

The Contingent Immunization of Bond Portfolios: An Empirical Study of the German Bond Market

1. Introduction

Since 1970 an increase in the volatility of interest rates could be observed on international bond markets. On the West German bond market the average yield to maturity of Government bonds varied between 5.16% and 11.42% over the last ten years. Bonds, considered to be risk-free for years, are therefore subject to considerable risk. An investment into the 6% Government bond with maturity on March 1st, 1993 lost 27% of its market price in a period from March 31st, 1978 to September 4th, 1981.

Immunization strategies on the basis of the duration concept of bonds were developed to neutralize the price and reinvestment risks of bond portfolios linked with interest rate changes. The quality of coverage offered by these strategies is disputed [1]. Although duration orientated immunization strategies do not completely determine the structure of a bond portfolio, they only leave little scope for active portfolio management and therewith for the exploitation of expected interest rate potential. It is this point of criticism which forms the starting point for the strategy of contingent immunization developed by Leibowitz and Weinberger [2].

This paper will, in the framework of an extensive empirical study, examine for the German bond market in how far the advantage of a combination of active portfolio management and simultaneous insurance of a minimal return on investment offered by contingent immunization can be realized in a

practical environment. The paper is organized as follows. In sections 2 and 3 the general principle of managing a bond portfolio by means of contingent immunization is presented and illustrated by the result of a simulation based on historical data. Section 4 describes the design of the empirical study. The findings of the study are presented in sections 5 to 7 and summarized in section 8.

2. Contingent Immunization

Portfolio management can basically be either active, passive or semiactive. The intention of active portfolio management is to realize a return on investment which is systematically above the market average. Passive management tries to reach the market average return without holding the "overall" market. The semiactive investment strategies can be placed somewhere between the two aforementioned strategies. They can be categorized into maturity and insurance strategies. The latter unlike the maturity strategies, require an interest rate related rebalancing of bond portfolios. If the complete elimination of interest rate risk is the main objective then a pure immunization strategy is pursued. If, though, active portfolio management is the central element and the insurance target only moves into the foreground in the case of a negative development of the portfolio value, then one can call these strategies insurance strategies with interest rate potential. The contingent immunization strategy is such a strategy [3].

Contingent immunization represents a combination of classic immunization and active management techniques. This offers the opportunity of being able to both pursue active portfolio management and achieve a minimum rate of return or a minimum terminal portfolio value, should the expectations underlying the active strategy not come true. To make use of these advantages one must, though, sacrifice part of the return of investment one could have achieved with full immunization. This sacrifice of return on investment, which is called cushion spread, opens up scope for active portfolio management. The chosen active strategy can be pursued as long as the current portfolio value secures the minimum rate of return over the entire planning period. The switch to an immunization strategy must be made if the minimum rate of return is endangered in any one point of time for the entire planning period.

To make the definition of a contingent immunization strategy precise, three elements of this strategy must be specified. Firstly, it has to be clarified which type of active strategy is pursued. Secondly, the method of how the portfolio is to be immunized against interest rate risk, whenever it proves necessary, must be defined. Thirdly, the size of the cushion spread has to be fixed. Therefore, there exists a considerable amount of freedom to select one procedure from the class of contingent immunization strategies. An example for the performance of one particular contingent immunization strategy is given below.

The successful execution of a contingent immunization strategy hinges on two conditions:

- (1) The development of the portfolio value over time must be observed continuously in order to be able to react immediately to critical interest rate changes.
- (2) Speed and magnitude of interest rate changes must permit timely rebalancing of the portfolio. If a sudden unexpected jump in the interest rate causes the current value of the portfolio to drop considerably below the portfolio value necessary to secure the minimum rate of return the switch to an immunization strategy is triggered but

the achievement of the minimum return on investment is no longer guaranteed. One possibility to reduce the effects of interest rate leaps is to determine a sequence of high interest rate levels at which, when reached, a part of the portfolio is immunized against interest rate changes up to the planning horizon (multi-point stop-loss strategy).

3. Contingent Immunization: An Example

To illustrate the general description of contingent immunization in section 2 the results from a simulation based on historical data for a 4 year period are presented in figure 1. In this figure the development of four different portfolio values is presented:

- The dashed line (long dashes) shows the value of a portfolio which is theoretically immunized against interest rate risk from the very beginning of the planning period. In every point of time it consists of two bonds in such a way that the duration of the portfolio equals the time distance to the planning period. For this purpose those two bonds were selected from the universe of bonds issued by the German Government, the German National Railways or the German National Post Office whose durations differ approximately half a year from the planning horizon.
- The dash-dotted line represents the minimum value the actively managed portfolio must have in every point of time in order to guarantee the minimum rate of return for the 4-year planning period. This minimum rate of return is specified at the beginning of the planning period as the rate of return of a fully immunized portfolio minus a cushion spread of 50 BP p.a. Whenever the value of the actively managed portfolio falls below the current minimum terminal value the portfolio strategy switches to the immunization strategy.
- The bold line shows the value of the actively managed portfolio until May, 18th, 1979. After

this “trigger point” it represents the value of the fully immunized portfolio, whereas continuing active management results in the dotted line. The active strategy is defined in a very simple way: Every Friday that bond from the universe of bonds defined above is selected which currently has the highest yield to maturity. Whenever the bond with the highest yield to maturity changes, the portfolio is rebalanced.

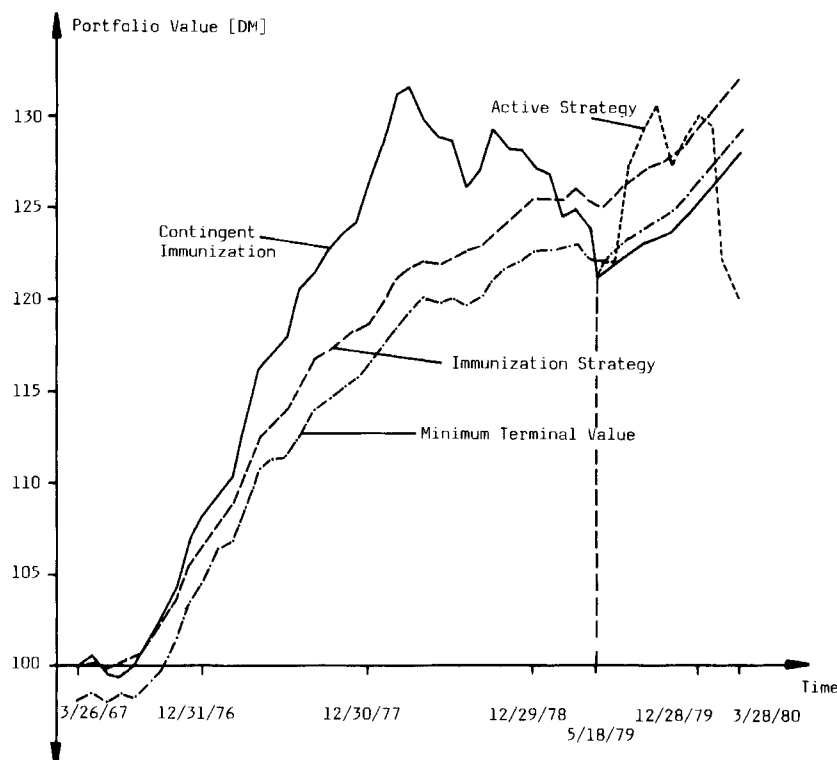
As can be seen from figure 1 this example is based on a planning period from March 26th, 1976 to March, 28th, 1980. During this period the average yield to maturity of public bonds fell from about 8% to 5.2% (February 1978) and then rose sharply to 10%.

Transaction costs for rebalancing the portfolio are not accounted for. A weekly check is carried out to determine whether the current portfolio value is above the critical value. At the beginning of the

planning period, a risk-free rate of return of 7.11% p.a. is achievable up to the planning horizon. Together with a cushion spread of 50 BP p.a. this results in a minimum rate of return of 6.61% p.a.

Figure 1 makes clear that with active management as described above the portfolio value is above the critical portfolio value until May 11th, 1979. The portfolio is rebalanced on May 18th, 1979 and an immunization strategy using the duration concept is followed up to the end of the planning period. By this way the conditional immunization strategy leads to a rate of return of 6.39% p.a. over a 4-year planning period. This means that the result is 22 BP p.a. below the intended minimum rate of return. Two reasons must be mentioned for this negative deviation. Firstly the portfolio value was DM 1 below the critical portfolio value at the point of rebalancing and, secondly, the pursued immunization strategy did not lead to a complete elimination of the interest rate risk.

Figure 1: Portfolio Value under the Contingent Immunization Strategy and the Corresponding Substrategies. (Period from March 26th, 1976 to March 3rd, 1980, without transaction costs).



If the active strategy had been pursued beyond May 18, 1979 up to the planning horizon this would have led to a rate of return of 4.69% p.a., being 170 BP less than the result achieved with contingent immunization. As a comparison, an immunization strategy carried out from the beginning of the planning period would, in retrospect, have delivered a rate of return of 7.22% p.a. and therewith 11 BP more than the value attained in advance.

Fig. 1 furthermore makes clear that a positive development of the interest rate in the period after May 18th, 1979 did not lead to a return to the active strategy. Once a portfolio has switched to the immunization status it remains as such up to the planning horizon (one-point stop-loss).

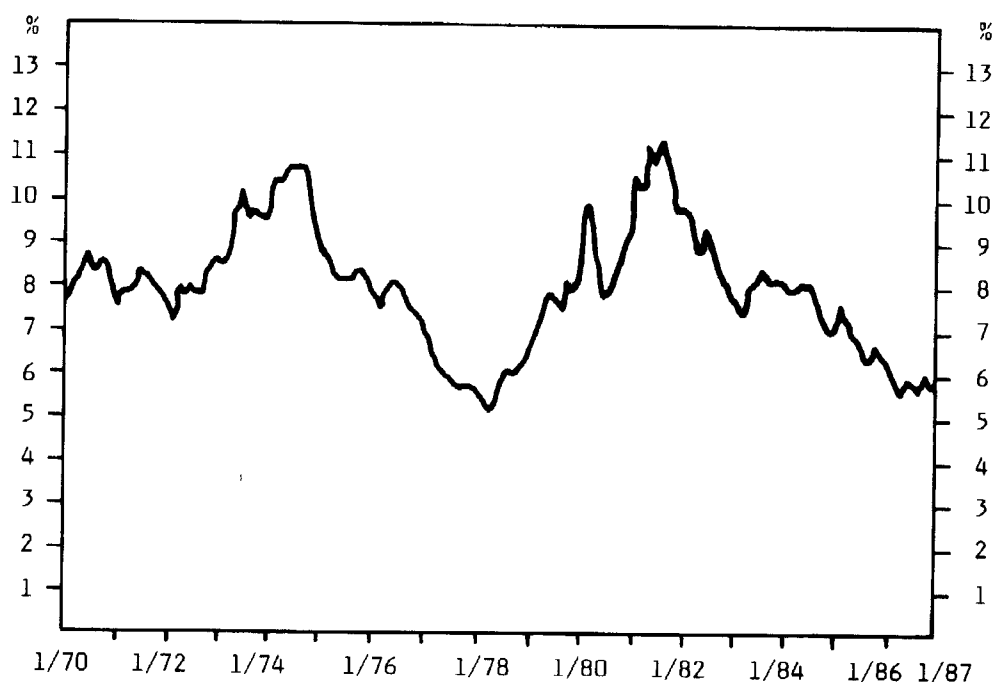
4. The Structure of the Empirical Study

Although the contingent immunization of bond portfolios has been discussed and recommended since 1981 there exist, to the knowledge of the authors, no published empirical studies examining

the quality of this risk control strategy for either the North American or the European bond market. One reason for this deficit could be the fact that - as explained above - with the contingent immunization strategy there is a considerable amount of freedom to define the active strategy.

- (1) This study is based on a period from March 1970 to December 1986. There were phases of both strongly rising and falling yields to maturity in this examined period. It furthermore includes subperiods with normal, flat and inverted term-structures of interest rates. The data base consists of all non callable "bullet"-bonds issued by the German Government, the German National Railways and the German National Post Office with their weekly closing prices. The average yield to maturity of public bonds as published by the German Federal Reserve Bank for this period is shown in figure 2.
- (2) Contingent immunization strategies are examined for planning periods of 1, 2, 3, 4, 5 and 6 years. The individual simulations begin in

Figure 2: Average Yield to Maturity of Bonds Issued by the German Government, the German National Railways and the German National Post Office. (January 1970 to January 1987).



quarter year intervals starting with March 27th, 1970. The number of simulations for the evaluation of the strategies ranges from 64 for 1-year planning periods to 44 for 6-year planning periods. In addition to these 1- to 6-year planning periods the strategies for the phases of rising and falling bond yields are examined. Due to the overlapping periods of time the simulation results are not stochastically independent of each other. For this reason no statistical tests presupposing such independence of observations are performed.

- (3) The portfolios are always rebalanced when a coupon or redemption payment has taken place for a bond in the portfolio (payment dependent rebalancing). In addition, a weekly rebalancing of the portfolio is carried out for the active management in a supplementary survey.
- (4) The strategies are tested with and without consideration of transaction costs. 0.25% provision in relation to the maximum of price and nominal value and 0.0375% courtage of the nominal value as transaction costs are considered when the portfolio is bought, rebalanced and liquidated. These transaction costs represent half the costs a private investor would have to pay. For institutional investors they would amount to approximately 0.1% of the nominal value. Transfer taxes, from which public bonds are excluded, as well as minimum expenses, limit and depot charges are not included.
- (5) The cushion spread c which has to be accepted in order to gain the scope for active portfolio management is selected, to some extent arbitrarily, to be 50 BP p.a. Then the minimum rate of return is the risk-free return on investment r_o less the cushion spread of 50 BP which can be achieved at the beginning of the planning period. That yield to maturity of a bond is defined as risk-free which has the shortest remaining time to maturity among all bonds that mature at or after the planning horizon. With the help of the risk-free return r_o and the cushion spread c the theoretically achievable

minimum terminal value MV_T of a contingently immunized portfolio can be determined as follows:

$$MV_T = 100 \cdot (1-TAC) \cdot (1+(r_o-c))^T$$

Here T is the length of the planning period, the size of the initial investment is standardized to 100 and TAC is the size of transaction costs per DM.

- (6) On every Friday it is checked whether the current portfolio value V_t is still sufficient to achieve the minimum value. If, when investing the current portfolio value at the current risk-free interest rate r_t , the minimum terminal value is exceeded, then active management of the portfolio can continue, should this not be the case then, independently from the rebalancing period described under (3), the portfolio is liquidated and a switch to an immunization strategy is enforced. The rebalancing decision can be made more precise by the following expression:

Liquidation value LW_t of the portfolio:

$$LW_t = V_t \cdot (1-TAC)$$

If $(LW_t - TAC) \cdot (1 + r_t)^{T-t} > MV_T$ then active management of the portfolio is continued otherwise the portfolio is immunized at the point of time t (and all following points of time).

- (7) The specification of the active strategy is fundamental for the definition of a contingent immunization strategy. A realistic representation of an active strategy would require the modelling of the interest rate development expected by the portfolio manager. This costly and subjective procedure was not chosen for this study. The active management is represented by a comparatively mechanical strategy: The entire resources of the portfolio are invested into the bond with the highest yield to maturity (maximum yield strategy) in every possible point of time. The criticism of this decision is obvious.

For reasons of market liquidity it is not possible to restructure portfolios of realistic size according to the maximum yield strategy. Nevertheless, this strategy was chosen to obtain first insights.

- (8) Both a duration strategy and the maturity strategy are examined as possible immunization strategies. The maturity strategy consists of buying that bond which was used to define the risk-free return in (6) when switching to the immunization phase. The duration strategy requires the construction of a portfolio whose duration equals the length of the remaining planning period of the investor. For this a narrow bullet is constructed around the planning horizon. The selection of those bonds of which the bullet portfolio is to consist is carried out in two steps. First all those bonds are determined whose duration is at least half a year below the planning horizon and those bonds whose duration exceeds the planning horizon by at least half a year [4]. Then that bonds is selected from each group whose duration has the smallest possible distance to the planning horizon. These two remaining titles are then combined in such a way that the required portfolio duration is achieved. The duration of an individual bond is computed using its yield to maturity.
- (9) The following questions shall be answered:
 - What rate of return will the contingent immunization strategy, the active strategy, and the pure immunization produce? How much do their means and standard deviations differ?
 - Will it be possible to cover the minimum terminal value if a switch to the immunization status is necessary? Which of the two immunization techniques, duration or maturity strategy, leads to better coverage?
 - What are the costs and returns resulting from contingent immunization of a portfolio?
- (10) The following performance criteria will be applied to answer these questions:
 - The highest, average and lowest returns of
 - the maximum yield strategies,

- the duration, resp. maturity strategies as well as
- the contingent immunization strategies.
- The quality of insurance of the contingent immunization strategy will, in those cases in which immunization was carried out, be measured by the average difference of the portfolio value V_T at the planning horizon from the minimal terminal value MV_T and by the number of simulations for which $V_T \geq MV_T$ holds.

In an ideal case the difference between the returns for contingent and pure immunization strategies must be exactly equal the cushion spread of 50 BP.

- Opportunity costs of the contingent immunization strategy arise if a switch to the immunization status was executed but in retrospect proved to be unnecessary. The (positive) difference between the returns achieved by upholding active management or switching to the immunization status is defined as the cost of contingent immunization.

If, ex post, the switch to the immunization status was the correct decision then the differences between the returns from contingent immunization and active management represent the insurance gain.

In the following sections the most important results of the empirical study are presented. In order to minimize notation, the concepts introduced so far will be extended by the following: The minimal return will also be referred to as "promised" return; "payment dependent rebalancing" denotes that the portfolio will be rebalanced only at coupon or maturity dates. A switch to an immunization strategy will be deemed successful if the portfolio value at the planning horizon is larger than the portfolio value achieved with active management.

5. Results I: The Performance of Contingent Immunization with Payment Dependent Rebalancing

In this section three types of results are presented. Firstly, the general performance of contingent immunization compared with an active management or a full immunization of the portfolio is described in figure 3 and table 1. Secondly, a more detailed comparison with the active strategy is given in tables 2, 3 and figure 4. Thirdly, contingent immunization is measured against the performance of a fully immunized portfolio in figure 5 and tables 4 and 5.

5.1 General Performance of Contingent Immunization

Figure 3 shows the maximum, minimum and average geometric returns with payment dependent rebalancing without transaction costs for active, contingent immunization and duration strategy. The fact comes to light that the contingent immunization strategy matches the highest returns achieved by the maximum yield strategy while, at the same time, the lowest returns are increased considerably. Furthermore the variability of the returns drops with stronger emphasis on portfolio insurance and (for mathematical reasons) with the length of the planning period. The results with the inclusion of transaction costs show no qualitative difference to those in figure 3.

Figure 3: Highest, Average and Lowest Values for Returns. (Payment dependent rebalancing, without transaction costs, immunization by means of duration strategy).

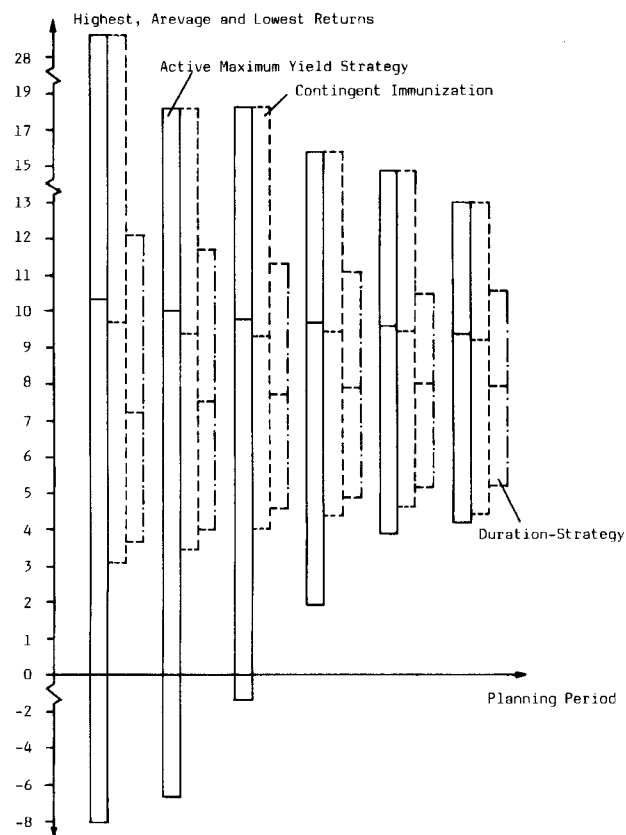


Table 1 shows the average difference in returns between the return realized with contingent immunization and the promised return as well as the percentage of cases in which the minimum return was achieved. The promised return, if transaction costs are neglected, is, on average over all planning

Table 1: Comparison between Realized and Promised Returns. (Payment dependent rebalancing, immunization by means of duration strategy).

	ex. transaction costs						inc. transaction costs					
planning period	1	2	3	4	5	6	1	2	3	4	5	6
deviation from promised return	3.07	2.32	1.95	1.94	1.92	1.75	0.36	1.44	0.63	0.81	1.10	1.10
realized return \geq promised return (%)	59.38	56.67	62.50	67.31	66.67	70.45	25.00	40.00	28.57	40.38	50.00	43.18

periods, exceeded by 216 BP p.a. If transaction costs are included this minimum is still exceeded by 91 BP p.a. The demanded minimum terminal value is, on average over all planning periods, achieved in more than 56% of all simulations. This percentage drops to a range from 25% to 50% depending on the length of the planning period if transaction costs are included.

A more detailed comparison of the results obtained by contingent immunization with those from the active management of a portfolio is given in tables 2, 3 and figure 4.

5.2 Contingent Immunization versus Active Management

Table 2 shows that a switch to the immunization status is executed in at least 50% of the simulations. Only approximately 45% of these prove to be successful, i.e. produce a return better than if the active strategy had been continued. As expected, the switch to the immunization status occurs more often if transaction costs are included. The percentage of successful switches, however, is not significantly influenced by the transaction costs.

In figure 4 the differences of the returns between contingent immunization and the active strategy are presented for those cases in which immunization was carried out. A maximum gain in return between 1.4% p.a. and 11.22% p.a. in case of a successful switch is opposed by a maximum loss of return between 4.4% p.a. and 15.4% p.a. If no distinction is made between retrospectively successful or unsuccessful switches it can be seen that, inde-

Figure 4: Highest, Average and Lowest Values for the Differences in Returns between Contingent Immunization Strategy and Active Strategy for those Cases in which a Switch to Immunization Took Place. (Differentiated into successful and unsuccessful switches, payment dependent rebalancing, exclusive of transaction costs).

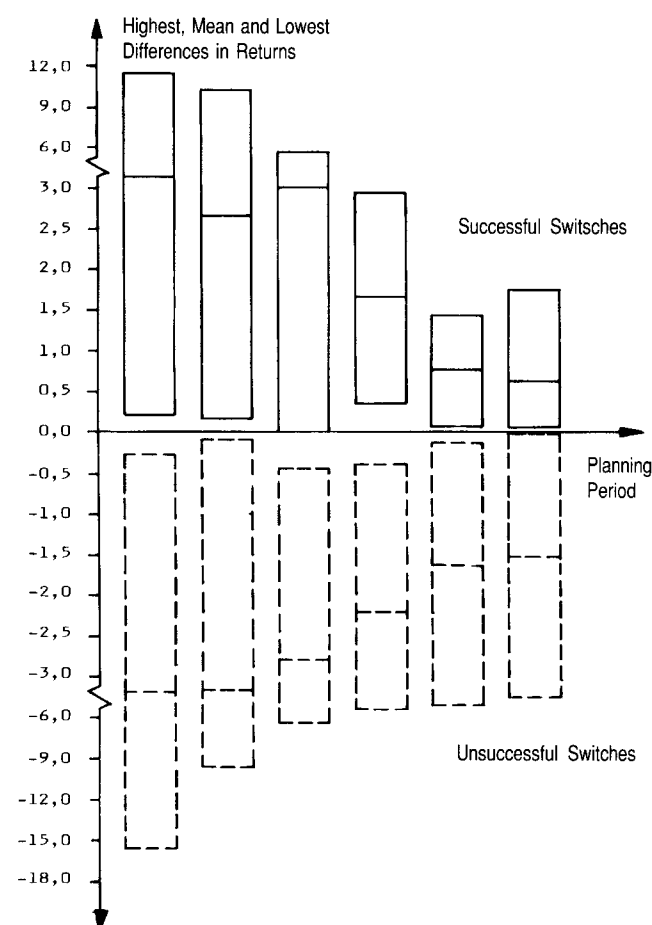


Table 2: Executed and Successful Switches to the Immunization Strategy. (Payment dependent rebalancing, inclusive/exclusive transaction costs, immunization by means of duration strategy).

planning period	1	2	3	4	5	6	1-6
number of simulations	64	60	56	52	48	44	324
switch to immunization	34/53	34/39	30/44	26/36	26/31	25/28	175/231
successful switches	13/16	15/17	10/15	11/15	14/19	14/18	77/100

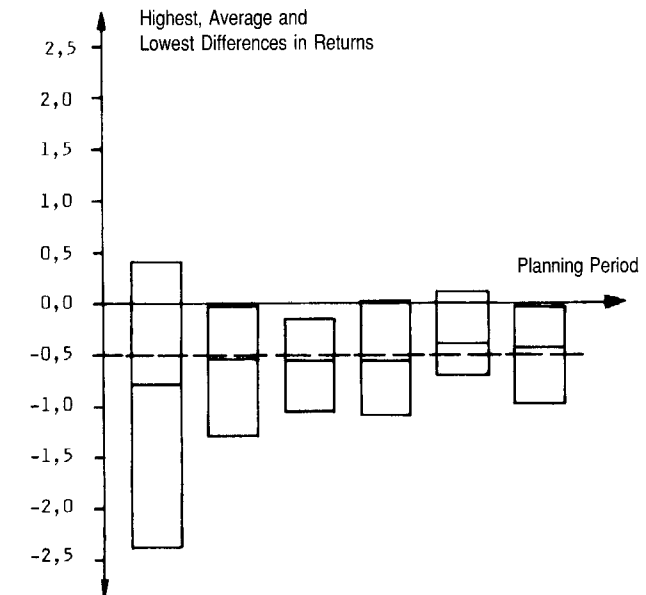
pendently from the length of the planning period, the average difference in returns between contingent immunization and active strategy is negative. Against expectations, this means, that on average the switch to the immunization strategy is of disadvantage. The average loss of return caused by these circumstances is, on average over all planning periods, 0.83% p.a.

The quality of coverage of the contingent immunization strategy is summarized in table 3. First one must note that in the worst case (min) and on the average, the realized return is below the promised return. These differences are even worse if transaction costs are considered. The reasons for these differences have been explained casuistically by the example in the introductory part 2. Since the differences are distributed approximately symmetrically around the mean if transaction costs are excluded, it can be conjectured that the high variance of these differences results from the disappointing performance of the immunization strategy. It is remarkable that independently of the fact whether transactions costs are considered or not the coverage quality of contingent immunization improves with the length of the planning period.

5.3 Contingent Immunization versus Full Immunization

A comparison between the returns from contingently and fully immunized portfolios is made in fig. 5. If

Figure 5: Highest, Average and Lowest Values for the Differences in Returns between Contingent and Full Immunization Strategies by Means of Duration for those Cases in which a Switch to Immunization Status Took Place. (Payment dependent rebalancing, exclusive of transaction costs).



the immunization strategy would exactly guarantee the risk free return r_o , the difference between the returns of a contingently and a fully immunized portfolio must equal the cushion spread of 50 BP. Three reasons can be stated for the reported deviation from the cushion spread: (i) The switch to the immunization status is performed too late. (ii) At

Table 3: Comparison between Realized and Promised Returns for those Cases in which a Switch to Immunization Took Place. (Payment dependent restructuring, immunization by means of duration strategy).

		ex. transaction costs						inc. transaction costs					
planning period		1	2	3	4	5	6	1	2	3	4	5	6
deviation from promised return	min	-1.23	-1.04	-0.70	-0.52	-0.47	-0.37	-2.35	-1.44	-1.18	-0.83	-0.89	-0.46
	mean	-0.13	-0.20	-0.16	-0.07	-0.08	-0.01	-0.87	-0.45	-0.40	-0.26	-0.16	-0.16
	max	1.80	0.67	0.29	0.54	0.39	0.33	0.85	0.76	0.16	0.30	0.30	0.04
realized return \geq promised return (%)		23.53	23.53	30.00	34.62	38.46	48.00	9.43	7.69	9.09	13.89	22.58	10.71

the switching point of time the values of the fully immunized portfolio and the actively managed portfolio do not differ by an amount which corresponds with the cushion spread. (iii) After switching to the immunization status the new portfolio does not necessarily consist of the same bonds as the fully immunized portfolio.

Table 4 (line 1) shows, that, if the maturity strategy is used instead of the duration strategy and disregarding transaction costs, the returns of these two strategies only show minor differences. This result

is confirmed by comparing

- realized returns with promised returns (comp. table 1 with lines 2 and 3),
- the differences of returns for the contingent immunization and the coverage strategy (comp. figure 5 and line 4) and
- the differences of returns of the contingent immunization and the active strategy (comp. figure 4 and line 5).

The maturity strategy gains attraction if transaction costs are taken into account. Compared with the

Table 4: Comparison between Duration and Maturity Strategy as Coverage Instruments. (Payment dependent rebalancing).

planning period	ex. transaction costs						inc. transaction costs					
	1	2	3	4	5	6	1	2	3	4	5	6
$r^{b,D} - r^{b,M}$	0.06	0.00	-0.03	0.00	0.01	0.00	-0.39	-0.12	-0.18	-0.10	-0.06	-0.09
$r^{b,M} - r^p$	3.01	2.32	1.99	1.94	1.92	1.75	0.75	1.55	0.80	0.92	1.17	1.19
$r^{b,M} \geq r^p$ (%)	59.38	51.67	62.50	73.08	62.50	72.73	32.81	38.33	42.86	55.77	68.75	68.18
$r^{b,M} - r^{M*}$	-0.82	-0.68	-0.57	-0.56	-0.53	-0.43	-0.84	-0.67	-0.68	-0.56	-0.47	-0.40
$r^{b,M} - r^{a*}$	-1.22	-1.11	-0.88	-0.56	-0.34	-0.33	-2.15	-0.65	-1.75	-0.66	-0.17	-0.10

Legend

$r^{b,D}$	=	return with cont. immunization and duration strategy
$r^{b,M}$	=	return with cont. immunization and maturity strategy
r^a, r^D, r^M	=	return by active-, duration-, maturity strategy
r^p	=	promised return,
*	=	in immunization status

Table 5: Comparison between the Realized Returns of the Contingent Immunization and the Promised Returns for those Cases in which a Switch to Immunization Took Place. (Payment dependent restructuring, immunization by means of the maturity strategy).

planning period		ex. transaction costs						inc. transaction costs					
		1	2	3	4	5	6	1	2	3	4	5	6
deviation from promised return	min	-1.60	-1.14	-0.38	-0.49	-0.58	-0.57	-1.49	-1.14	-0.65	-0.73	-0.79	-0.57
	mean	-0.24	-0.20	-0.08	-0.07	-0.09	-0.01	-0.40	-0.28	-0.18	-0.11	-0.07	-0.02
	max	1.80	1.99	0.32	0.33	0.34	0.47	0.85	1.44	0.57	0.56	0.39	0.34
realized return \geq promised return (%)		23.53	14.71	30.00	46.15	30.77	52.00	18.87	5.13	27.27	36.11	51.61	50.00

duration strategy the returns increase between 6 BP and 39 BP p.a. The average difference of returns and the number of simulations with which the promised return is exceeded increase (comp. table 1 with lines 2 and 3).

By a comparison of tables 3 and 5 the coverage quality of the maturity and the duration strategy can be assessed. Again, without transaction costs, no coverage strategy dominates the other, whereas including transaction costs for most planning periods the maturity strategy is better than its counterpart. These results emphasize that the maturity strategy is at least as suitable for coverage as the bullet duration strategy.

The results presented in this section are based on the full interest rate cycles as described in figure 2. These results are also summarized in section 8. In addition it is interesting to know whether contingent immunization compared with the active and the full immunization strategy behaves differently in periods with rising or falling yields.

6. Results II: Periods with Rising and Falling Yields

In periods with increasing interest rates and without transaction costs contingent immunization proves, according to expectations, to be of advantage. With an average return of 6.44% p.a. its return is 1.98% p.a. higher than that of the active strategy. Compared with full immunization the average in return is 0.12% p.a. higher.

A switch to immunization status occurs in 75% of the simulations, which leads to an average gain of 2.64% p.a. compared with continuing the active strategy. The maximum gain in return amounts to 11.22% p.a. while the maximum loss of return is 1.23% p.a. Compared with a fully immunized portfolio the loss of the contingent immunization strategy varies between -30 BP and -80 BP with an average value of 56 BP.

In periods of decreasing interest rates the switch to immunization status only occurs in 20% of the simulations, these, though, were all successful. The

gain in return compared with the active strategy is, on average, 55 BP p.a. Compared with a fully immunized portfolio, in these cases, the average return is lower by 46 BP p.a.

The superiority of the contingent immunization strategy is lost with the inclusion of transaction costs. If interest rates go up the fully immunized portfolio produces the maximum average return on investment with 5.67% p.a. Contingent immunization achieves 5.12% p.a. while the active strategy falls to 2.99% p.a. The switch to the immunization strategy, carried out in 83% of all cases, leads to an advantage in return of 2.56% p.a. compared with the active strategy, while producing a return which is, on average, 0.76% lower than that yielded by full immunization. If the interest rate drops, then, as expected, the active strategy proves to produce the highest returns. With an average of 17.09% it betters contingent immunization by 1.7% p.a. and the fully immunized portfolio by an average of 9.22%. A switch to immunization status occurs in 30% of all simulations which results in an average loss of 5.65% p.a. despite the fact that two thirds of the switches proved to be successful.

The results discussed in sections 5 and 6 are based on a payment dependent rebalancing strategy. In the following section the results for a weekly rebalanced, actively managed portfolio are presented.

7. Results III: Weekly Rebalancing

It is to be expected that the results of the contingent immunization strategies fundamentally depend on the practiced form of active management. For an initial analysis of this influence the maximum yield strategy was slightly modified by raising the rebalancing frequency. Instead of rebalancing at coupon or redemption dates a weekly check is made to determine whether the bond in the portfolio still has the maximum yield of all circulating public bonds. The rebalancing frequency of the duration strategy - if used - is not changed.

Comparing the table below with table 2 shows, that, without transaction costs, the number of switches to

Table 6: Executed and Successful Switches to Immunization Strategy. (Weekly rebalancing, exclusive/inclusive transaction costs, immunization by duration strategy).

planning period	1	2	3	4	5	6	1-6
number of simulations	64	60	56	52	48	44	324
switch to immunization	19/62	19/60	18/56	14/52	9/48	6/44	85/322
successful switches	5/55	4/54	0/55	0/52	0/48	0/44	9/308

the immunization strategy drops by half and the number of successful switches drops to 11% of all switches. According to these circumstances the active strategy is strongly superior to contingent immunization. The inclusion of transaction costs changes this situation completely. The transaction costs reduce the value of the actively managed portfolio so far that the switch to immunization status occurs in nearly every simulation and is nearly always successful.

The results from table 6 are emphasized by table 7 showing the differences in returns produced by the various strategies. Without transaction costs the active strategy surpasses contingent immunization on average over all planning periods by 5.25% p.a. if the duration strategy is used, and by 5.20% p.a. if the maturity strategy is pursued. If transaction costs are included contingent immunization dominates

the active strategy strongly. A comparison of the two immunization strategies (lines 3 and 4) shows that, independently from the treatment of the transaction costs, the average return produced by contingent immunization is below the returns from the immunization strategies approximately by the amount of the cushion spread.

The high quota of unsuccessful switches to immunization status when using the maximum yield strategy as active management technique lets it appear sensible to extend the contingent immunization strategy so far conceived as an irreversible stop-loss order strategy into a reversible stop-loss strategy which permits a return to active management after a switch to immunization status if a positive development of the interest rate occurs in the course of the remaining planning period [5]. This would make it possible to exploit the interest rate potential

Table 7: Comparison between the Realized Returns of the Active, the Contingent Immunization with Duration and Maturity Strategies and the Full Immunization Strategy in those Cases in which a Switch to Immunization Status was executed. (Weekly rebalancing).

planning period	ex. transaction costs						inc. transaction costs					
	1	2	3	4	5	6	1	2	3	4	5	6
$r^{b,D} - r^a$	-5.91	-5.12	-4.72	-5.90	-5.11	-4.77	7.04	7.72	8.13	8.20	8.28	8.22
$r^{b,M} - r^a$	-5.92	-5.12	-4.63	-5.87	-5.11	-4.56	7.57	8.01	8.36	8.42	8.42	8.40
$r^{b,D} - r^D$	-0.71	-0.49	-0.51	-0.61	-0.49	-0.49	-0.85	-0.66	-0.56	0.64	-0.52	-0.51
$r^{b,M} - r^M$	-0.84	-0.61	-0.54	-0.58	-0.50	-0.36	-0.83	-0.67	-0.63	-0.61	-0.58	-0.57

Legend:

$r^{b,D}$ = return with cont. immunization and duration strategy
 $r^{b,M}$ = return with cont. immunization and maturity strategy
 r^a, r^D, r^M = return by active-, duration-, maturity strategy

Table 8: Comparison between the Realized Returns of the Contingent Immunization and the Promised Returns for those Cases in which a Switch into Immunization Took Place. (Weekly rebalancing of the actively managed portfolio, immunization by means of the maturity strategy).

		ex. transaction costs						inc. transaction costs					
planning period		1	2	3	4	5	6	1	2	3	4	5	6
deviation from promised return	min	-0.94	-0.85	-0.25	-0.63	-0.58	-0.50	-1.49	-1.14	-0.67	-0.64	-0.79	-0.83
	mean	-0.19	-0.08	-0.08	-0.08	-0.11	+0.25	-0.39	-0.20	-0.19	-0.17	-0.14	-0.13
	max	1.06	1.88	0.15	0.17	0.29	0.47	1.03	1.83	0.85	0.56	0.37	0.47

arising after a switch while achieving coverage of a minimum terminal value at the time. A suitably defined stop-loss strategy will provide approximately the same coverage as a put option in the no transaction case. Of course, good performance can not be expected from this strategy if transaction costs are considered.

The weekly rebalancing influences whether and at what point of time a switch into the immunization status occurs as long as the portfolio is managed actively. A comparison of table 8 with table 5 shows that no systematic influence on the coverage quality of contingent immunization can be observed if the maturity strategy is used. The same statement hold true for the duration strategy.

8. Summary

Simulation studies only permit statements for the examined research period and the used test methodology. Nevertheless, as the long research period (1970-1986) covers a broad spectrum of possible interest rate developments (periods with rising and falling interest rates, points of time with normal, flat and inverse term structures of interest rates), a series of conclusions can be drawn:

- Contrary to the active strategy the contingent immunization strategy produces positive returns in all simulation runs.
- The highest returns realized by the active strategy are also reached by contingent immunization

while it increases the lowest returns substantially.

- In those cases in which a switch to immunization status was executed the return yielded by contingent immunization is, on average, below the return promised in advance. The quality of coverage, though, increases with the length of the planning period.
- Compared with a fully immunized portfolio contingent immunization produces a return which, on average, is lower by the cushion spread if transaction costs are excluded.
- Without transaction costs it turns out that the maturity strategy is as suitable as a coverage instrument as the duration strategy. With transaction costs the maturity strategy dominates the duration strategy.
- Weekly portfolio rebalancing together with the consideration of transaction costs lead to a complete change in the results. Contingent immunization proves to be of advantage compared with the active strategy in nearly all simulation runs.
- In phases of falling and rising interest rates contingent immunization is superior to the active strategy. If transaction costs are taken into account this can only be observed for periods with rising interest rates.
- A modification of the irreversible contingent immunization strategy into a reversible stop-loss strategy seems promising.

Footnotes

- [1] See for example BIERWAG (1987), pp. 287-320, GULTEKIN/ROGALSKI (1984), INGERSOLL (1983) and the discussion between BIERWAG/KAUFMAN/LATTA/ROBERTS (1989) and GULTEKIN/ROGALSKI (1989a) and (1989b) in the "Journal of Portfolio Management".
- [2] Compare LEIBOWITZ/WEINBERGER (1981), pp. 55, (1982a), p. 1, (1982b), p. 17 and (1983), p. 35.
- [3] For further insurance strategies with interest rate potential see BOOKSTABER (1985), pp. 36-50 and PEROLD/SHARPE (1988). For an empirical study of portfolio insurance for the German security market see BÜHLER (1988) and HOLZER (1990), pp. 266-313.
- [4] The definition of a minimum distance of half a year around the planning horizon was made for transaction cost reasons. Doing without this condition and using a narrower bullet would have had the consequence that a continual change of the bonds to be entered into the portfolio would have taken place. Strategy simulations with narrower bullet portfolios proved not to be superior to the above defined ones if transaction costs were excluded. With the inclusion of the transaction costs they were substantially worse.
- [5] See BOOKSTABER (1986), p. 126.

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