressed in the future, we may expect that spot prices and option prices will be internally consistent, regardless of the scale of purchase of put options by customers of the pension system.

This leaves questions about the equity premium, and potentially about equity volatility. This paper has assumed ‘undistorted values’ for these parameters. If the pension system engages in extremely large investments in index funds coupled with extremely large purchases of put options, it is conceivable that one or both of these parameters could change, in general equilibrium.

6.7.4 Feasible Policy Alternatives

Despite these difficulties, there are mechanisms through which a DC pension system in India can move towards access to some kinds of guarantees:

- **100 percent self-funding principle** It would be prudent for the DC pension system to put decisions in the hands of each participant, where the participant makes a choice to determine his own guarantee structure (if any), pays a full price for it, and the guarantee is actually purchased from private financial markets.

- **Short dated guarantees** This implies that the guarantees which can be offered in the forseeable future would have to be short-dated. If liquidity on the index options market builds up, it may be possible to obtain guarantees going 1-3 years out.

  For many workers, an attractive lifetime investment strategy may be to hold 100 percent unhedged equities when young, and initiate protection using put options when nearing retirement. This strategy can be fully achieved using a sequence of short-dated guarantees.

- **Fostering the market for index put options** The key factor which can impact upon the availability of guarantees from private markets would be rising sophistication and liquidity of the index option market. There are numerous policy impediments which are holding back this market today. These include regulatory impediments against equity derivatives transactions by banks, insurance companies and pension funds, a ban on bank credit to arbitrageurs, a prohibition against banks engaging in arbitrage, a lack of short selling mechanisms on the spot market which are required to do arbitrage, etc.

- **International diversification** The easiest way through which a DC pension system in India can access an equity premium, while having access to liquid private option markets where guarantees can be obtained, is to exploit international diversification.

  International diversification is a sound and useful idea in investment, regardless of the question of guarantees. An internationally diversified portfolio will (in general) be safer than any portfolio held in only one country. The lower volatility of internationally diversified portfolios implies that guarantees would be cheaper when applied to these.

  The availability of liquid options markets on offshore stock indexes constitutes one additional reason why international diversification should play a major role in India's pension sector.

6.8 Conclusion

Pension guarantees are financial derivatives. As with all derivatives, the guarantee is associated with a price, and we have the ability to *measure* this price in a complete-markets setting.

At a conceptual level, hedging enhances welfare when the expected utility of the hedged position is higher than the expected utility of the unhedged position. This inexorably links questions about guarantee structures to questions about the utility function. Our results about poverty, in this paper, can be interpreted as the implication of using a utility function with utility=0 for a state of poverty and utility=1 for a state outside poverty.

For this utility function, we get striking results, where the poor would see equity investment as offering some chance of escaping poverty, while the rich would be comfortable with riskless assets, since they are certain to escape poverty without needing the equity premium.

Valuation exercises, such as those undertaken in this paper, have a strong role in public policy. They should help more informed decision making on the part of the State; if a State adopts such liabilities, this could be done with a full awareness of the off-balance sheet consequences which flow from a stated guarantee structure. When a full assessment of the public debt is made, such calculations would be useful in computing the implicit pension debt which should be taken into account.

Our calculations highlight the extent to which individuals who are given free guarantees have incentives to alter their contribution rates and equity exposure, in order to maximise the value of the guarantee that is given to them. These distortions could have major consequences for the structure of asset prices in the economy, and for the finances of the government.

From a policy perspective, the most attractive strategy appears to be one where individuals make choices about the three fundamental facets of their old age planning – (a) the contribution rate (b) the equity exposure and (c) the guarantee structure desired – and the individual pays the full price of purchasing the guarantee from private markets. Such a mechanism avoids the distortions that are caused by free guarantees.

There may be a role for the State here to overcome the 'missing markets' problem, where long-dated equity index options tend to be fairly illiquid. However, this calls for a considerable governance capacity on the part of the State.