WALTER WASSERFALLEN, DANIEL LIECHTI*

The Short-Term Hedging Performance of Swiss Interest Rate Futures

1. Introduction

Derivative instruments can be used by investors for speculative as well as hedging purposes. The decision to actually use these instruments, especially for hedging, must be based on their performance in achieving the desired goals. Such information can only be obtained by evaluating past experience. In this paper, the interest rate futures contracts recently introduced on the Swiss Options and Financial Futures Exchange, SOFFEX, are examined with respect to their effectiveness to hedge a large number of spot assets with different characteristics. Weekly returns for several contracts over the years 1991 to 1995 are selected for this purpose. This paper therefore concentrates on the hedging characteristics over short horizons. Two widely used methods to calculate variance minimizing hedge ratios are compared. The first one is based on regression analysis exploiting time series of realized returns, the second one relies on the duration of spot assets and interest rate futures.
The remainder of the paper is organized as follows. The methods to calculate hedge ratios are outlined in the next section which also includes a brief description of the data. The spot assets and the futures contracts are respectively presented in sections 3 and 4. Sections 5 and 6 contain the empirical results. A summary and some conclusions complete the paper.

2. Methodology

The hedging performance of the various futures contracts is evaluated through the maximum reduction in the standard deviation of returns achievable by using futures to hedge a variety of spot assets. Two methods are used to calculate the so-called minimum variance hedge ratio.[1]
The first method is based on the time series of past returns for the asset to be hedged, called the spot asset, and the respective interest rate futures. The change in value of a hedged portfolio including the spot asset and the futures over period t, measured in Swiss Francs, $H_t - H_{t-1}$, is given by

$$H_t - H_{t-1} = n_{t-1} (S_t - S_{t-1}) + m_{t-1} (F_t - F_{t-1}) \quad (1)$$

where n_{t-1} is the number of spot assets and m_{t-1} the number of futures contracts, written on one unit of the spot asset, both determined at the beginning of the period. S and F respectively denote the spot and futures prices. t is a time index.
At the beginning of the period, wealth consists entirely of spot assets because no funds must be used

*We thank an anonymous referee for his useful comments. Excellent research assistance has been provided by Martin Hess. Walter Wasserfallen, Studienzentrum Gerzensee, 3115 Gerzensee, Tel.: 031-781 27 11, Fax 031-781 30 39, e-Mail szgerzensee@clients.switch.ch.

to buy or sell the futures contracts. Therefore, $H_{t-1} = n_{t-1} S_{t-1}$.[2] Dividing equation (1) by H_{t-1} results in the following expression for the return on the hedged portfolio over period t, R_{Ht}.

$$R_{Ht} = R_{St} + h_{t-1} R_{Ft} \qquad (2)$$

R_{St} and R_{Ft} are the returns on the spot asset and the futures contract respectively over period t. The hedge ratio at the beginning of the period, h_{t-1}, is defined as $(m_{t-1} F_{t-1})/(n_{t-1} S_{t-1})$. Under the assumption that the hedge ratio is constant over time, the variance of the hedged return is given by

$$Var(R_H) = Var(R_S) + h^2 Var(R_F) + 2 h Cov(R_S,R_F) \qquad (3)$$

Var denotes a variance and Cov a covariance term. Minimizing $Var(R_H)$ with respect to h yields the variance minimizing hedge ratio, h_{Min}

$$h_{Min} = -\frac{Cov(R_S, R_F)}{Var(R_F)} \qquad (4)$$

The above covariance term is typically positive, implying that futures contracts are sold in combination with a long position in the spot asset. Assuming a stationary bivariate distribution for the returns, h_{Min} can be calculated by estimating the following simple regression.[3]

$$R_{St} = \alpha + \beta R_{Ft} + \varepsilon_t \qquad (5)$$

The slope coefficient β is then equal to $-h_{Min}$.
The second method to quantifiy the minimum variance hedge ratio is to rely on the contractually agreed stream of future payments provided by the spot asset and the security underlying the futures contract. Assuming a flat term structure of interest rates and a linear approximation to the bond pricing formula, the return on the spot asset is given by

$$R_{St} = -D_{St-1} (y_t - y_{t-1}) \qquad (6)$$

D_{St-1} is the modified Macaulay duration, evaluated at the beginning of the period, and y is the level of market interest rates.[4] An analogous formula applies to the value of the hedged portfolio and to the futures contract. The modified duration of the futures is equal to the current modified duration of its underlying spot asset minus the time remaining to the maturity of the futures contract. Using equation (6) to get variances and covariances of returns and substituting into equation (3) yields[5]

$$D^2_{Ht-1} = D^2_{St-1} + h^2_{t-1} D^2_{Ft-1} + 2h_{t-1} D_{St-1} D_{Ft-1} \qquad (7)$$

Setting the derivative of the above equation with respect to h_{t-1} equal to zero yields the hedge ratio which minimizes the duration of the hedged portfolio and therefore the variance of its return. The result is a second expression for the variance minimizing hedge ratio, namely

$$h_{Min,t-1} = -\frac{D_{St-1}}{D_{Ft-1}} \qquad (8)$$

Empirically, equation (8) is implemented by using the yield to maturity for the respective asset to calculate duration at the beginning of every holding period, e.g. every week.
The above techniques deal primarily with interest rate risk. The restrictive assumptions underlying the methods may negatively affect the hedging performance. Examples are a stationary distribution of returns for the regression method and a flat term structure for calculating duration. In addition, a number of other risk factors influence the performance of fixed-income portfolios. These factors include credit risk, the risk of early repayment of callable bonds, market liquidity as well as basis risk and delivery risk associated with interest rate futures. Therefore, a large number of spot assets with different characteristics are chosen in the empirical work to evaluate the hedging performance of the various futures contracts.
The Swiss Options and Financial Futures Exchange, SOFFEX, introduced the first interest rate futures contract on March 22, 1991. The sample period

Table 1: Spot Assets

Swiss government bonds

Symbol	Issue	Maturity	Coupon	Callable	Deliverable
B1	15.11.79	15.11.94	4.00	15.11.92	No
B2	5.2.80	5.2.92	4.50	No	No
B3	5.9.83	5.9.95	4.50	5.9.91	No
B4	1.3.84	1.3.93	4.50	No	No
B5	10.4.84	10.4.94	4.50	No	No
B6	11.9.84	11.9.96	4.75	11.9.92	No
B7	25.2.87	22.2.12	4.25	25.2.02	No
B8	25.9.87	25.9.97	4.00	25.9.95	No
B9	12.1.88	12.1.98	4.00	No	No
B10	5.2.88	5.2.99	4.00	5.2.96	No
B11	12.4.88	12.4.95	4.00	No	No
B12	6.4.89	6.4.97	4.75	No	No
B13	24.8.89	24.8.97	5.25	24.8.95	No
B14	16.7.90	16.7.99	6.50	16.7.97	No
B15	22.1.91	22.1.01	6.75	22.1.99	No
B16	15.7.91	15.7.02	6.25	15.7.00	Yes
B17	5.2.92	5.2.02	6.50	No	Until 5.2.94
B18	9.7.92	9.7.01	7.00	No	Until 9.7.93
B19	10.4.92	10.4.04	6.50	No	Yes
B20	11.6.92	11.6.03	6.75	No	Until 11.6.95
B21	10.9.92	10.9.05	7.00	10.9.03	Yes
BP	Equally weighted portfolio of deliverable bonds against the "bond future"				
BC	Cheapest to deliver bond against the "bond future"				

Euro Swiss Franc investment

Symbol	Description
E1	Investment in Euro SFr. deposit with a maturity of 3 months

Bond mutual funds

Symbol	Name	Issuer	Debtors	Maturity (years)
F1	Helvetinvest	UBS	Government: 45.5 %, Banks: 31.4 %, Industry: 23.1 %	1-5: 45.0 %, 5-10: 40.0% above 10: 15 %
F2	SFr. Fund, A	SBC	Europe: 34.2 %, Japan: 15.1 %, Int. Org.: 14.4 %, Rest: 36.3 %	1-4: 24.6 %, 4-9: 34.3 %, above 9: 41.1 %
F3	Money Market	SBC	Swiss money market: 27.2 %, Euro money market: 28.9 %, Rest: 43.9 %	Average: 0.4

Bond indices

Symbol	Debtors	Coupon (% p.a.)	Maturity (years)
I1	Government. All levels	All	All
I2	Electrical power, gas, water	All	All
I3	Banks, financial companies	All	All
I4	Industrial firms	All	All
I5	Foreign governments	All	All
I6	Foreign private firms	All	All
I7	All domestic	All	All
I8	All foreign	All	All
I9	All	All	All
I10	All	<4	<3
I11	All	<4	3-7
I12	All	<4	>7
I13	All	4-6	<3
I14	All	4-6	3-7
I15	All	4-6	>7
I16	All	>6	<3
I17	All	>6	3-7
I18	All	>6	>7
I19	All	<4	All
I20	All	4-6	All
I21	All	>6	All
I22	All	All	<3
I23	All	All	3-7
I24	All	All	>7

Swaps

Symbol	Maturity (years)
S1	2
S2	3
S3	4
S4	5
S5	7
S6	10

Coupons: Percent per year, paid annually. Callable: First call date. Deliverable: Bond can be delivered against "bond future". UBS: Union Bank of Switzerland. SBC: Swiss Bank Corporation.

underlying the empirical work starts on this date and ends on June 16, 1995. Weekly returns, based on Thursday closing prices and expressed in percent per week, are used.[6] Coupon payments, occurring once per year in Switzerland, and accrued interest are taken into account according to market rules. Problems of low liquidity, typical for the Swiss fixed income market, can at least be partially considered by chosing a relatively long return interval while retaining enough observations for a meaningful analysis. Spot assets are described in the next section, followed by a discussion of futures contracts in section 4.

3. Spot Assets

A wide variety of spot assets with different characteristics are used to assess the hedging performance of the various futures contracts. An overview is provided in table 1. The first category of spot assets are individual bonds issued by the Swiss government. Credit risk is absent in this case. Remaining time to maturities range from 2 to 13 years and coupon rates from 4 to 7 % p.a. Some of the bonds have call features. The bonds B16 to B21 are deliverable against the "bond future", described in the next section. These deliverable bonds have much more liquid markets than the rest, as measured by the number of quotes per day. Two additional return series are created. The first one, BP, is an equally weighted average of the returns on all deliverable bonds whereas BC is the return on the currently cheapest-to-deliver bond. Following market conventions, weekly holding period returns include coupon payments and accrued interest.

An investment in a 3-month Euro SFr. deposit forms the second category. The third category includes several mutual funds specialized in fixed income investments. Helvetinvest holds a portfolio of bonds issued by the Swiss government, individual member states and firms. The SBC SFr. fund specializes in bonds issued by foreign organizations but denominated in Swiss Francs.[7] The money market fund invests in short-term securities, typically with maturities up to one year. Cash payments to fund investors are included in the return calculations.

The bond indices compiled by Banque Pictet in Geneva form the next category of investments. The various indices provide returns on portfolios differing with respect to debtor classes, coupon payments and remaining time to maturity.

Returns based on interest rate swaps in Swiss Francs quoted in London are included in the last category. This market is known for its much higher liquidity than the domestic fixed income market. Interest rate swaps are defined as an exchange of a long-term bond for a short-term bond between two counterparties. The long-term bonds included in the swap, ranging in maturity from 2 to 10 years, are used in this study. In table 1, the symbols S1 to S6 denote these assets. The weekly holding period returns are given by the relative change in the price of the long-term bond in the swap. Prices at the beginning and the end of the week are obtained as the sum of the promised payments discounted by the implied spot rates.[8]

4. Futures Contracts

Three interest rate futures contracts have so far been traded on SOFFEX. Expiration dates are quarterly on the third Wednesday in March, June, September and December. Depending on the contract, the next four or five expiration months are traded. Contrary to many other exchanges, SOFFEX operates a decentralized computer-based trading system with automatic matching of orders. Designated market makers have to provide quotes continously. The monitoring of open contracts is organized in the same way as on other organized exchanges. Gains and losses are settled daily (mark to market) through interest bearing margin accounts maintained at SOFFEX. Table 2 provides an overview of the interest rate futures underlying the empirical analysis.

The first interest rate futures contract, introduced on March 22, 1991, is based on the Euro SFr. rate for 3-month deposits and is therefore called the "3-month future".[9] The contract value is 1 Mio. SFr. The futures price is recorded as 100 minus the annualized forward rate in percent. The minimum tick is 0.01 percentage points implying a minimum change in the value of the contract of 25 SFr. Cash settlement occurs at maturity. Trading was abandoned on June 18, 1993, due to a lack of volume.

A number of steps have to be taken to calculate weekly returns. First, forward rates in percent per year, f_{3t}, implicit in the quoted futures price are calculated. Second, the value of the underlying 3-month deposit is determined according to

$$F_{3t} = \frac{1}{1 + \frac{f_{3t}}{400}} \qquad (9)$$

The percentage change in F_{3t} then provides the holding period return on the futures contract. Duration of this futures contract at the beginning of every week is determined as its remaining time to maturity in years divided by $(1+f_{3t})$.

Table 2 shows that six contracts are evaluated in the empirical work. In addition, returns on an artificial contract are calculated in order to increase the number of observations. This contract combines the returns on the individual futures expiring in September 1991, March 1992 and September 1992.

The second futures contract is based on a synthetic bond with a coupon rate of 6 %, paid annually, and a time to maturity of 5 years, starting at the maturity of the futures. Subsequently, this contract is named the "5-year future". Repayment of principal is assumed to occur at par. The underlying synthetic bond is priced using the spot rates implicit in the term structure of swap prices observed in London.[10] The contract size is 100'000 SFr. Futures prices are quoted as a percentage of the face value, rounded to two decimal digits. Consequently, one tick is equivalent to a change of 10 SFr. in the value of the contract. Settlement at maturity is in cash. The contract was introduced on SOFFEX on October 3, 1991, but trading was abandoned at the beginning of 1993, again due to a lack of volume. The return on the futures contract is equal to the percentage change in the quoted futures price. In this case, four contracts are evaluated as shown in table 2. Again, a combined contract is formed based on the returns for the futures expiring in March 1992 and September 1992.

The third futures contract traded on SOFFEX, named the "bond future", is written on a synthetic bond of the Swiss government with a coupon rate of 6 % p.a., to be paid annually starting one year after the maturity of the futures contract. The contract started trading on May 29, 1992, and has become the most popular interest rate futures contract in Switzerland and the only one that survived. The contract size is 100'000 SFr. Prices are quoted in percent of the face value. The minimal price change is 0.01 percentage points, implying a change of 10 SFr. in the value of the futures. Contrary to the other two contracts, physical delivery occurs at maturity. The seller can choose among all currently issued Swiss government bonds with a remaining time to maturity between 8 and 13 years. The bonds are made comparable to the synthetic bond and therefore to each other through respective conversion factors. Nevertheless, complete comparability is never achieved, implying that there is always one bond which is cheapest-to-deliver at maturity of the futures contract. Consequently, the price of the futures at any given date is based on the cheapest-to-deliver bond at the time of pricing minus a premium reflecting the option of the seller to chose the bond to be delivered. The buyer faces the risk that the cheapest-to-deliver bond may change until maturity. The weekly returns of the bond future are calculated as the percentage change in the quoted futures price. At the beginning of every week, the modified duration of the currently cheapest-to-deliver bond minus the remaining time of the futures until maturity is taken in order to derive the modified duration of the future. Again, combined contracts are artificially created as above over different periods. Table 2 includes the bond futures evaluated in the empirical work.

5. Empirical Results

The evidence on the hedging performance of interest rate futures is shown in tables 3 to 6. Results for a representative subset of spot assets and futures contracts is reported. Throughout, the hedging performance, HP, is assessed by the percentage decrease in the standard deviation of weekly returns, expressed in percent per week, achieved through a minimum variance hedge relative to an unhedged position. Consequently,

$$HP = \frac{\text{Std. dev.}(R_S) - \text{Std. dev.}(R_H)}{\text{Std. dev.}(R_S)} \cdot 100 \qquad (10)$$

The presentation of the results proceeds in two steps. The years 1991 and 1992, that is immediately

Table 2: Interest Rate Futures Contracts

Expiration month	Observation interval	Number of weekly returns	Modified duration (Years, average)
3-month Euro SFr. future (3-month future)			
September 1991	4.4.91-12.9.91	24	0.23
December 1991	27.6.91-12.12.91	25	0.23
March 1992	19.9.91-12.3.92	25	0.23
June 1992	19.12.91-11.6.92	25	0.23
September 1992	19.3.92-10.9.92	26	0.23
December 1992	18.6.92-10.9.92	13	0.23
Combined	4.4.91-10.9.92	75	0.23
5-year swap-based future (5-year future)			
March 1992	10.10.91-12.3.92	22	4.15
June 1992	3.1.92-11.6.92	24	4.15
September 1992	3.1.92-10.9.92	37	4.15
December 1992	4.6.92-10.9.92	15	4.14
Combined	10.10.91-10.9.92	48	4.15
Swiss government bond future (bond future)			
September 1992	4.6.92-10.9.92	15	7.71
December 1992	4.6.92-10.9.92	15	7.69
March 1993	1.1.93-12.3.93	10	
June 1993	12.3.93-11.6.93	13	
September 1993	11.6.93-10.9.93	13	
December 1993	10.9.93-10.12.93	13	
March 1994	10.12.93-11.3.94	13	
June 1994	11.3.94-10.6.94	13	
September 1994	10.6.94-16.9.94	14	
December 1994	16.9.94-16.12.94	13	
March 1995	16.12.94-10.3.95	12	
June 1995	10.3.95-16.6.95	14	
Combined 93/95	1.1.93-16.6.95	128	
Combined 93	1.1.93-10.12.93	49	
Combined 94	17.12.93-16.12.94	52	
Combined 95	16.12.94-16.6.95	26	

after the introduction of interest rate futures on SOFFEX, are covered in section 5.1. The findings reported in section 5.2 are based on more recent observations over the years 1993 to 1995 for the "bond future". It might be expected that the hedging performance becomes better as market participants get used to the new instruments and liquidity increases.

5.1 The Early Years: 1991 and 1992

Table 3 exhibits results based on the regression methodology outlined in section 2. The reported values for HP are in-sample and therefore use information to calculate hedge ratios which would not be available in practical applications. In this case, the standard deviation of the hedged return is equal to the standard deviation of the estimated residuals in the regression equation (5).[11]

No reduction in the standard deviation of returns is achieved using the first contract ever traded on

Table 3: Hedging Performance In-Sample: 1991 and 1992

Spot asset	3-month future			5-year future			Bond future	
(symbol)	Sept. 91	Sept. 92	Comb.	March 92	Dec. 92	Comb.	Sept. 92	Dec. 92
Swiss government bonds								
B1	2.41	-0.09	3.02	21.70	11.16	13.63	-1.36	0.12
B4	-2.09	-0.07	1.75	15.70	4.83	6.63	-3.44	-2.56
B12	0.08	-1.85	1.82	13.87	2.99	5.03	-3.16	4.03
B15	-1.22	13.18	9.98	21.62	32.68	26.03	6.18	8.36
B16							8.70	11.34
B17		13.23					29.89	41.71
BP							21.98	32.35
BC							27.51	
Euro Swiss Franc investment								
E1	-0.08	26.53	29.57	26.25	27.92	26.91	9.77	17.30
Bond mutual funds								
F1	-1.21	0.39	2.20	2.21	5.47	3.46	-3.76	-1.47
F2	-1.52	0.24	4.36	20.33	14.34	16.18	-3.59	-3.73
F3		-0.19		-2.47	-0.77	-1.06	-3.76	-3.13
Bond indices								
I1	0.06	4.15	7.32	27.19	27.22	21.43	3.80	17.23
I2	-1.66	-0.64	-0.27	19.63	0.21	1.54	21.99	1.53
I3	-1.94	-0.67	1.44	14.37	7.81	9.65	-3.03	2.67
I4	-2.06	-2.06	0.97	20.72	7.22	10.00	-3.64	-2.65
I8	-2.23	-1.28	4.90	34.36	17.55	22.29	-3.70	-2.02
I9	-2.24	-0.51	4.49	32.26	18.13	21.08	-3.61	1.48
I10	-1.52	-1.05	3.48	16.73	7.09	7.75	-1.66	-2.62
I12	-0.10	-1.15	-0.63	7.94	5.34	6.35	1.11	1.55
I16	-1.92	0.08	0.33	-1.17	2.77	1.89	-3.66	-3.73
I18	-0.62	-1.44	3.16	23.96	15.96	16.77	-3.73	0.77
Swaps								
S2	1.86	0.73		2.92	2.36			
S4	2.39	1.02		6.01	3.36			
S6	0.54	0.52		6.72	2.98			

The futures contract and the expiration month are shown at the top of each column. Spot assets are identified by their symbol explained in table 1. Due to the availability of data, the June 1992 contract of the 3-month future and the 5-year future are used for swaps instead of the September 1992 contract. The numbers shown are the reduction (in percent) of the standard deviation of returns of the unhedged portfolio achieved by using the respective futures contract.

SOFFEX, the 3-month future expiring in September 1991. This outcome is independent of the spot asset investigated. Subsequent 3-month futures perform somewhat better as shown by the contract maturing in September 1992 and the combined contract. Not surprisingly, the largest reduction in the standard deviation of returns is obtained when a 3-month Euro SFr. investment is hedged. Nevertheless, the reduction of about 30 % in the standard deviation of the return appears to be surprisingly small. The preceding footnote however shows that this value corresponds to a correlation of 0.71 between returns on the spot asset and the futures contract which is not unexpectedly low given that changes in a spot rate and a forward rate are compared over weekly intervals. Rather surprisingly, a similar reduction in standard deviation is not achieved for the money market fund F3. An important reason for the bad performance with respect to longer-term spot assets is the highly variable relationship between short-term and long-term interest rates over the sample period, which will be discussed in more detail below.

The performance of the two longer term futures is slightly better, even for short-term spot assets. Market liquidity of futures and spot assets is presumably an important factor. The 5-year future based on the highly liquid London swap market provides a considerable reduction in the standard deviation of returns, especially when relatively liquid spot assets with similar duration are hedged. The best example is the Swiss government bond B15. Furthermore, the 5-year future does relatively well in hedging the various index portfolios. Similar characteristics are observed for the bond future which performs best in hedging bonds which can be delivered against it. However, exceptions occur also. Especially surprising is the weak hedge that the swap based 5-year future provides with respect to investments in the swap market.

Table 4 shows that duration based hedges actually increase the volatility of holding period returns

Table 4: Hedging Performance using Duration

Spot asset	3-month future			5-year future			Bond future	
(symbol)	Sept. 91	Sept. 92	Comb.	March 92	Dec. 92	Comb.	Sept. 92	Dec. 92
Swiss government bonds								
B1	-32.09	-61.87	-25.42	23.57	-4.50	12.41	1.46	3.64
B4	-10.56	-14.75	-25.65	17.50	-5.74	5.21	-2.51	-2.07
B12	-16.35	-62.68	-51.07	-1.52	-8.46	-10.32	-2.41	6.30
B15	-65.12	-270.19	-73.64	-1.55	5.15	3.24	-17.44	6.96
B16		-101.68			13.87		26.43	41.57
B17		-223.22						
BP							12.39	34.68
BC							1.53	
Euro Swiss Franc investment								
E1	-17.71	-61.31	28.19	28.03	9.90	26.87	12.76	13.71
Bond indices								
I1	-155.15	-245.33	-147.17	-29.12	-31.29	-33.96	-18.73	19.34
I2	-152.20	-150.76	-149.11	-71.39	-28.79	-62.25	-42.38	-16.26
I3	-175.07	-444.86	-250.91	-117.76	-94.36	-110.64	-69.47	-12.45
I4	-151.84	-391.79	-180.31	-61.84	-63.58	-62.11	-57.11	-19.52
I8	-178.36	-377.03	-208.61	-58.02	-43.65	-66.04	-54.87	-15.54
I9	-238.25	-451.88	-252.90	-83.12	-81.20	-89.77	-79.53	-17.30
I10	-66.47	-134.33	-74.78	-0.79	-12.22	-12.79	-24.19	-11.40
I12	-10.89	-201.22	-32.56	-43.24	-37.72	-44.62	-9.35	2.44
I16	-27.74	113.67	-59.16	-24.24	-3.27	-13.76	-11.63	-7.07
I18	-152.51	-314.72	-240.87	-103.70	-58.19	-95.49	-53.60	-7.10
Swaps								
S2	-1'415.55	-328.59		-26.58	-27.55			
S4	-1'307.75	-350.18		-27.01	-35.45			
S6	-792.67	-463.14		-69.00	-94.06			

The futures contract and the expiration month are shown at the top of each column. Spot assets are identified by their symbol explained in table 1. Due to the availability of data, the June 1992 contract of the 3-month future and the 5-year future are used for swaps instead of the September 1992 contract. The numbers shown are the reduction (in percent) of the standard deviation of returns of the unhedged portfolio achieved by using the respective futures contract.

Table 5: Hedging Performance Out-of-Sample

Spot asset (symbol)	3-month future				5-year future	
	March 92		Dec. 92		Dec. 92	
	Regr.	Duration	Regr.	Duration	Regr.	Duration
Swiss government bonds						
B1	-32.98	18.24	-12.65	-61.87	-3.09	-4.50
B4	3.57	-3.47	-17.77	-14.75	-8.54	-5.74
B12	10.12	-27.68	-6.28	-62.68	-2.18	-8.46
B15	7.41	-37.77	19.88	-270.19	27.85	5.15
Euro Swiss Franc investment						
E1	17.58	53.18	-80.00	-61.31	7.33	9.90
Bond indices						
I1	8.56	-90.84	-7.58	-245.33	4.92	-31.29
I2	5.63	-146.02	-17.26	-150.76	-4.98	-28.79
I3	-4.85	-207.56	-18.97	-444.86	-7.46	-94.36
I4	-3.74	-126.03	-71.33	-391.79	-2.59	-63.58
I8	-1.17	-122.59	-53.36	-377.03	3.28	-43.65
I9	-0.62	-164.05	-46.32	-451.88	-2.69	-81.20
I10	-10.70	-18.71	-27.32	-134.33	-1.29	-12.22
I12	-95.39	-71.27	-23.40	-201.22	-4.48	-37.72
I16	0.77	-42.70	-2.98	-113.67	2.70	-3.27
I18	10.09	-183.86	-34.97	-314.72	-4.87	-58.19

The futures contract and the expiration month are shown at the top of each column. Regr. and Duration indicate the method of calculating the hedge ratio. Spot assets are identified by their symbol explained in table 1. The numbers shown are the reduction (in percent) of the standard deviation of returns of the unhedged portfolio achieved by using the respective futures contract.

considerably over the sample period under investigation. The major reason probably is that the assumption of a flat term structure underlying the duration measures used here is violated. Over the years 1991 and 1992, short-term rates are on average 7.40 percent and long-term rates 6.30 percent. The difference between short-term and long-term rates has a standard deviation of 0.65 percentage points, a maximum of 1.90 and a minimum of -0.20 percentage points. The correlation between the two rates is 0.70, both in levels and first differences.

A true comparison between the two methods of calculating minimum variance hedge ratios has to rely on out-of-sample performance. Table 5 contains information based on such a procedure. In this case, hedge ratios using regression analysis are calculated with data from the contract expiring just before the one actually used for hedging. For example, the performance reported for the 3-month future expiring in March 1992 are based on hedge ratios using data for the September 1991 contract. Duration-based hedge ratios exploit the characteristics of the contractually promised stream of cash flows and therefore only use currently available information. Relative to the in-sample results shown in table 3, the hedging quality of regression based procedures decreases as expected. Most of the performance measures included in table 5 are negative, implying a higher standard deviation of returns for the hedged relative to the unhedged strategy. A notable exception is the investment in the Euro SFr. market. Overall, the regression method achieves slightly better outcomes than the duration method, contrary to the results reported by TOEVS and JACOB (1987) for the United States.

5.2 More Recent Years: 1993 to 1995

A comparison between tables 3 and 6 demonstrates clearly that the hedging performance of the "bond future" has improved considerably since its introduction. This comparison is based on the in-sample regression procedure. The representative examples included in table 6 show that the maximum achievable reduction in the standard deviation through hedging is above 60 % as compared to about 30 % immediately after the introduction of the contract. Better results are especially achieved if the hedged instrument is a bond which is deliverable against the futures.

6. Conclusions

The hedging performance of the three interest rate futures traded on SOFFEX is evaluated with respect to a wide variety of assets with different characteristics. Two well-known methods to calculate minimum variance hedge ratios are used for that purpose. The first one is based on regression analysis, the second one on the duration of the spot asset and the futures contract. Weekly returns over the years 1991 to 1995 underlie the empirical investigations.
The results show that during the first two years of trading only a relatively small reduction in the standard deviation of weekly holding period returns can be achieved by using futures for hedging purposes. In many cases, the volatility of returns is even increased. A number of factors may be responsible for this outcome. First, market liquidity of the spot assets as well as the various futures contracts is rather limited in Switzerland. For that reason, two of the three futures stopped trading within two years after their introduction on SOFFEX.[12] Second, short-term and long-term interest rates as well as the slope of the term structure are quite variable over the sample period. Duration measures assuming a flat term structure, as conventionally used, may therefore contain substantial errors. Third, the results may be negatively influenced by the relatively small number of observations that have to be used in the empirical analysis. Fourth, returns on fixed-income investments are frequently quite small in absolute amount making it difficult to identify the hedging performance using weekly observations which are typically quite noisy. Hedging performance may

Table 6: Bond Futures 1993 - 1995: Hedging Performance In-Sample

Spot asset (symbol)	June 93	June 94	June 95	Comb. 93	Comb. 94	Comb. 95	Comb. 93/95
Swiss government bonds							
B7	32.25	0.19	15.67	8.76	18.29	6.86	13.88
B9	18.58	22.99	9.74	8.89	17.70	9.60	15.37
B17	76.83	33.02	27.81	67.82	39.00	30.00	54.09
B18	79.06	31.03	14.27	62.43	35.32	19.33	47.75
B20	66.60	67.29	28.94	65.47	55.38	28.49	60.71
B21	66.21	64.29	47.03	60.63	52.08	43.26	60.14
Euro Swiss Franc investment							
E1	17.56	7.46	3.89	13.28	5.65	3.05	1.59
Bond indices							
I9	17.70	28.75	18.09	31.10	23.12	19.21	26.06

The futures contract and the expiration month are shown at the top of each column. Spot assets are identified by their symbol explained in table 1. The numbers shown are the reduction (in percent) of the standard deviation of returns of the unhedged portfolio achieved by using the respective futures contract.

become better for longer horizons but the limited number of data points precluded an empirical investigation of this issue. Hedging performance has improved considerably during more recent years, 1993 to 1995, presumably because market liquidity has increased. Consequently, the "bond future", which is the only remaining contract trading on SOFFEX, has become a useful instrument for hedging purposes.

Footnotes

[1] For a detailed presentation the reader is referred to TOEVS and JACOB (1987).

[2] Gains and losses on futures are settled daily. Opportunity costs do not arise because funds on margin accounts carry interest at the riskless rate.

[3] This assumption cannot be literally correct because the interest rate risk of the spot asset as well as the futures decrease over time as the remaining time to maturity of both instruments becomes shorter.

[4] Modified duration is equal to simple Macaulay duration divided by one plus the interest rate.

[5] The variance of R_S is equal to $D_{st-1}{}^2 \, Var(y_t - y_{t-1})$ and the covariance between R_S and R_F is equal to $D_{st-1} D_{Ft-1} \, Var(y_t - y_{t-1})$. Note that terms in $Var(y_t - y_{t-1})$ cancel when introduced into equation (3).

[6] First bid and then ask prices are used if no transactions price is available. The average of Wednesday and Friday prices is chosen if none of the above is available for Thursday. This procedure had to be used in only a small fraction of the observations.

[7] Bonds issued by foreign debtors are excempt from the withholding tax of 35 % on coupon payments.

[8] Spot rates implied by the observed swap rates are derived with the usual bootstrapping procedure.

[9] The contract specifications are the same as for the Euro SFr. contract available on LIFFE in London where it still trades rather actively.

[10] The spot interest rates are derived from the swap rates using a bootstrapping procedure. The SWIMEAN rates are used for that purpose. The swap rates are chosen because this is the most liquid market in Swiss Francs.

[11] The following relationship between HP and the coefficient of determination in a regression of R_S on a constant and R_F, R^2, holds

$$R^2 = 1 - (1-HP)^2$$

Values for HP of 0.40, 0.30, 0.20, 0.10 and 0.05 respectively are therefore equivalent to R^2's of 0.64, 0.51, 0.36, 0.19 and 0.10. Since R^2 is equal to the squared correlation coefficient between R_S and R_F, the implied correlations for the above values of HP are respectively 0.80, 0.71, 0.60, 0.44 and 0.31.

[12] JOHNSTON and MCCONNELL (1989) argue that a specific futures contract disappeared in the USA because its hedging performance deteriorated relative to close substitutes.

References

JOHNSTON, J. T. and J. J. MCCONNELL (1989): "Requiem for a market: An analysis of the rise and fall of a financial futures contract", Review of Financial Studies 2, pp. 1 - 23.

TOEVS, A. and D. P. JACOB (1987): "A comparison of alternative hedge ratios methodologies with interest-rate futures", in: Fabozzi, F. J. and Pollack, I. M., The handbook of fixed income securities, chapter 43, pp. 918 - 938.