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# An evaluation of contingent immunization

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ABSTRACT

This paper tests the effectiveness of contingent immunization, a stop loss strategy that allows portfolio managers to take advantage of their ability to forecast interest rate movements as long as their forecasts are successful, but switches to a pure immunization strategy should the stop loss limit be encountered. This study uses actual daily transactions in the Spanish Treasury market covering the period 1993–2003 and uses performance measures that accounts for skewness and kurtosis as well as mean variance. The main result of this paper is that contingent immunization provides excellent performance despite its simplicity.

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## 1. Introduction

The aim of this research is to test the effectiveness of contingent immunization techniques. The pioneer works in this field, Leibowitz and Weinberger (1981, 1982, 1983), developed contingent immunization as a midpoint in a risk-return framework between pure immunization and active bond management strategies. Contingent immunization is a stop loss strategy that allows portfolio managers to take advantage of their ability to forecast interest rate movements as long as their forecasts are successful, but switches to a pure immunization strategy should the stop loss limit be encountered. Specifically, contingent immunization consists of forming a bond portfolio with a duration larger or smaller than the investor's planning period depending on interest rate expectations. If the investor thinks that interest rates are going to rise more than the market expects she would buy a bond portfolio with a duration smaller that her planning period and vice versa. However, if interest rates move opposite to the investor's expectations and the portfolio value falls to a given stop loss limit then she would immunize and guarantee this lower limit for the eventual portfolio return. This strategy gives contingent immunization an option like feature:[1] limiting losses but preserving upside potential if interest rates movements are favourable. Therefore contingent immunization strategies represent an attempt to capture positive (or avoid negative) skewness.

While prior work is supportive of immunization, the accuracy of the results is affected by the assumption that portfolio weights are adjusted periodically rather than when a payment is made from the underlying portfolio. For instance, Fooladi and Roberts (1992) and Ventura and Pereira (2006) assume semi-annual rebalancing while Soto (2001, 2004) assumes quarterly adjustments. Late rebalancing can lead to poor results because immunization can be applied late after the stop loss limited is violated. Late rebalancing therefore can have an important impact on the assessment of contingent immunization as a viable strategy especially if interest rates fluctuate sharply as in the case of the Spanish market during the period 1993–1998.

This paper makes a number of contributions. First this paper makes a high computational effort in measuring the holding period returns of all strategies as realistic and exact as possible by rebalancing the portfolio each time payments are due instead of periodically and checking the portfolio value every day to determine whether the stop loss rule should be implemented. Consequently this paper makes the most accurate assessment of contingent immunization to appear in the literature so far.

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[1] In particularly it could be compared to a synthetic call option.

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**Table 1**
Summary statistics of monthly changes of interest rates from the estimated Spanish term structure.

| | January 1993–January 2003 | | | January 1993–December 1998 | | | January 1999–January 2003 | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 month | 1 year | 10 year | 1 month | 1 year | 10 year | 1 month | 1 year | 10 year |
| Mean (%) | −0.099 | −0.089 | −0.058 | −0.174 | −0.147 | −0.102 | 0.012 | −0.006 | 0.005 |
| Standard deviation | 0.630 | 0.330 | 0.314 | 0.787 | 0.379 | 0.373 | 0.232 | 0.219 | 0.185 |
| Median | −0.030 | −0.120 | −0.050 | −0.173 | −0.143 | −0.076 | 0.033 | 0.00002 | −0.012 |
| Maximum | 2.069 | 0.581 | 0.755 | 2.069 | 0.581 | 0.755 | 0.370 | 0.466 | 0.391 |
| Minimum | −4.049 | −2.287 | −1.142 | −4.049 | −2.287 | −1.142 | −0.591 | −0.545 | −0.372 |
| Skewness | −2.222 | −2.483 | −0.472 | −1.668 | −2.487 | −0.229 | −0.670 | −0.087 | 0.190 |
| Kurtosis | 16.903 | 15.844 | 1.656 | 10.462 | 13.931 | 0.701 | 0.302 | −0.419 | −0.665 |

Second, we borrow from the recent hedge fund literature to include the mean, variance, skewness and kurtosis in our assessment of performance. This is especially important for contingent immunization because, as mentioned earlier, the stop loss limit inherent in contingent immunization can be seen as a deliberate attempt by investors to capture moments of the distribution other than mean and variance. Moreover we examine the performance of not only a variety of contingent immunization strategies, but also classical immunization, active bond and passive equity strategies. Third, we employ an extensive data set of *actual* daily transactions in the Spanish Treasury market covering a 10-year period from January 4, 1993 to January 3, 2003.

We find that contingent immunization strategies implemented via Fisher and Weil (1971) duration provide excellent results, as these strategies are able to capture upside potential while the stop loss limit is by and large effective in preventing large losses. Using a second order duration measure to implement contingent immunization strategies improves the effectiveness of the stop loss limit. We find that by adjusting performance measures for skewness and kurtosis the relative ranking of contingent immunization strategies do improve suggesting that contingent immunization strategies do improve the distributional properties of holding period returns. Moreover these attractive results are achieved without the need for interest rate derivatives that are often illiquid and require complex valuation methods.[2]

This paper is structured as follows. First, we describe the data. Then we determine the structure of the portfolios and propose a model to implement alternative contingent immunization as well as active and pure immunization strategies. In implementing contingent immunization we mainly use traditional Fisher–Weil duration measures but we also consider two factor duration measures that adjust for changes in the level and slope of the yield curve. Third we introduce traditional and innovative portfolio performance measures, specifically the Shape ratio and adjusted Sharpe ratio that account for mean variance, and the modified Sharpe ratio that accounts for four moments of the distribution of holding period returns. Then we present and comment on the results and finally summarize the main conclusions.

## 2. Data

The data set consists of mean daily bonds, bills and repo prices of actual transactions in the Spanish public debt market over the period from January 4, 1993 until January 3, 2003. This data is provided by *Banco de España* and is comprised of daily information on more than 66 different bonds[3] during the whole sample period as well as bills and one-week repo market transactions.

To understand the behaviour of Spanish interest rates during the sample period we first estimate the Spanish term structure every day for the entire sample period.[4] The summary statistics of monthly changes of interest rates are given in Table 1. The levels of one-month, one-year and 10-year interest rates are represented in Fig. 1. Clearly there was a dramatic decrease in interest rates and a twist in the yield curve during the sample period especially during the first half. Moreover, these dramatic changes in interest rates are reflected in the distributional characteristics of changes in interest rates where, especially in the first half, interest rate changes are characterised by negative skewness and large excessive kurtosis. As expected, short rates have a greater volatility than long-term interest rates.

Moreover we conduct a factor analysis of the yield curve.[5] The first three factors can be identified (as usual) as parallel, slope and curvature changes of the yield curve accounting for 77.94%, 15.69% and 4.68% of the total variance respectively. Compared with other countries (see Barrett, Gosnell and Heuson 2004 and Driessen, Melenberg and Nijman 2003) parallel shifts seem to explain less of the behaviour of the term structure so the risk of failure of immunization strategies due to twists of the yield curve is greater than in other default free bond markets.[6]

## 3. Portfolio design

We specify a three-year planning period and divide the sample into 29 three-year overlapping periods. Each period starts at quarterly intervals on the first trading day of January, April, July and October from January 1993 to January 2000. The opportunity set consists of six Treasury bonds with the highest liquidity selected from all the Spanish government bonds outstanding.[7] Two bonds must have a remaining maturity shorter than three years, two bonds must have a maturity longer than three years and the final two bonds must have a maturity close to three and 10 years.

The initial portfolio is rebalanced each time coupons are paid either by reinvesting these payments among the existing bonds in the portfolio or in new bonds with a duration to maintain the given strategy. This is an important innovation as prior empirical work, for example Fooladi and Roberts (1992) and Soto (2001,

[2] We note that one could also use interest rate swaps to implement contingent immunization strategies. Under normal market conditions swaps would be cheaper as a rebalancing instrument as typical bid ask spreads in the swap market can be as little as one to three basis points. However the spread between the swap and the underlying Treasury bond market is subject to liquidity risk so the spreads can widen unexpectedly as the market conditions of 2008 and 2009 have shown.

[3] See http://www.bde.es/banota/series.htm. Of the 66 instruments, at least 29 and at most 33 are outstanding at any point in time during the sample period.

[4] Daily estimates were made using Vasicek and Fong (1982) methodology applied to mean daily prices of all bond and bills traded each day.

[5] Monthly changes in one, three, six and 12-month interest rates and two year to 10-year interest rates were used as inputs to undertake factor analysis.

[6] Immunization risk is the risk of obtaining a lower return than target at the end of the investor's holding period due to term structure movements different from those assumed (usually parallel shifts of the term structure).

[7] Liquidity is measured by its trading volume. For a more detailed analysis of the liquidity of the Spanish Treasury bond market and other related institutional issues see Díaz, Merrick and Navarro (2006).

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