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**INTEREST RATE DERIVATIVES AS A TOOL OF EFFICIENT HEDGING –  
EMPIRICAL ANALYSIS FOR POLAND**

**Introduction**

The development of the financial market in Poland commenced with the beginning of the transition of the country's social-economic system in 1989. Due to the fact that there had been no financial market with demand and supply for financial instruments (products) in the Polish economy before 1989, such a market had to be constructed from the very scratch. This meant creation of typical financial markets institutions (such as stock exchange) and as well as instruments, including quite wide range of derivatives.

The first segment of financial market in Poland, developing quickly at the beginning of the 1990s, was interbank deposit market which facilitated management of Polish banks' liquidity. At the same time, treasury bills market providing financing for budget deficits and foreign exchange market (currency market) started to grow.

On 16<sup>th</sup> April 1991, Giełda Papierów Wartościowych w Warszawie (Warsaw Stock Exchange) begun its operation mainly due to ongoing privatization of state-owned companies.

Continuous liberalization of foreign exchange regime at the beginning of the 1990s triggered development of foreign exchange derivative market.

By the mid-1990s, Polish financial market was already a well-developed market characterized by high liquidity and high turnover, with two basic segments – stock market and fixed interest rate bonds market – which are typical for financial market in any developed economy.

Gradually, other segments of financial market also started to appear in Poland. Further liberalization of foreign exchange market allowed launching of foreign currency swap market which in turn facilitated swift development of bank derivative market for Forward Rate

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Agreement contracts (FRA). And continuing integration of Polish economy with European markets and its internationalization let Polish investors to participate in international foreign exchange markets through use of another bank derivative - Interest Rate Swap contracts (IRS)<sup>1</sup>.

Regards public market in Poland, derivative instruments trade was launched at the Warsaw Stock Exchange on 16<sup>th</sup> January 1998 when futures for WIG-20 index were introduced<sup>2</sup>.

Nowadays, derivatives are common for all segments of the financial market in Poland: interbank market, money market, foreign exchange market, as well as capital market, where advanced financial engineering is employed.

## **1. Derivatives in financial market**

Financial market is defined as a market that provides mechanism for creating and exchanging financial assets which are intangible. Intangible assets represent legal claims to future benefits which makes them different from tangible assets – the latter's value depends on its particular physical properties<sup>3</sup>.

There are many differing classifications of financial market. One of the most widely used is the classification based on the functions of financial market, as presented in figure 1.

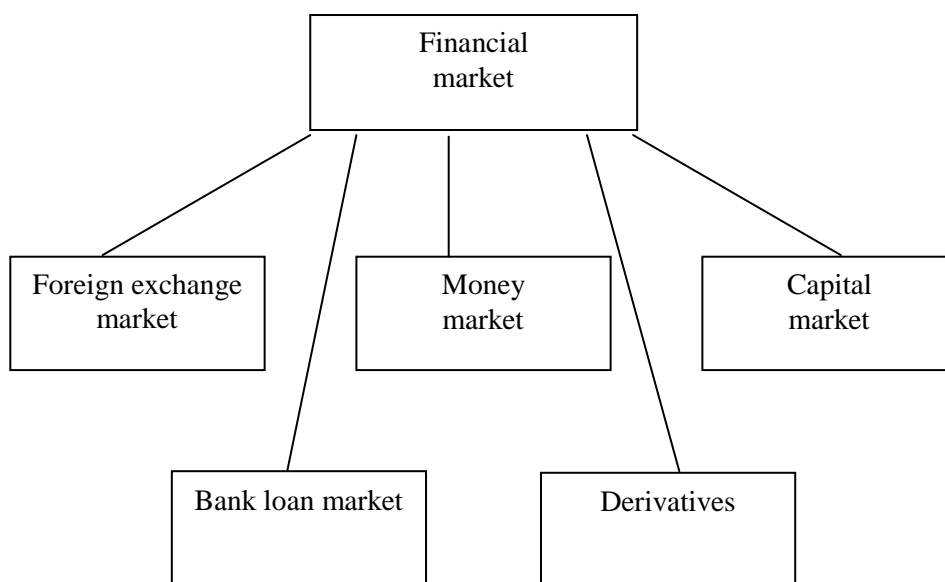
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<sup>1</sup> *Rynek finansowy w Polsce 1998–2001*, Narodowy Bank Polski, Warszawa 2002, [www.nbp.pl](http://www.nbp.pl), p. 5-6, (July 2008).

<sup>2</sup> J. Momot, *Publiczny obrót kontraktami terminowymi na WIG-20*, in: *Hedging i nowoczesne usługi finansowe*, edit. M. Biegański, A. Janc, Wydawnictwo AE w Poznaniu, Poznań 2001, p. 214.

<sup>3</sup> F.J. Fabozzi, *Investment Management*, Prentice Hall Upper Saddle River, NJ 1998, p. 15-16.

**Figure 1. Sectors of financial market according to criterion of function**



Source: *Rynek pieniężny i kapitałowy*, edit. I. Pyka, Wydawnictwo AE w Katowicach, Katowice 2003, p. 13-15.

**Foreign exchange market**, also called currency market, is a market where currencies (as the most liquid financial instrument) are traded and where prices for currencies (currency exchange rates) are set. The main items traded on this market are foreign currencies. **Bank loan market** includes transaction between financial institutions (banks) and entities which do not have access to financial funds and between banks in order to maintain a given liquidity level<sup>4</sup>. Obviously, the main items traded in this market are different bank loans and loans provided by other institutions, both short- and long-term. **Money market** and **capital market** are the most popular segments of financial market. They are different from each other because of maturity of claim. And so, the money market is financial market for short-term debt instruments, where short-term means less than one year. The capital market, on the other

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<sup>4</sup> *Rynek pieniężny i kapitałowy*, edit. I. Pyka, Wydawnictwo AE w Katowicach, Katowice 2003, p. 13-15.

hand, is financial market for financial assets of maturity over one year<sup>5</sup>. However, the money market and the capital market cannot be totally separated: supply of and demand for capital can be alternatively transferred between those two segments<sup>6</sup>. Money market is the market for e.g. treasury bills, commercial papers and banker's acceptances, whereas the typical items on the capital market are securities such as stocks and bonds. The most essential feature of **derivative market** is providing entities with protection against risk encountered in financial market through use of derivative instruments<sup>7</sup>. There are many differing types of derivatives, with different qualities, depending on the basic instrument which a given derivative underlies at.

Another classification, also worth mentioning here, is the division of the financial market into regulated market and over-the-counter (OTC) market. The first one (regulated financial market) is formalized, featuring many regulations and standardized procedures which enhances quality and safety of trading. The main examples of regulated markets are stock exchanges. The latter one – OTC market – is a less-regulated market which offers entities more flexibility<sup>8</sup>.

As mentioned above, one of the youngest (traded for the first time at Chicago Board Options Exchange in 1973<sup>9</sup>) and specialized segment of financial market is **derivative** market. A derivative is defined as an asset whose price derives its value from the price of the underlying financial asset. The derivative market can be either money market (short-term) or capital market, and also either a regulated market (e.g. futures contract traded in stock exchanges) or an OTC market. The most typical feature of all derivatives is that they are contracts specifying transactions that are to be completed at some future date<sup>10</sup>.

Since derivatives are a varied group of financial instruments, their most common classifications are presented in table 1.

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<sup>5</sup> F.J. Fabozzi, *Investment...*, op.cit., p. 15-16.

<sup>6</sup> Z. Fedorowicz, *Rynek pieniądza i rynek kapitału*, Poltext, Warszawa 1999, p. 25.

<sup>7</sup> *Rynek...*, edit. I. Pyka, op.cit., p. 15.

<sup>8</sup> A. Sopoćko, *Rynkowe instrumenty finansowe*, Wydawnictwo Naukowe PWN, Warszawa 2005, p. 19-22.

<sup>9</sup> *Instrumenty pochodne. Wprowadzenie*, Reuters, Dom Wydawniczy ABC, Kraków 2001, p. 20.

<sup>10</sup> F.J. Fabozzi, *Investment...*, op.cit., p. 26.

**Table 1. Classification and types of derivatives**

Criterion	Types of derivatives	Examples of specific derivatives
Instrument complexity	plain vanilla (generic)	forward contracts, options underlain on basic instruments
	portfolio of plain vanillas	swap options
	path-dependent instruments	Asian options
	new types of underlying assets	loan derivatives, insurance derivatives
Trading floor	stock exchange derivatives	futures and options underlain on stock quotations or indices (DJIA, WIG)
	OTC derivatives	currency options, futures and swaps, <b>interest rate derivatives</b>
Issuer	instruments issued by stock exchange governing body	futures underlain on indices
	instruments issued by banks	<b>interest rate derivatives</b>
	instruments issued by enterprises and government institutions	bonds, Treasury bills, stocks, commercial papers
Underlying asset	financial derivatives	<b>interest rate derivatives</b> , stock exchange index derivatives
	commodity derivatives	crude oil price derivatives
	other derivatives	derivatives underlain on real estates indices
Contract closing	contracts closed by physical delivery of the underlying asset	crude oil futures
	contracts closed by financial settlement (without delivery)	financial derivatives

Source: W. Grabowski, *Instrumenty pochodne a współczesne kryzisy finansowe*, Biblioteka Menedżera i Bankowca, Warszawa 1998, p. 26-28.

This article concentrates on interest rate derivatives traded in OTC market in Poland. They are shown in bold in table 1.

## 2. Interest rate derivatives in Poland

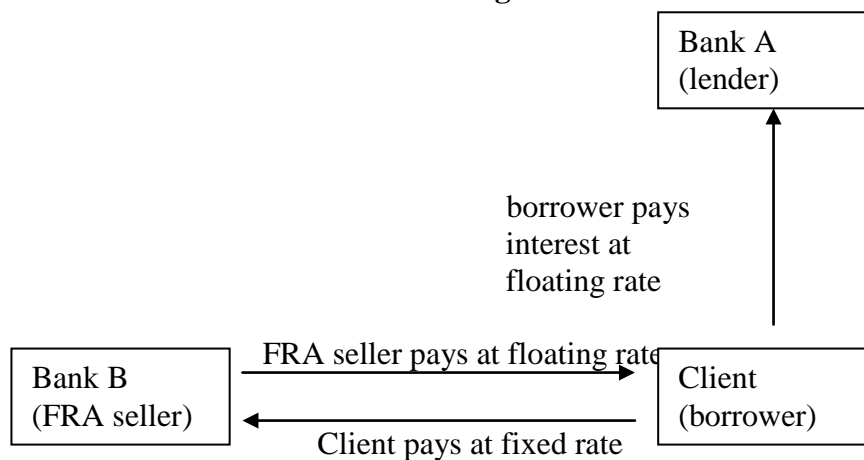
Derivatives based on interest rate as the underlying financial asset are usually traded in OTC markets. To the most typically used interest rate derivatives belong:

- Forward Rate Agreement contracts,
- Interest Rate Swap contracts,
- Overnight Index Swap contract,
- interest rate options.

A **Forward Rate Agreement contract (FRA)** is a contract between two parties to exchange interest payments, where one of the payments is typically based on a fixed interest rate and the other - on a floating interest rate. Only net cash flows resulting from this contract are paid<sup>11</sup>.

The mechanism of a Forward Rate Agreement contract is presented in figure 2.

**Figure 2. Mechanism of Forward Rate Agreement contract**



Source: *Zastosowanie transakcji IRS do zabezpieczania ryzyka zmiany stóp procentowych w Polsce i na świecie*, www.bzwbk.pl/skarb, July 2008.

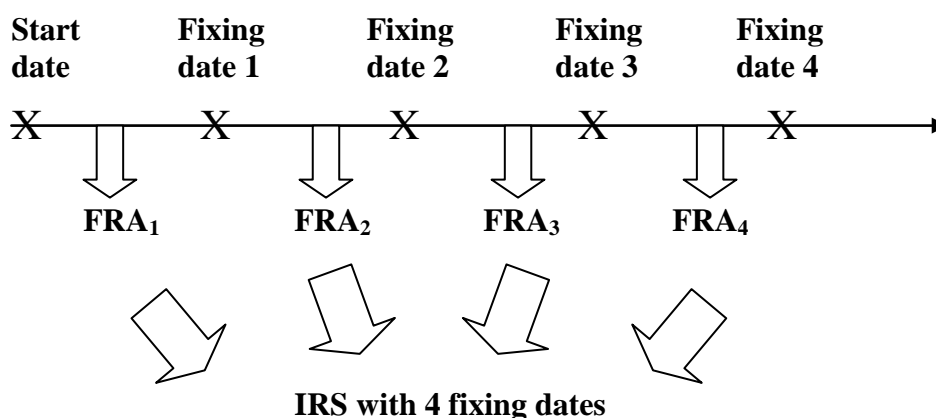
A client, borrowing money at a floating interest rate, bears the risk of interest rate increase. To protect themselves against this risk, the

<sup>11</sup> E.M. Remolona, P.D. Wooldridge, *The euro interest rate swap market*, BIS Quarterly Review, March 2003, www.bis.org, 2003.

borrower may buy a FRA contract with following specifications: face value of transaction, beginning and final date, type of floating rate, fixing date (the date when interest payments are due) and fixed interest rate. In the FRA contract the borrower exchanges floating interest rate for fixed interest rate and therefore diminishes incurred risk during period of interest rate growth<sup>12</sup>.

An **Interest Rate Swap contract (IRS)** can be referred to as a portfolio of FRA contracts<sup>13</sup>. The main difference between a FRA contract and an IRS contract is that during the life of each IRS contract several fixing dates are set. A situation in which upon termination of each FRA contract a new one is bought constitutes in fact an IRS contract covering the whole period in which FRAs are bought, as presented in figure 3. A FRA contract can be therefore described also as a single-period IRS, in which interest payments are exchanged only once.

**Figure 3. Interest Rate Swap contract as a portfolio of Forward Rate Agreement contracts**



Source: own work.

Both IRS and FRA contracts provide protection from unfavorable changes of interest rates, which makes them a safe, convenient and

<sup>12</sup> Zastosowanie transakcji IRS do zabezpieczenia ryzyka zmiany stóp procentowych w Polsce i na świecie, www.bzwbk.pl/skarb, July 2008.

<sup>13</sup> E.M. Remolona, P.D. Wooldridge, *The euro interest rate...*, op.cit.

flexible hedging instrument (the notion of hedging is explained later in the article).

An **Overnight Index Swap contract (OIS)** is a fix-for-floating interest rate swap with a floating rate leg tied to an index of daily interbank rates. In the European money market, OIS contracts refer mostly to EONIA – euro overnight index average rate<sup>14</sup>. Such construction in fact makes an OIS contract a special type of a FRA contract.

An **interest rate option** is defined as a financial instrument that gives the owner the right, but not the obligation, to buy or sell specific assets (interest rate, in this case) at a predetermined price (the strike or exercise price) at or up to a certain future date (the exercise or maturity date)<sup>15</sup>.

Turnover on the OTC markets for interest rate derivatives in the world and in Poland is presented in table 2.

**Table 2. Turnover on the OTC markets for interest rate derivatives in the world and in Poland (in billions of USD)**

	global turnover			turnover in Poland		
	FRA	IRS	interest rate options	FRA	IRS	interest rate options
<b>1998</b>	74	155	36	n/a	n/a	n/a
<b>2001</b>	129	331	29	n/a	n/a	n/a
<b>2004</b>	233	621	171	0,691	0,267	0
<b>2007</b>	258	1210	215	1,435	1,245	0,006

Source: *Triennial Central Bank Survey*, BIS, [www.bis.org/publ/rpfx07t.pdf](http://www.bis.org/publ/rpfx07t.pdf), 2007 and *Wyniki badania obrotów w kwietniu 2007 na krajowym rynku walutowym i rynku pozagieldowych instrumentów pochodnych*, [www.nbp.pl](http://www.nbp.pl), April 2008; n/a – data not available.

Every three years the Bank for International Settlements (BIS) organizes a world-wide survey on foreign exchange and OTC derivatives market operation.

In 2004, the central bank of Poland – NBP – conducted for the first time a survey on the Polish OTC market, compliant with the survey organized every 3 years by BIS, which enables comparison of the global

<sup>14</sup> Ibidem.

<sup>15</sup> *ECB Glossary*, [www.ebc.eu](http://www.ebc.eu), July 2008.

and the Polish OTC derivative market. Such a comparison discloses many differences between those two markets, main of which are:

- the biggest segment of the Polish OTC derivative market is the FRA market, comparing with the IRS being the most liquid segment of the global OTC derivative market,
- the interest rate options market in Poland is of very small size, comparing to significant proportions of the global interest rate options market<sup>16</sup>.

The next central bank survey on the foreign exchange and OTC derivatives market activity was conducted by the Bank of International Settlements with participation of 54 central bank form all over the world in 2007. Its results reveal general 73% increase of value of operations in derivative OTC market in comparison to 2004<sup>17</sup>. The same is true for the Polish derivative OTC market – the increase rate of 39% (2007 compared to 2004). Despite this high rate of increase, the structure of the Polish derivative OTC remained unchanged – and therefore still differing from the structure of the international derivative OTC market.

The OTC interest rate derivative market in Poland is in addition more liquid than the regulated one which differentiates the Polish market from the global one<sup>18</sup>.

Generally, there are three main functions derivatives (including interest rate derivatives) perform in financial market:

- hedging – providing protection from unfavorable changes of prices on a market; generally it is a transfer of risk from entities with high risk aversion to entities that are willing to accept this risk,
- speculation – drawing predictions over expectations of future market movements which should enable speculating entity achieve profits because of conducting right transaction in the right moment,
- arbitrage – basing on the law of one price – when a good (instrument) on one market has a lower price than on another

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<sup>16</sup> *Wyniki badania obrotów w kwietniu 2004 na krajowym rynku walutowym i rynku pozagiełdowych instrumentów pochodnych*, www.nbp.pl, April 2008; *Triennial Central Bank Survey*, BIS, www.bis.org/publ/rpfx05.pdf, 2005.

<sup>17</sup> *Triennial Central Bank Survey*, BIS, www.bis.org/publ/rpfx07t.pdf, 2007.

<sup>18</sup> *Wyniki badania obrotów w kwietniu 2007 na krajowym rynku walutowym i rynku pozagiełdowych instrumentów pochodnych*, www.nbp.pl, April 2008.

market, it is recommended to buy this good (instrument) on a market with a lower price and sell it immediately on another market at a higher price<sup>19</sup>.

Out of those three, the hedging function is the one most widely known and applied on well-developed financial markets. However, some investors tend to use derivatives mainly as a speculation instrument and very often public opinion links derivatives with speculation only. Therefore, it should be widely reminded that the proper use of derivatives can reduce risk, as it has been presented earlier in figure 2 where the hedging function of a FRA has been depicted – use of a FRA contract has allowed the borrower to basically avoid changes of interest rate in the situation of general interest rate increase in the market.

In this article, we concentrate on the hedging properties of derivatives.

### **3. Hedging with use of derivatives – empirical approach**

As explained earlier, interest rate derivatives are used as hedging instruments. Because of their differing constructions, FRA, IRS and OIS contracts and interest rate options are used in different ways in these operations. Out of these four, the contract which is most often used in the Polish financial market is FRA. Therefore in this article, we regard FRA as the instrument which fully presents all the hedging features of an interest rate derivative. The following empirical verification should prove that use of FRA contracts does in fact minimize the risk attached to operation on financial, and especially money, market.

From the fact that FRA contracts, as described earlier, are traded on the OTC segment there might be the problem of access to actual FRA quotations. There are not many financial institutions in Poland which publish FRA quotations regularly and openly and hence there is a problem with obtainment of data chains long enough to provide statistically significant outcomes. The lack of regular and open to public FRA quotations results from the fact that this contract is an OTC market instrument. This means there is no regulated market for it and its bid/ask prices are very often negotiated by both sides of the contract. On top of

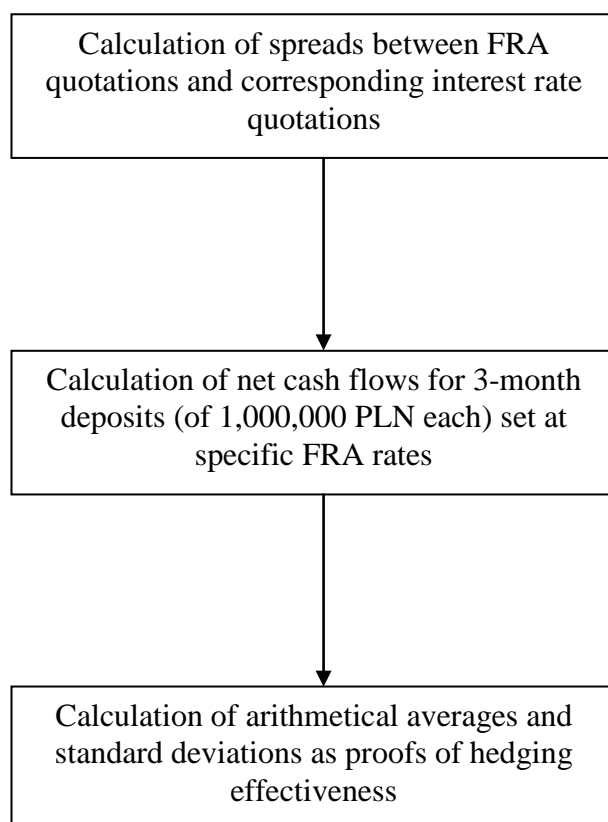
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<sup>19</sup> K. Jajuga, K. Kuziak, P. Markowski, *Inwestycje finansowe*, Wydawnictwo AE we Wrocławiu, Wrocław 1997, p. 32.

that, 99% of the FRA trading in Poland is executed by the banking sector institutions which also hinders access to the quotations<sup>20</sup>.

We will conduct analysis of the hedging aspect of interest rate derivatives in Poland as depicted in figure 4.

**Figure 4. Stages of analysis of hedging aspect of interest rate derivatives in Poland**



Source: own work.

In this article we use FRA quotations provided by Dresdner Bank AG SA Oddział w Polsce (the Polish branch of Dresdner Bank AG) – see table 3.

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<sup>20</sup> *Wyniki...*, 2004, op.cit.

**Table 3. FRA quotations for the period July 2006 – April 2007 (in %)**

Month	FRA 1x4		FRA 3x6		FRA 6x9		FRA 9x12	
	bid	ask	bid	ask	bid	ask	bid	ask
<b>Jul 06</b>	4,18	4,23	4,27	4,33	4,48	4,53	4,74	4,79
<b>Aug 06</b>	4,24	4,3	4,36	4,41	4,69	4,75	4,94	4,99
<b>Sep 06</b>	4,25	4,3	4,45	4,51	4,8	4,85	5,02	5,07
<b>Oct 06</b>	4,24	4,3	4,41	4,46	4,62	4,67	4,82	4,87
<b>Nov 06</b>	4,22	4,28	4,34	4,4	4,55	4,6	4,67	4,73
<b>Dec 06</b>	4,22	4,28	4,34	4,4	4,55	4,6	4,67	4,33
<b>Jan 07</b>	4,2	4,25	4,26	4,31	4,41	4,46	4,52	4,58
<b>Feb 07</b>	4,22	4,28	4,33	4,38	4,52	4,57	4,67	4,73
<b>Mar 07</b>	4,34	4,39	4,49	4,55	4,69	4,75	4,79	4,85
<b>Apr 07</b>	4,42	4,47	4,58	4,63	4,75	4,8	4,85	4,9

Data: [www.dresdnerbank.pl](http://www.dresdnerbank.pl) (April 2008).

Quotations for given time periods (months) are quotations at the end of a given month. The reference interest rate for all the FRA contract quotations presented in table 1 is WIBOR 3M (Warsaw Inter-bank Offered Rate)<sup>21</sup>. Descriptions of specific FRA contracts are to be understood as follows:

- FRA 1x4 – is a quotation of an interest rate for a deposit/loan that will start in a month and will expire three months later – which will be 4 months since the beginning of a given FRA contract; for example FRA 1x4 for July 2006 is a quotation for a deposit/loan that will start in August 2006 and expire in November 2006;
- FRA 3x6 – is a quotation of an interest rate for a deposit/loan commencing in three months and expiring after 3 months – which will make in total 6 months from the month when the given FRA started; e.g. FRA 3x6 for July 2006 provides quotation for a deposit/loan beginning in October 2006 and expiring in January 2007;

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<sup>21</sup> *Definitions of terms related to loans*, [www.brebank.pl](http://www.brebank.pl), April 2007.

- FRA 6x9 – is a quotation of an interest rate for a deposit/loan beginning in 6 months and expiring 3 months later – 9 months in total since the month when the given FRA contract started;
- FRA 9x12 – is a quotation of an interest rate for a deposit/loan beginning in 9 months and expiring 3 months later – 12 months in total since the month the given FRA started.

The ask price is the price (interest rate) used when an entity buys (and the bank sells) a FRA contract – this is recommended for entities that seek protection from increase of interest rate, for example when they have a loan at a floating (variable) interest rate. The bid price is a price used when an entity sells (and the bank buys) a FRA contract – this is recommended for entities that seek to avoid decrease of interest rate, e.g. because they hold a deposit at a variable interest rate.

In order to determinate whether FRA contracts can actually be used as a hedging instrument on the Polish money market, spreads between the FRA quotation and the actual realization of the FRA reference interest rate (WIBOR 3M) were calculated.

The WIBOR 3M interest rates in the period July 2006 to February 2007 are presented in table 4.

**Table 4. WIBOR 3M interest rates in the period July 2006 – April 2007 (in %)**

Month	t+1	t+3	t+6	t+9
	WIBOR 3M	WIBOR 3M	WIBOR 3M	WIBOR 3M
<b>Jul 06</b>	4,2	4,2	4,2	4,4
<b>Aug 06</b>	4,22	4,2	4,2	4,45
<b>Sep 06</b>	4,2	4,21	4,24	4,71
<b>Oct 06</b>	4,2	4,2	4,4	4,81
<b>Nov 06</b>	4,21	4,2	4,45	5,03
<b>Dec 06</b>	4,2	4,24	4,71	5,1
<b>Jan 07</b>	4,2	4,4	4,81	5,18
<b>Feb 07</b>	4,24	4,45	5,03	5,56
<b>Mar 07</b>	4,4	4,71	5,1	5,7
<b>Apr 07</b>	4,45	4,81	5,18	5,64

Data: [www.dresdnerbank.pl](http://www.dresdnerbank.pl) (April 2008).

To compare the data with table 1, WIBOR 3M rates have been put into following columns:

- t+1 – corresponding with the FRA 1x4 – provides rates for the month following the month when the given FRA started, e.g. rate described as July 06 is actually the August 06 rate;
- t+3 – corresponding with the FRA 3x6 – presents rates achieved 3 months after the beginning of a given FRA contract, e.g. rate described as July 06 is actually the October 2006 rate;
- columns t+6 and t+9 follow the same rules as described above.

Spreads between FRA quotations and corresponding WIBOR 3M rates are presented in table 5.

**Table 5. Spreads between FRA quotations and corresponding WIBOR 3M rates (July 2006 – April 2007; in %)**

Month	FRA 1x4		FRA 3x6		FRA 6x9		FRA 9x12	
	bid	ask	bid	ask	bid	ask	bid	ask
<b>Jul 06</b>	-0,02	-0,03	0,07	-0,13	0,28	-0,33	0,34	-0,39
<b>Aug 06</b>	0,02	-0,08	0,16	-0,21	0,49	-0,55	0,49	-0,54
<b>Sep 06</b>	0,05	-0,1	0,24	-0,3	0,56	-0,61	0,31	-0,36
<b>Oct 06</b>	0,04	-0,1	0,21	-0,26	0,22	-0,27	0,01	-0,06
<b>Nov 06</b>	0,01	-0,07	0,14	-0,2	0,1	-0,15	-0,36	0,3
<b>Dec 06</b>	0,02	-0,08	0,1	-0,16	-0,16	0,11	-0,43	0,77
<b>Jan 07</b>	0	-0,05	-0,14	0,09	-0,4	0,35	-0,66	0,6
<b>Feb 07</b>	-0,02	-0,04	-0,12	0,07	-0,51	0,46	-0,89	0,83
<b>Mar 07</b>	-0,06	0,01	-0,22	0,16	-0,41	0,35	-0,91	0,85
<b>Apr 07</b>	-0,03	-0,02	-0,23	0,18	-0,43	0,38	-0,79	0,74

Data: author's own calculations.

For the bid quotations, spreads have been calculated as subtraction of the WIBOR 3M rate from the corresponding FRA quotation – as the investor aims to protect themselves from interest rate decrease, so they gain when the FRA quotation is higher than the actual WIBOR 3M rate for the given period. For the ask quotations, spreads have been calculated as subtraction of the FRA quotation from the corresponding WIBOR 3M rate - as the investor protects themselves

from interest rate increase, so they gain when the actual WIBOR is higher than the FRA quotation. In the period July 2006 – April 2007 spreads above 0 meant realization of the investor's expectations of the level of the actual interest rate which resulted in investor's gain.

In order to examine the hedging aspect of FRA contracts deeper, net cash flows for a 3-month deposit of 1,000,000 PLN (one million) set at a floating (variable) interest rate hedged with use of a FRA contract were calculated for the given period. The net cash flows are presented in table 6.

**Table 6. Net cash flows for 3-month deposits**

Month	FRA 1x4		FRA 3x6		FRA 6x9		FRA 9x12	
	bid	ask	bid	ask	bid	ask	bid	ask
<b>Jul 06</b>	-2439	-3659	8537	-15854	-34146	-40244	40476	-46429
<b>Aug 06</b>	2433	-9732	19512	-25610	-59756	-67073	57988	-63905
<b>Sep 06</b>	6098	-12195	29233	-36541	-67961	-74029	35591	-41332
<b>Oct 06</b>	4878	-12195	25610	-31707	-26190	-32143	1135	-6810
<b>Nov 06</b>	1218	-8526	17073	-24390	-11834	-17751	-39867	33223
<b>Dec 06</b>	2439	-9756	12136	-19417	18370	12629	-47253	84615
<b>Jan 07</b>	0	-6098	-16667	10714	45403	39728	-71895	65359
<b>Feb 07</b>	-2427	-4854	-14201	8284	56478	50941	-93096	86820
<b>Mar 07</b>	-7143	1190	-25258	18370	45055	38462	-93814	87629
<b>Apr 07</b>	-3550	-2367	-26107	20431	46841	41394	-81950	76763

Data: author's own calculations.

The net flows were calculated using the spreads from table 5. The spread for the given month was multiplied by 1,000,000 PLN (deposit) and result was discounted at the WIBOR 3M for the given month (with monthly capitalization) which shows present value of the deposit at the time of its beginning. Inflation was not included in this calculation due to its low level in the given period.

Next, arithmetical mean was calculated for all bid and ask net cash flows in the given period. The result – 2620 PLN shows that generally for that period use of FRA contracts as a hedging instrument did not prove to be successful. However, standard deviation for all bid and ask net cash flows reached relatively high level of 40745 PLN, which

indicates that net cash flows differed significantly from the arithmetical average for all quotations. It is especially visible for FRA 9x12 quotations for which net cash flows are the highest in the whole sample.

Arithmetical average for all bid net cash flows is – 6839 PLN with standard deviation at the level of 15055 PLN. This proves that selling FRA contracts as a means of hedging operations on the market with high expectations of interest rate increase is not effective as such operations bring rather losses than gains.

On the other hand, arithmetical average for all ask cash flows is +1598 PLN with standard deviation at the level of 15103 PLN. This indicates that buying FRA contracts when there is persisting expectation of interest rate increase proves efficient and beneficial for the investor. This is where effectiveness of hedging operations is distinctly visible.

Furthermore, it should be noticed here that the longer the period for which FRA quotation is set, the higher capitalized net cash flow (gain of the investor), of course on the condition of correct prediction of interest rate changes.

All of the above proves that use of FRA contracts as hedging instruments should be taken into consideration by entities conducting operations on financial markets. Opening positions in FRA contracts, when predicting accurately changes in the levels of interest rates, proves to be beneficial. In the examined cases, during lasting predictions of interest rates increase, net cash flows achieved were generally above 0. The quite simple method of calculation used in this examination allows to state that FRA contracts can be used effectively as a hedging instrument in the OTC market.

Due to low amount of OTC derivative market research in Poland it is worth to continue this research in the future – however, researchers should be able to work with longer data chains. The period that has been taken into account in this article may not seem long enough to conclude binding results. We remain aware of the weaknesses of this research. It is however worth to underline here that there are not many examples of OTC market derivatives empirical research in Poland.

## **Conclusion**

In the conclusion, it should be emphasized here that there is a continuous need to minimize risk connected with operations on the financial market. Interest rate derivatives, especially FRA contracts, have

been used in Poland mainly in the interbank market. Other participants of the financial market should be made aware of existing possibilities of risk minimization. The need of hedging is not realized enough in the Polish economy, especially in operations outside the financial market. Derivatives are often perceived in Poland only as an instrument of speculation and its hedging functions are rather diminished by managers outside the financial sector. In order to facilitate change of this approach, especially with consideration for the increase of the derivative OTC market, further extensive education of managers in Poland with special focus of possibilities offered by different sectors of derivative market is highly required.

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