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MANAGING INTEREST RATE RISK WITH INTEREST RATE FUTURES

Upravljanje kamatnim rizikom pomoću kamatnih fjučersa

Abstract

Due to the wide impact that interest rate changes have on business performance, it is very important to manage this type of risk. A large number of instruments can be used for protection against interest rate risk. Financial derivatives are a very simple way to minimize interest rate risk and therefore are extremely popular. The value of interest rate derivatives transactions in the world is increasing dramatically. Unfortunately, this is not the case in Serbia. In Serbia, interest rate derivatives market does not exist. Therefore, this paper aims to present to market participants one kind of interest rate derivative instrument – interest rate futures and to show how they can protect themselves against unwanted changes in interest rates with these instruments.

Key words: *futures, basis, hedge ratio, hedging strategies*

Sažetak

Zbog velikog uticaja koji promene kamatnih stopa imaju na uspešnost poslovanja, od izuzetnog je značaja adekvatno upravljanje ovom vrstom rizika. Postoji veliki broj instrumenata koji se mogu koristiti za zaštitu od kamatnog rizika. Finansijski derivati predstavljaju veoma jednostavan način minimiziranja kamatnog rizika, zbog čega su i izuzetno popularni. Vrednost transakcija kamatnih derivata u svetu se drastično povećava. Nažalost, to nije slučaj i u Srbiji. U Srbiji tržište kamatnih derivata ne postoji. Zbog toga ovaj rad ima za cilj da približi tržišnim učesnicima jednu vrstu kamatnih derivata – kamatne fjučerse i ukaže im na koji način se mogu zaštiti od neželjenih promena kamatnih stopa pomoću ovih instrumenata.

Ključne reči: *fjučersi, baza, hedž racio, hedžing strategije*

Introduction

Interest rate risk is the likelihood of adverse impact of changes in interest rates on income, cash flows, operating costs and economic value of institutions and it is one of the most significant risks in business. The great impact that changes in interest rates have on the business performance, the fact that every organization is more or less exposed to interest rate risk, as well as great volatility in interest rates in recent years, make interest rate risk one of the most significant risks that market participants face. The impact of interest rate risk depends largely on the value and the structure of balance sheet and off-balance sheet positions sensitive to changes in interest rates, the interest rate volatility and the time of exposure to risk. It is difficult to completely neutralize interest rate risk, but, because of its impact on the profitability and value of assets, it should be reduced to a minimum.

Market participants can use a number of instruments to hedge against interest rate risk. Financial derivatives (interest rate forwards/futures, options and swaps) are a very easy way to minimize interest rate risk and therefore are very popular. From year to year, turnover in interest rate derivatives markets in the world is increasing dramatically. However, this is not the case in Serbia. In Serbia, the interest rate derivatives market does not exist. Therefore, this paper aims to present to market participants one kind of interest rate derivatives – interest rate futures and to show how they can protect themselves against unwanted changes in interest rates with these instruments.

Futures

A futures contract is a contract between two parties in which one agrees to buy/sell from/to the other a specified asset (security) at a specified price at a specified future date [3, p. 95]. Counterparty that has an obligation to sell on agreed future date has a short position in a futures contract, and a party that has an obligation to buy on the agreed future date has a long position in a futures contract.

The price at which the counterparties agree to transact is called the delivery price or futures price. The futures price is contracted to equalize the value of the contract for both sides to zero. Later, that value becomes positive or negative depending on the movements of prices of underlying assets. For example, if asset price rises sharply after the conclusion of the contract, the value of long position in the futures contract becomes positive, while the value of the short position becomes negative, and vice versa, if asset price falls after the conclusion of the contract the value of long position becomes negative and the value of short position positive.

Futures contacts are standardized, which means that counterparties can easily match. Also, futures contracts are tradable until the delivery date, which in turn results in great liquidity of the futures market.

Different financial instruments can underlie interest rate futures. The most common are futures on Treasury Bills, Eurodollar futures, and futures on government notes and bonds.

Treasury bill (T-bill) futures. T-bill futures contracts are based on 90 day Treasury bill with a face value of USD 1 million [4, p. 141]. Futures prices are quoted as indices that are a function of the discount rate. For example, if the discount rate is 8.32%, the futures price will be quoted as 91.68. The value of the futures is calculated according to the following formula [8, p. 114]:

The value of the futures =1,000,000*(1- discount rate *n/360) (1)

where n is the number of days (90 or 91 depending on the adopted convention).

As the size of the contract is USD 1 million, the smallest possible change in price of the futures of one base point corresponds to a value of the contract of USD 25.

Eurodollar futures. Eurodollar deposits are deposits in dollars in banks outside the U.S. Thus, Eurodollar deposits are the underlying instrument for the Eurodollar futures contacts. Maturity of these futures contracts is three months. As Eurodollar deposits are non-transferable, they cannot be used as collateral. Therefore, the settlement is in cash. As most of these deposits are linked to Libor, Eurodollar futures price is also linked to Libor. The nominal value is USD 1 million, and the price is quoted as index (100-Libor). Minimal change is a one basis point, or USD 25. Relationship between yield on the futures and the discount rate is expressed by the following formula [8, p. 117]:

Yield = discount rate / (1-discount rate * n/360) (2)

Determining the value of the contract is the same as with futures on Treasury bills.

Treasury note (T-note) futures. There are 2-year, 5-year and 10-year T-note futures. Remaining maturity for the 2-year T-note futures contact must be between 21 months and 2 years, for the 5-year between 4 years and 3 months and 5 years and 3 months, and for 10-years between 6 years and 6 months and 10 years. For 5-years and 10-years futures contracts par value is USD 100,000, and for 2-years USD 200,000. The price is in terms of par being 100. The minimal price fluctuation is 1/64 of 1% of the par value, or USD 15.625. The minimal price fluctuation for 2-years futures contract is 1/128 of 1% of the par value, or USD 15.625.

Treasury bond (T-bond) futures. The underlying instrument for T-bond futures contracts is hypothetical USD 100,000 par value 20-years 8% coupon bond with maturity of at least 15 years on the first day of the delivery month and noncallable in that period. Par value of the futures contract is USD 100,000. The futures price is quoted in terms of par being 100 [5, p. 363]. For example, 97-16 (97 and 16/32) means 97.5% of the par value, or USD 97,500. The minimal price fluctuation is 1/32 of 1% of the par value, or USD 31.25 [4, p. 143]. As there is many bonds with other coupon rate than 8%, conversion factor is used to adjust the price to the price of the bonds that are actually being delivered.

The basis

The aim of hedging is to neutralize the risk associated with assets in the portfolio by adding a new asset in the portfolio. The initial assumption is that the price of futures contract changes when the price of the underlying assets changes. Success of hedging depends on the relation of the spot price and futures price of the assets. The basis for date t is the difference between the spot price and the futures price. Therefore, the basis is equal to [11, p. 909]:

$$B_{t,T} = S_t - F_{t,T} \tag{3}$$

where S_t is spot price on day t, and $F_{t,T}$ is futures price on day t.

The value of the basis on day 0 is known because the spot price and the futures price are known. Also, the value of the basis at the expiration of the futures contract should be zero, if the hedged asset and the underlying asset are the same [7, p. 53]. However, the value of the basis between these two dates is unknown. As time goes by, the spot price and the futures price do not change by the same amount, and the basis changes constantly. The uncertainty regarding how the basis will change is basis risk. The basis is very important for understanding the process of hedging. If the spot price rises faster than the price of the futures, the basis increases, becoming stronger. Strengthening of the basis improves the outcome of short hedge position, and worsens the outcome of long hedge position. If futures price rises faster than the spot price, the basis weakens. Weakening of the basis improves the outcome of long hedge position, and worsens the outcome of short hedge position.

Long hedge. Long position involves buying futures contracts in order to protect from interest rates falls. If an investor plans to purchase some assets (such as bonds), and expects decline in interest rates which will increase the cost of purchase, he can protect himself by buying futures. The decline in interest rates will increase the value of futures and will generate revenue based on the difference between current and future futures price, and thereby totally or partially neutralize loss from increased costs of buying bonds. Therefore, profit based on long futures positions is equal to [2, p. 412]:

$$P_{long} = -S_t + S_0 + F_t - F_0 \tag{4}$$

where P is profit, S_t – spot price of assets on day t, S_0 – assets price in the moment of futures buying, F_t – futures price on day t, F_0 – futures price in the moments of purchase. Profit is equal to the basis change:

$$P_{long} = B_o - B_t \tag{5}$$

where B_0 is basis value in the moment of futures purchase, and B_t – basis value on day t.

Suppose that investor knows that in six months he will have available USD 970,000 and plans to invest them in 3M T-bill with a nominal value of USD 1 million. Spot rate for 3M T-bill is 12%, while the 3M forward rate is 14% [8, pp. 138-139]. Investor fears that interest rates will fall by the time he receives funds and that USD 970,000 will not be enough to buy T-bill, and therefore decided to protect himself by buying futures on 3M T-bill. As 3M forward rate is 14%, the value of the futures contract is USD 965,000. After six months, the spot rate has fallen to 10%, and 3M forward rate to 12%. Investor now needs USD 975,000 for the purchase of 3M T-bill, or USD 5,000 more than six months ago. However, as the value of the futures rose to USD 970,000, the investor will make a profit of USD 5,000 on futures contract, which will completely neutralize the increase in costs for the purchase of T-bill.

Short hedge. A short hedge implies selling futures contracts. This strategy is used for protection against a possible rise in interest rates. If an investor owns an asset, for example, a 10-year T-bond, and fears that rising interest rates will diminish its value, he may protect himself by selling futures. In the case of rising interest rates, the value of bonds will fall, but the value of the futures will also fall and the investor will generate income on futures that completely or partially will neutralize loss on assets. This strategy is also used when an investor plans to borrow in the future and fears that interest rates will increase making borrowing more expensive.

Thus, the profit based on short futures positions will be equal [2, p. 412]:

$$P_{short} = +S_t - S_0 - F_t + F_0 \tag{6}$$

$$P_{short} = B_t - B_0 \tag{7}$$

Let's say that investor has 3M T-bill with a nominal value of USD 1,000,000 and current price of USD 975,000 (10%). However, he will need money in a month, so he is afraid that, in the meantime, interest rates will increase decreasing the value of the T-bill he owns. Therefore, he sales futures on Treasury bills. Currently the forward rate for 3M is 12%, and the value of the futures contract is USD 970,000. If in a month, the interest rate, according to investors' expectations, increases to 12%, the investor for T-bill would get only USD 970,000 instead of USD 975,000 (he would get if the interest rate remained 10%), or USD 5,000 less. However, as 3M forward rate will also increase to 14%, (the value of the futures contract would be USD 965,000) and investor will make a profit of USD 5,000 on futures contract, which will cover the loss on the sale of the T-bill.

Cross hedge. Cross hedging occurs when the hedged asset and the asset underlying futures contract differ by [8, p. 142]: 1) risk level, 2) coupon rate, 3) maturity, or 4) time period.

Let's say that an investor has decided to issue commercial paper with nominal value of USD 1 million in three months. Currently, 3M rate on investor's commercial paper is 17% [8, p. 142], so he would receive USD 957,500 by issuing commercial paper. As he expects interest rates to rise, the investor will, in order to protect himself from a possible rate increase, sell futures on Treasury bills. The rate on 3M futures on Treasury bills is 16%, and the value is USD 960,000. In three months, 3M rate on commercial paper has increased to 18% and the rate on 3M bills to 17%. Now, the investor would get USD 955,000 for commercial paper with a nominal value of USD 1 million or USD 2,500 less, but he would also make more profit on futures, because the value of the futures contract due to the increase in interest rates has fallen to USD 957,500.

The aim of hedging is, therefore, to eliminate the negative effects of interest rates movements. Complete hedge using futures implies that any change in the value of individual asset or portfolio is followed by change in the value of the futures in the same amount but in opposite direction. For example, fall in the value of the bond portfolio for USD 1 million should be offset by an increase in the value of futures contracts in the same amount in order to have successful hedge.

The hedge ratio

In the previous examples, the assumption was that the asset price and the futures price are equally sensitive to changes in interest rates. However, as changes in the asset price and the futures price do not have to be the same, in order to successfully hedge, it is necessary to determine the number of futures contracts needed to neutralize the change in the price of asset.

An indicator called the hedge ratio measures the interest rate sensitivity of underlying asset and futures. Hedge ratio is calculated by dividing the percentage change in the price of asset and percentage change in the futures price, or by the following formula [6, p. 109]:

$$HR = \%\Delta P_a / \%\Delta P_f \tag{8}$$

where $\%\Delta P_a$ is % price change of the hedged asset and $\%\Delta P_f$ – % price change of futures contract.

Hedge ratio is the number of futures contracts that must be transacted to offset the price volatility of an underlying asset. For example, if a 10% change in the asset price is associated with 5% change in the futures price, the hedge ratio will be 2, which means that the asset price is twice as volatile as futures price and that two futures contract must be transacted in order to hedge. Thus, ratio $\%\Delta P_a / \%\Delta P_f$ shows how the value of the underlying asset is changing in relation to a futures contract value. The bigger the change in the value of underlying asset in relation to a futures value (the bigger $\%\Delta P_a / \%\Delta P_f$ is), the bigger the hedge ratio is. Bigger hedge ratio means that more futures contracts will be needed for hedging.

Hedge ratio can also be calculated using the conversion factor, the value of the basis points, or duration. Using a conversion factor number of futures contracts is calculated by the following formula [6, p. 110]:

$$Number\_of\_futures\_contracts = \frac{Par\_value\_of\_bonds}{Par\_value\_of\_futures} * Conversion\ factor \tag{9}$$

The value of the basis points shows changes in the value (price) of assets for one base point (0.01%) change in interest rate. Hedge ratio in this case is calculated according to the following formula [6, p. 111]:

$$HR = \frac{BPV_a}{BPV_f} *CF \tag{10}$$

where the BPV is the value of basis point, and CF is the conversion factor.

Using the concept of duration, hedge ratio is calculated by the following formula [1, p. 309]:

$$HR = \frac{TV_a}{TV_f} * \frac{D_a}{D_f} *\beta_{af} *CF \tag{11}$$

where TV_a is value of assets, TV_f – futures value, D_a – duration of assets, D_f – duration of futures contract, CF – conversion factor, and β_{af} – average change in interest rate of underlying asset for a given change in interest rate on futures contract.

Depending on the maturity of the assets underlying futures contracts, one can distinguish between short-term, medium-term and long-term hedging strategies.

Short-term hedging strategies

Interest rate futures with underlying short-term assets – Treasury bills futures and Eurodollar futures are used for neutralizing exposure to interest rate risk in the short term. These futures are helpful for hedging interest rate risk connected with the planned future investment, borrowing, and sale of assets.

Locking profit on planned investment. An investor, who knows he will have same free funds in the near future, will be afraid that in the meantime interest rates could fall, because if that happens he will earn less on planned investment. To ensure certain rate of return, he can buy futures contracts. If interest rates decrease, price of futures will increase, so he will profit on futures and fully or to a large extent compensate a drop in income from planned investment.

Suppose that an investor [2, p. 428] knows that in three months he will have available funds in the amount of USD 1 million and plans to invest them in Treasury bills. Currently, the discount rate for T-bills is 8.20%, and 3M forward rate is 8.94%. This means that an investor can expect to pay USD 977,400 (1-0.0894 * 91/360) for USD 1 million nominal value T-bill. The current price of futures on T-bills is 91.32 (the price of one contract is USD 978,300). Investor fears that in three months interest rates will fall and the price of T-bills rise. To eliminate the risk of interest rates decrease he should take a long position in the futures market. In three months, in line with the expectations of investor, market interest rates have fallen and the rate on Treasury bills is now 7.69%, while the futures price is 92.54. The investor buys T-bill, but he pays USD 980,561 or USD 3,161 more than he planned. However, due to the decline in interest rates the value of the futures contract rose by USD 3,050 to USD 981,350 almost completely neutralizing the increase in costs arising from changes in the price of T-bills. If interest rate increases, investor would have to pay less for T-bills, but he would also have loss on the futures. So hedging using futures does not allow to profit on positive market movements.

Locking borrowing costs. An investor, who plans to borrow in the future, will be afraid of a possible rise in interest rates since if that happens his loan will become more expensive. By selling futures contracts, an investor can eliminate this risk. If interest rates really increase in the meantime, futures price will fall, and he will profit on futures and fully or partially neutralize an increase in borrowing costs.

Suppose an investor [2, pp. 430-432] knows that in three months he will need funds in the amount of USD 10 million, which he plans to provide issuing a commercial paper with maturity of 180 days. Currently, forward rate for investor's commercial paper is 10.58% for maturity of 180 days. This means that the investor will get USD 9.471 million by issuing securities with a nominal value of USD 10 million. Current price of Eurodollar futures is 88.23 (the value of one contract is USD 970,575). Investor fears that in three months interest rates could rise, and his debt become more expensive, so he takes a short position by selling 20 Eurodollar futures. After three months, interest rates have risen and the rate on commercial paper is 11.34% for maturity of 180 days. The investor will receive USD 9.433 million by issuing commercial paper, or USD 38,000 less than he expected. However, the prices of Eurodollar futures have fallen to 87.47. Investor buys 20 futures contracts at 87.47 (USD 968,675) and sells them at the agreed 88.23 (USD 970,575) earning USD 38,000 (20*(970,575-968,675)).

Locking profit on asset. Suppose that an investor plans to provide funds he would need in three months by selling T-bills from his portfolio. Currently, 3M forward rate on Treasury bills is 8.94%. This means that an investor can expect to get USD 977,400 for the T-bill with nominal value of USD 1 million. However, as he fears that in the meantime interest rates could rise and the price of T-bills fall, the investor sells futures contracts. The current price of T-bill futures is 91.32 (or USD 978,059). In three months, interest rates have risen and the interest rate on T-bills is 9.43%, while the futures price is 90.83. Investor sells T-bill, but he gets only USD 976,163 or USD 1,237 less than he planned. However, due to rising interest rates, the value of futures contracts have fallen to USD 976,819, so he has a profit of USD 1,240 on futures, which is enough to fully neutralize the unwanted change in the prices of T-bills.

Intermediate and long-term hedging strategies

The purpose of the intermediate and long-term strategies is the same as the short-term, with the only difference that in the case of a purchase or sale of futures contracts, the underlying instruments are long-term instruments – T-notes and T-bonds.

Locking profit on planned investment. Suppose that an investor plans to invest USD 1 million, which will be at his disposal in three months, in 9-years 11 5/8 T-note with nominal value of USD 1 million [2, pp. 437-439]. The current price of the T-note is 97-28, or USD 978,750. Current price of T-note futures is 78 21/32, or USD 78,656.25. In order to protect himself against interest rate drop, the investor will buy 12 contracts (assuming that conversion factor and β are 1). After three months, the interest rates have fallen and the current price of 11 5/8 T-note is 107 19/32, so the investor needs USD 1,075,937.50 to buy it, or USD 97,187.50 more than three months ago. Current price of the T-note futures is 86 6/32, or USD 86,187.50. The investor has an income of USD 7,531.25 on futures contract, and USD 90,375 for 12 futures contracts, which neutralizes to the great extent the sum he has to pay more for T-note.

Locking profit on asset. Let's say that an investor has USD 1 million in T-bond whose current price is 101-00, and the market value USD 1,010,000 [2, p. 436]. However, he will need the funds in three months and he is afraid that in the meantime interest rates could rise and the value of his portfolio fall. To protect himself against drop in the value of the bond, he sells futures on T-bonds. The current futures price is 110-16, and value USD 110,500 per contract. If the duration of the bond is 6.9 years, duration of the futures 7.2 years, a conversion factor 1.12, and β 1, he would need 10 futures contracts (1,010,000/110,500*6.9/7.2*1.12=9.8). If in three months bond price falls to 98-16, its market value will drop to USD 985,000, and the investor will have a loss of USD 25,000. However, as interest rates rose, the futures prices will fall to 108-16. The value of the futures contract will be USD 108,500, which means that the investor will have a profit of USD 2,000 per contract, or USD 20,000 in total, which will significantly reduce the loss from the sale of bond.

Locking long-term borrowing costs. The investor plans to issue bonds with total nominal value of USD 5 million in three months [2, pp. 439-440]. Currently, the price of similar bonds issued earlier is 99-10. The market value of the portfolio, according to the current price, would be USD 4,965,625. The investor, however, fears that in the meantime, interest rates could rise and the cost of the bond issue. Therefore, he purchases futures. The current futures price is 68-11 (contract value is USD 68,343.75). If the duration of the bond is 7.22, duration of T-bond futures 7.83, he would need 67 futures contracts for hedging. In three months, the rates are in line with investor expectations, and the current price of his bonds is 90-24. Thus, the portfolio will have a market value of USD 4,537,500, which means that he would have USD 428,125 less than expected. However, futures price have fallen to 60-25, and the value of one contract is USD 60,781.25, so the investor will have a profit of USD 7,562.5 per contract, or in total USD 506,687.5, which is more than enough to cover losses on the bonds issue.

Advanced hedging strategies

Hedging a floating rate loan. When borrow at a variable rate which level is determined on the agreed future dates for the following period, an investor concerns about growth in interest rates from one period to another when interest rate is determined. The investor in this case has two possibilities. The first one is to sell a specified number of futures contracts with different maturities that coincide with the period of establishing the rate on the debt. Upon maturity or closing positions, the investor will have profit on futures that will more or less neutralize rising costs. For example, if he takes a loan in December for a period of one year at a variable rate which is determined on a quarterly basis, the investor would sell 10 March futures contracts, 10 June futures contracts and 10 September futures contracts. This strategy is known as a *strip hedge* [1, p. 312].

Another option is to sell futures contracts whose maturity coincides with period of the loan, and to close his positions in a certain number of futures contracts every time when the interest rate for the next period is determined, because in this way the profit from futures will neutralize to greater or lesser extent growing borrowing costs. For example, if investor takes a loan in December for a period of one year at a variable rate which is determined on a quarterly basis, he should sell 30 September futures contracts since the last determination of interest rates will be in September. This strategy is known as a *stack hedge* [1, p. 312].

In the case of a parallel yield curve shifts both strategies give the same result. However, in the case of nonparallel shifts in the yield curve, stack hedge is not effective because it locks the first interest rate, while strip strategy allows locking the average interest rate. In addition, the stack hedge cannot be used for longer periods because it can happen that there are no available futures contracts with convenient maturity.

Suppose that an investor plans to borrow USD 10 million for a period of three months, and the interest rate for the month will be determined each first Friday in the month in the amount of 3M Libor plus 1% [2, pp.432-433]. The current 3M Libor is 9.68% so the interest rate for the first month will be 10.68% per annum. However, investor is afraid that in the next two months interest rates could rise, and hence his costs. To protect against interest rates increase, investor sells Eurodollar futures. The current futures price is 90.75, and the value of one contract is USD 976,875. In order to hedge risk in the second month, (interest rate for the first month is already known) investor sells three Eurodollar futures contracts (10,000,000/976,875*4/12=3.4). Investor also sells three futures contracts to neutralize the risk in the third month (10,089,000/976,875*4/12=3.4). Thus, he sells in total six futures contracts. After a month Libor rate has risen to 10.09%, so the interest rate for the second month will be 11.09%. Futures price is 90.47 and the value of the futures contract is USD 976,175. Investor will get from futures contracts USD 700 per futures contract, or USD 2,100 in total, which he uses partially to repay the loan. The basis for the calculation of interest for the second month will be the principal plus interest for the first month and minus the income from futures (USD 10,086,900). After another month, Libor has further increased to 10.79%, and the interest rate for the third month will be 11.79%. Futures price is 89.99, and the value of the contract USD 974,975. Investor gets from the remaining three futures contracts USD 1,900 per contract, or USD 5,700 in total, which he also uses to reduce his liability. By the end of the third month, the investor will have loan in the amount of USD 10,274,384, while without hedging the loan would be USD 10,282,280.

Macro hedge

All mentioned strategies for interest rate risk protection refer to the protection of the value of certain assets from adverse market movements. However, the investor may also try to protect the value of the entire portfolio instead of individual hedge from adverse movements in interest rates. In that case, it is macro hedge.

In Table 1 market value of assets is USD 100 million and average duration 2.70 years. Average duration of liabilities is 1.03 years. Duration gap is calculated according to the following formula [10, p. 628]:

$$DUR_{gap} = DUR_a - \left(\frac{P}{A} * DUR_p \right) \tag{12}$$

where DUR_{gap} is duration gap, DUR_a – average duration of assets, DUR_p – average duration of liabilities, P – market value of liabilities, and A – market value of assets. Duration gap will be:

$$DUR_{gap} = DUR_a - \left(\frac{P}{A} * DUR_p \right) = 2.70 - \left(\frac{95}{100} * 1.03 \right) = 1.72$$

Table 1: Duration gap

	Amount (USD million)	Duration (years)	Weighted duration (years)
Assets	100		
Cash	5	0.0	0.00
Securities	20		
Less than 1 year	5	0.4	0.02
1 to 2 years	5	1.6	0.08
Over 2 years	10	7.0	0.70
Residential mortgages	20		
Variable rate	10	0.5	0.05
Fixed rate	10	6.0	0.60
Commercial loans	50		
Less than 1 year	15	0.7	0.11
1 to 2 years	10	1.4	0.14
Over 2 years	25	4.0	1.00
Physical capital	5	0.0	0.00
		Average duration 2.70	
Liabilities	95		
Checkable deposits	15	2.0	0.32
Money market deposit accounts	5	0.1	0.01
Savings deposits	15	1.0	0.16
CDs	35		
Variable rate	10	0.5	0.05
Less than 1 year	15	0.2	0.03
1 to 2 year	5	1.2	0.06
Over 2 years	5	2.7	0.14
Fed funds	5	0.0	0.00
Borrowings	20		
Less than 1 year	10	0.3	0.03
1 to 2 years	5	1.3	0.07
Over 2 years	5	3.1	0.16
		Average duration 1.03	

Source: [10, p. 626]

If he wants to protect himself against adverse interest rate movements, the investor should sell futures contracts because in that case if interest rate increase, the value of assets would decrease but this decrease would be offset by a profit from futures contracts. Let's say that 5-years T-bond futures with duration of 1.72 years are available in the market. In this case, the investor would need 1,000 futures contracts to protect against possible rise in interest rates.

$$Number\_of\_contracts = \frac{V_a}{V_f} * \frac{DUR_{gap}}{DUR_f} = \frac{100{,}000{,}000}{100{,}000} * \frac{1.72}{1.72} = 1{,}000 \qquad (13)$$

where V_f is value of futures contract, V_a – market value of assets, DUR_f – average duration of bonds underlying futures, and DUR_{gap} – duration gap.

Interest rate increase from 10% to 11% will cause the change in the market value of net worth as a percentage of assets [10, p. 628] by:

$$\%NV = -DUR_{gap} * \left(\frac{\Delta i}{1+i}\right) = -1.72 * \frac{0{,}01}{1+0{,}01} = -1{,}6\% \qquad (14)$$

Thus, when interest rate increases by 1%, from 10% to 11%, the value of the assets will be reduced by USD 1.6 million. The value of the futures contract (according to the same formula) will also be reduced by 1.6% or by USD 1,600 per contract. Total profit from futures contracts will be USD 1,600,000 (completely neutralizes the decline in net worth due to rising interest rates).

It is unlikely that the investor in reality will find futures on bonds whose duration is exactly the same as duration gap. However, this problem can be easily overcome by a combination of futures contracts on bonds of varying duration so that the average duration of the portfolio is equal or close to duration gap.

Pros and cons of futures contracts

Futures contacts are standardized, which means that counterparties can easily match. Beside that, futures contracts are tradable until the delivery date, which in turn results in great liquidity of the futures market. In addition, credit risk is eliminated as the clearinghouses are mediators between buyers and sellers.

Although futures contracts are very useful for neutralizing the risk arising from adverse market movements, the biggest drawback of these financial derivatives is that they do not allow benefiting on positive interest rates movements.

Conclusion

Interest rate risk is the likelihood of adverse impact of changes in market interest rates on income, cash flows, operating costs and economic value of an organization. Thus, interest rate risk is one of the most significant risks.

Market participants in different ways can protect themselves from adverse changes in interest rates. Financial derivatives (futures, options, swaps) are a very easy way to manage interest rate risk or to reduce it to the lowest possible level and therefore are extremely popular. Moreover, the derivatives market has developed so much in recent years that market participants usually can find something that fully meets their needs.

Interest rate futures are contracts that specify interest rate to be paid or received on a certain future date. By fixing the interest rate that will be paid or received the uncertainty about the future level of interest rates and the potential loss in the event of adverse movements in markets are eliminated.

However, although they are good for protection against unwanted market movements, the major drawback of futures is that fixing the interest rates means not only protection from unwanted interest rate movements but also rejecting the possibility to benefit on positive.

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