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Mortgage Pricing in Russia: A Methodological Introduction

Prepared by

Michael J. Lea
R. Marisol Ravicz

The Urban Institute
2100 M St. NW
Washington, DC 20008

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ABSTRACT

This report provides a methodology for pricing residential mortgages in Russia. In establishing an appropriate mortgage interest rate, banks must take into account a variety of risks including credit risk, interest-rate risk, spread risk, liquidity risk, and options risk. In addition, the interest rate must be large enough to cover the bank's cost of originating, servicing and funding the loans. For each component of the mortgage price mentioned above, this report reviews the theory of how this risk or cost is priced, how the pricing is handled in Western countries, and how it might be handled in Russia. The report also provides worksheets for pricing components requiring complex computations. The report is tailored to the Deferred Adjustable Instrument for Russia (DAIR), but is largely applicable to other instruments.

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MORTGAGE PRICING IN RUSSIA: A METHODOLOGICAL INTRODUCTION

I. EXECUTIVE SUMMARY

The purpose of this manual is to provide a methodology for the pricing of residential mortgages for banks in Russia. Mortgage pricing is defined as providing a yield on the mortgage sufficient to cover marginal funding costs, operating costs and expected losses, and provide an acceptable return to equity investors.[1]

In establishing a rate on their mortgages, banks must take into account the risks of making and funding the loans. These risks include credit risk, interest-rate risk, spread risk, liquidity risk and options risk. In addition, the rate must include a spread to compensate the bank for its incremental costs of originating, servicing and funding the loans. These components, when added to a base funding rate, will generate a break-even risk adjusted yield for the bank. A profit spread must be added to this yield to determine the rate to the borrower.

The discussion and examples in this manual are based on use of the Deferred Adjustable Instrument for Russia ("DAIR").[2] However, the methodology underlying the discussion is not instrument specific and is sufficiently general to apply to a wide variety of instruments. The manual contains a discussion of the theory of mortgage instrument pricing and in-depth explanations and examples of the key components of mortgage price. In each of the component discussions, reference is made to the range of values typically found in Western housing finance systems. In addition, a methodology is presented for estimating component values when historical information is unavailable. Spreadsheets developed to price credit risk and interest rate risk are available from the authors.

Pricing mortgages in Russia is complicated by the lack of experience and legal basis for this type of lending as well as the unstable economic environment. Thus, the parameter values used in the discussion and examples are meant to be illustrative and do not constitute recommendations for lenders.

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[1] The yield is the internal rate of return over the life of the loan which may be different from the initial rate on the loan. Equity investors are the bank's shareholders.

[2] See Ravicz and Struyk. 1993. "Product Description for the Deferred Adjustable Instrument for Russia." Washington, D.C.: The Urban Institute.

II. THE THEORY OF MORTGAGE PRICING

In order to provide an acceptable return on investment, mortgage investments must be priced at a spread over the cost of the marginal source of funds. This spread must account for the expected costs of investing in a portfolio of mortgages and a targeted return on investment for the owners of the bank. The expected costs include premiums for the risks of mortgage lending and the operational costs of raising funds and making loans. Specifically, these factors include:

- **Credit Risk** - Potential loss due to borrower default;
- **Interest Rate Risk** - Potential loss deriving from mismatched funding (e.g., if loan rates adjust less frequently than funding rates in a rising interest rate environment);
- **Options Risk** - Reinvestment loss due to early redemption of fixed-rate mortgages (prepayment risk) and funding loss associated with locking a rate to a borrower prior to loan closing (commitment risk);[3]
- **Spread Risk** - Potential loss deriving from change in funding margin (relative to a reference rate) if lending with a fixed margin (relative to a reference rate);
- **Liquidity (Marketability) Risk** - Cost of maintaining reserves or lines of credit, or losses associated with the sale of assets to raise cash;
- **Administrative Cost** - Marginal cost of raising funds, originating mortgages and servicing mortgages;
- **Profit Spread** The targeted return on shareholder investment, net of expected losses and costs, necessary to compensate investors for the uncertainty of cost and loss estimates (e.g., through increased volatility in interest rates) and the opportunity cost of their investment.

The mortgage yield can be expressed as the sum of the marginal funding rate and the spread components listed above. The interbank interest rate is used as the benchmark for the mortgage rate.[4] It is assumed that the bank funds its

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[3] These costs can be zero if prepayment is precluded, the mortgage rate is not fixed, or rates are not locked until closing.

[4] The interbank rate is currently the closest approximation to a market rate in Russia. [Although currently negative in real terms, the interbank rate should move towards a positive rate responding to competitive pressure and macroeconomic stability.] Other proxies for the marginal cost of funds can be used, including the Central Bank discount rate or the rate on short term (i.e., one month) time deposits. Whatever index is used it is important that it be market determined and reflect the costs of

mortgage investments with a combination of 95 percent debt and 5 percent equity.[5] The analysis in this manual refers to pre-tax returns from mortgage investment.

III. CREDIT RISK

Theory:

Loan default is an expected occurrence in mortgage lending. Default loss can occur for systemic (e.g., widespread property price decline or unemployment) or non-systemic (e.g., individual borrower or property specific) reasons. Non-systemic default can be reduced through conservative underwriting. However, there is a cost associated with overly conservative underwriting in the form of profitable lending opportunities foregone. The goal of underwriting is to keep default rates (and costs) within an acceptable (typically non-zero) range.

The main factors underlying mortgage default are the borrower's ability-to-pay and willingness-to-pay. Ability-to-pay is principally determined by the relationship between the borrower's income and the mortgage payment. Willingness-to-pay is principally determined by the relationship between the market value of the mortgage and the market value of the property. Additional factors include the borrower's ability to sell the property within the allowable period of mortgage arrears and the borrower's perception about the likelihood of the bank initiating and a court approving foreclosure.

There are several costs to lenders of mortgage default. The lender suffers a loss if the proceeds from sale of a repossessed house are less than the outstanding balance (including accrued interest) on the loan. In addition, there are administrative costs of managing defaulted loans and repossessed properties. Lenders incur costs to maintain, repair and market repossessed properties. Default costs may also include lost interest or principal associated with

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raising additional funds rather than a bank's historical liability costs.

[5] This ratio can be adjusted to reflect the relative risk of different types of investment. For example, The Bank for International Settlements ("BIS") recommended equity-to-assets ratio (risk weight) for residential mortgages is 4 percent and for commercial (i.e., enterprise) loans is 8 percent. A higher capital-to-assets ratio requires a higher mortgage yield (other factors held constant) because equity investors require a higher return than debt holders (as equity holders are the residual claimants to the cash flows). Alternatively, a lower risk weight could be used with a higher targeted return on equity (to reflect higher risk).

forbearance or restructuring of defaulted loans and the time necessary to obtain the property through foreclosure.

Management:

Credit risk is managed through setting of guidelines for acceptable risk exposure (typically by a credit committee). The principal underwriting guideline associated with ability-to-pay is the loan payment-to-income ratio (at the time the loan is granted and that expected in the future). The principal underwriting guideline associated with willingness-to-pay is the loan-to-value ("LTV") ratio (both initial and expected in the future). Values for these guidelines are generally established before lending commences and reviewed periodically in light of changes in economic conditions and property market conditions. Individual loans are underwritten according to the guidelines with emphasis on establishing borrower income and the value of the property (e.g., through an appraisal process).

Western Guidelines:

Lending institutions establish guidelines for acceptable payment-to-income and loan-to-value ratios. Payment-to-income ratios typically range between 25 and 36 percent, depending on the loan type, country and definition of payment and income.[6] Maximum loan-to-value ratios are typically 80 percent. Loans for amounts in excess of 80 percent of value can be obtained but must be insured or underwritten independently of the first mortgage.[7]

In developed housing finance systems, most credit losses come from loans with LTVs greater than 80 percent. In the U.K. and the U.S, mortgage insurance covers this risk.[8] In some European countries, incremental funds can be obtained from other lenders (e.g., unsecured personal or "top-up loans) or from the primary lender at a higher rate. Exhibit 1 contains representative pricing for

[6] This ratio can be defined narrowly to include only the mortgage payment or broadly to include property taxes, insurance, utilities and other housing specific expenses.

[7] In developed housing finance systems there can be multiple liens on a property. Priority is typically given to the earliest registered lien and other liens are subordinated to the first lien. As such they have higher risk and typically a higher rate.

[8] Mortgage insurers take the risk of loss over a certain LTV (e.g., 75%) in exchange for an up-front fee or additional spread over the mortgage rate.

the credit risk of a 90% LTV loan (i.e., for the incremental exposure over an 80 percent LTV loan).[9]

Exhibit 1
Representative Credit Risk Pricing

Country	Allocation Method	Pricing (%)[10]
Denmark	Top-up loan	0.34
France	Primary loan	0.78
Germany	Top-up loan	0.31
United Kingdom	Mortgage insurance	0.63
United States	Mortgage insurance	0.35

Source: Diamond and Lea (1992)

The pricing differences in Exhibit 1 reflect differences in the mortgage instruments and lending conditions in the various countries. The Danish, German and U.S. credit risk premiums were the lowest in 1990. German underwriting guidelines are very conservative and default is rare. The United States benefits from a well developed information base on mortgage default and considerable geographic diversification.[11] Denmark, Germany and the United States rely primarily on fixed-rate mortgages. Because nominal mortgage payments are constant over the life of the loan, mortgage default due to payment shock (the loan payment rising faster than income) is mitigated. France and the United Kingdom have significantly higher credit

[9] The 80 percent threshold in developed housing finance systems is premised on relative house price stability. As the stability of house prices has yet to be established in Russia, credit risk is likely to exist, and should therefore be priced, in loans with LTVs less than 80 percent.

[10] Nineteen Ninety values for representative borrowers and loans. This column shows the increase in the interest rate on the entire loan amount. If the exposure over 80 percent is priced separately, the loan rates would range from 3 to 7 percentage points over the rate on the primary (i.e., LTV less than or equal to 80 percent) loan. These values can change over time as expectations about loan default and property market conditions change.

[11] Diversification can reduce risk (volatility of returns) if the returns on loans made in different geographic regions or for different purposes are uncorrelated or negatively correlated. Thus the risk of lending in two different geographic areas may be less than that of lending within one area if the economic performance (and resultant property values) diverge. An example of diversification is given below.

risk premiums. In the United Kingdom, reliance on high LTV, variable-rate loans in an environment of falling nominal house prices has led to high rates of mortgage default. Also the housing market is illiquid and geographically concentrated, increasing lender and insurer risk. Higher default costs in France reflect the fact that foreclosure laws strongly favor borrowers (the average time to foreclose ranges between 2 and 4 years) and appraisal methods are relatively undeveloped.

Credit risk premiums in these countries are competitively set and rely on time series data relating mortgage and economic characteristics with mortgage payment history. All of these countries use some form of risk-based pricing (i.e., loan rates or insurance fees rising with LTV reflecting greater risk with lower borrower downpayment). It may be instructive to look at French market as the closest analog to Russia. The difficulties of repossession by lenders and the vagaries of property valuation increase the credit risk premium. As a result, mortgage lenders rarely make loans in excess of 80 percent of estimated property valuation and rely primarily on verification of income in their underwriting. To further manage risk, loan payments are direct debited from borrower bank accounts.

Russia:

Historical information on credit risk for housing loans in Russia is unlikely to be useful in predicting the future level of defaults. In the past, only Sberbank has made loans for housing purchase. These loans were fixed rate instruments with relatively low payment-to-income ratios, made in a very stable economic environment in which, for a variety of reasons, default was difficult or even impossible. However, most of the conditions that discouraged default under the old regime do not exist in the new lending environment.

In theory a new system of foreclosure laws should help reduce the costs associated with mortgage default. In practice however these laws are untested, and provide enormous latitude for individual judges' and bailiffs' discretion. Given this lack of historical experience, the uncertainty and instability of the current environment, and banks' lack of experience in market-oriented servicing procedures, bankers should assume a relatively high probability of default and severity of loss to obtain an initial credit risk spread. An example of this methodology is contained in Exhibit 2. Over time as experience is gained in the current environment, this premium can be adjusted to reflect actual loan portfolio performance.

Exhibit 2
Annual Average Additional Interest Spread
for a DAIR Mortgage
Under Different Default Assumptions

Cumulative Share of Portfolio Defaulting[12]

Recovery[13]	**5%**	**10%**	**20%**	**30%**
50%	0.28	0.58	1.23	1.96
0%	0.48	.98	2.07	3.29
-100%	0.58	1.19	2.50	3.98

Assumptions:
Rb. 200 million mortgage portfolio (average loan Rb. 5 million)
15 year term
Initial interbank lending rate: 124 percent
Initial mortgage rate: 129 percent

The cells in Exhibit 2 contain the annual spread that must be added to the mortgage rate in order to cover the expected default loss associated with a particular interest rate scenario,[14] probability of default and recovery from default. The cumulative probability of default refers to the proportion of loans in the portfolio expected to default over the life of the portfolio. The recovery reflects the proportion of the outstanding principal balance that the lender would expect to recover after

[12] Proportion of initial loan portfolio value defaulting over the life of group (or pool) of mortgages. Loans are assumed to default discretely (one or more per year during the second through the sixth years of repayment). Alternative default patterns can be specified (e.g., a certain percentage of outstanding loan balance per year).

[13] Recovery refers to the percent of interest and outstanding principal recovered after default occurs. This figure can be less than 0 percent of the outstanding loan balance because the total loss to the bank includes legal and administrative costs of foreclosure. Recoveries (or legal and administrative) losses are assumed to occur 1 year after default occurs.

[14] For the purposes of these examples, we assume that the interest rate is fixed at 5 percentage points above the inter-bank lending rate. We assume that the interbank lending rate is initially 124 percent, rises to 390 percent by year 7 of loan amortization, and falls thereafter to 51 percent by year 15.

default (this can be less than 0 percent reflecting the costs of foreclosure and the lost interest during the foreclosure process). The losses are assumed to occur during the first 6 years of the loan amortization period. The Exhibit refers to a DAIR mortgage. This instrument will experience significant negative amortization in an inflationary environment. Therefore the loss can be far in excess of the original loan balance. Different mortgage instruments, with different amortization patterns (and different probabilities of default) can be analyzed using this framework.

The mechanics of the spreadsheet generating Exhibit 2 are portrayed in Exhibit 3. In this program, a portfolio of loans of a given interest rate and term is amortized with different default assumptions. A portion of the outstanding principal is assumed to default at the end of particular years.

Exhibit 3
Mortgage Default Risk Example
(Rubles millions)

		End of Month (Rb. MM)				
Month	Monthly Contract Rate	Interest Owed	Payment Owed	Default	Ending Balance	Recovery
0					200	
1	7.39	14.72	1.77	0.0	212.9	0.00
2	7.56	16.10	1.77	0.0	227.3	0.00
23	10.55	122.52	10.13	0.0	1,273.7	0.00
24	10.64	135.56	10.13	31.84	1,367.3	0.00

Defaults represent negative cash flows and recoveries (if any) represent positive cash flows (and are assumed to occur one year after the default - the timing of recovery can also be varied). The spreads in Exhibit 2 are derived by increasing the interest rate in the default scenario until the discounted value of the payment stream (cash flow) from the portfolio is equal to what it would have been if no default had occurred. The values in Exhibits 2 and 3 reflect a particular scenario and will vary depending on the assumptions input by the user. The spreadsheet model used to generate Exhibits 2 and 3 is available from the authors. A manual for this model is contained in Annex 1 of this document.

Default costs are influenced by several factors. First is the timing of default. Earlier defaults are more costly for the bank because a larger share of the total value of loan payments is lost. Second is the level of interest rates. At the high nominal interest rates that currently exist in Russia, even relatively high default rates have a modest cost to the lender. The present value of the lost payments due to subsequent defaults is relatively small in relation to the total cash flows of the portfolio, because the discount rate in later years is very high.[15] If the mortgage lending rate were constant at 15 percent instead of beginning at 129 percent and fluctuating over the life of the loan, the mortgage lender would receive much less cash in the early years of the loan life. The additional interest spread necessary to cover a 20 percent cumulative loss rate and 0 percent recovery would rise from 2.07 to 2.19 percentage points for the 15 percent mortgage interest rate (which represents a much higher premium relative to the initial mortgage rate).

Default rates are likely to differ by instrument. The DAIR loan in this example has significant negative amortization in its early life. The LTV may rise if interest rates rise significantly faster than property prices. Thus the DAIR may have a higher default probability than an amortizing mortgage instrument (e.g., a classic fixed-rate, level payment mortgage or "FRM"). Furthermore, DAIR payments increase in nominal terms over time (but fall rapidly in real terms). Thus, relative to a level payment mortgage there is a greater likelihood of default due to a rising payment-to-income ratio. Although FRMs may have a lower probability of default, such mortgages (as will be shown below) may greatly increase the lender's interest rate risk exposure.

Finally, the payment rate on the DAIR will affect credit risk. The higher the payment rate relative to the contract rate, the more the discounted value of mortgage payments is concentrated in the early years of loan amortization.[16] If, in present value terms, most of the loan is repaid in the first several years of loan repayment, then defaults occurring in later years will have only a relatively small impact on bank profitability.

Because there is no experience with mortgage default in Russia, there is no basis for a specific default probability or severity recommendation. The lender will have to select an initial combination based on its underwriting criteria and market conditions. The premium can be adjusted as conditions change and experience is gained.

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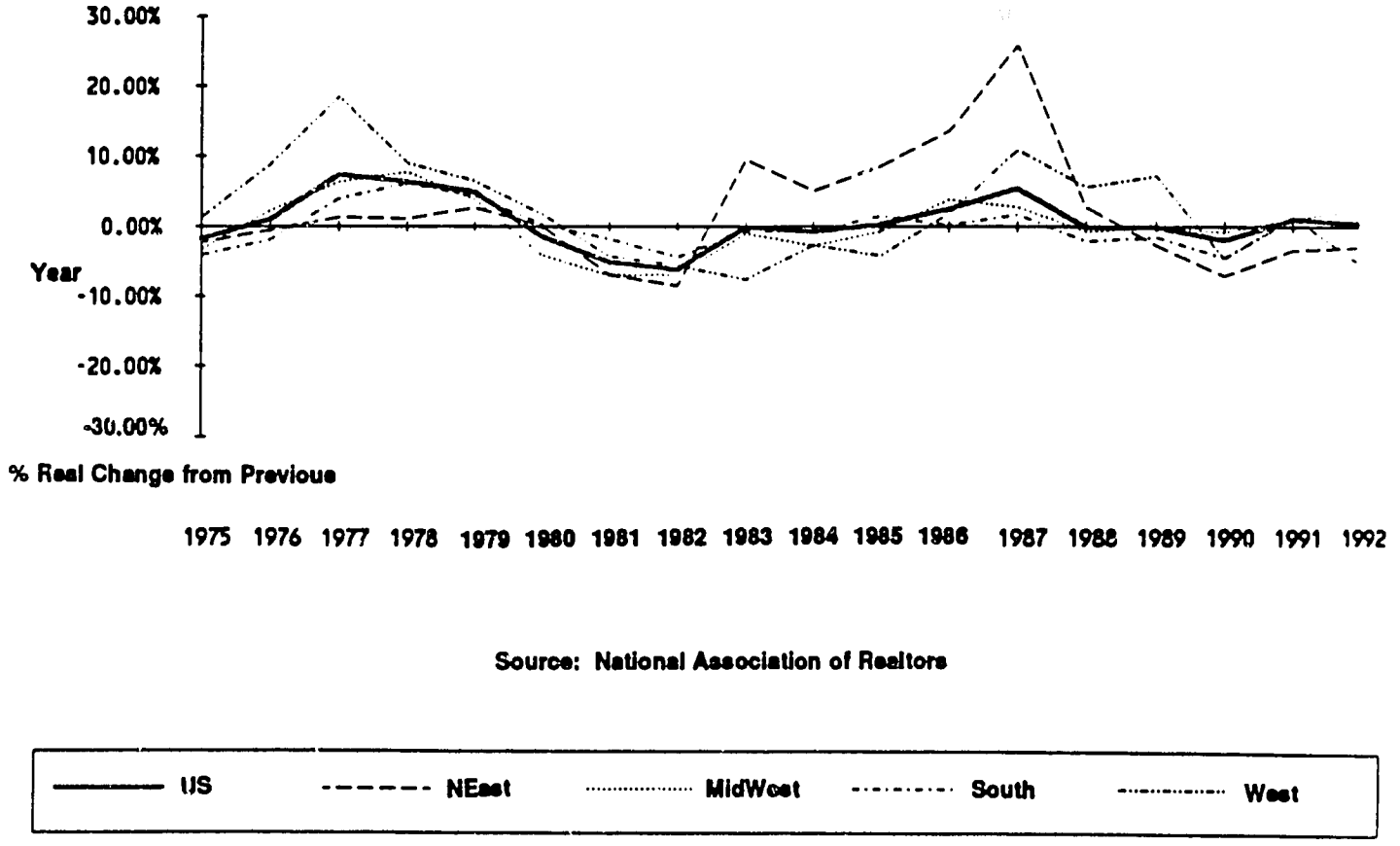
[15] For the purposes of these examples, we use the interbank lending rate as the discount rate.

[16] The payment rate is the rate used to calculate borrower payments. The contract rate is the rate used to calculate interest accrual. The higher the payment rate relative to the contract rate, the greater the share of interest owed is paid each month.

Credit risk can be reduced through geographic diversification, as house price changes in different regions often vary. As shown in Exhibit 4, real house prices in different U.S. regions have varied considerably over the past decade (USchg refers to the evolution of average real house prices for the entire country and NE, MidW, South and West refer to the Northeast, Midwest, Southern and Western regions of the country respectively). Nationwide lenders fared better than those with loans concentrated in specific geographic areas of the country.

Exhibit 4
U.S. Real House Price Change



Source: National Association of Realtors

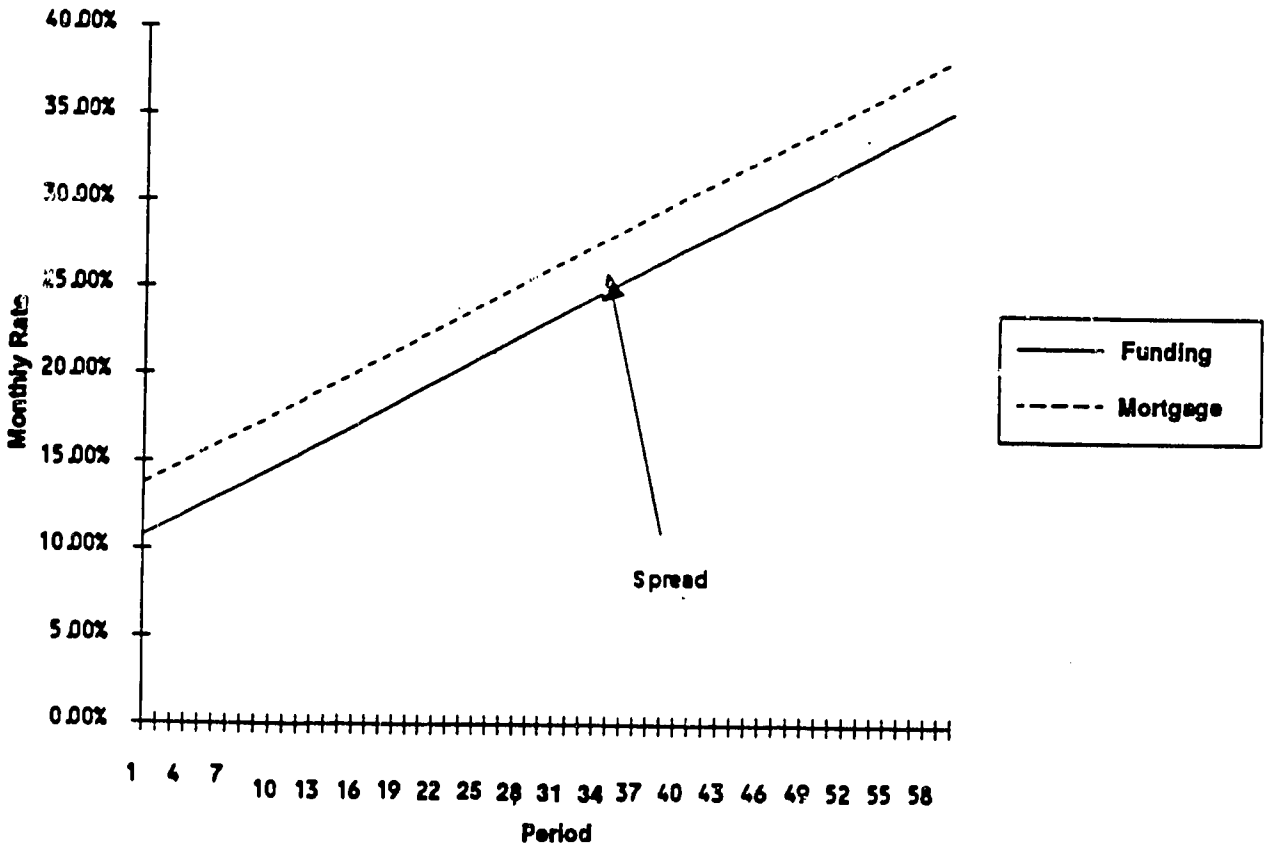
IV. INTEREST-RATE RISK

Theory:

Interest-rate risk relates to the impact that changes in interest rates have on the value of a lending institution's assets, liabilities and income stream. If a lender's assets and liabilities are perfectly matched (specifically the cash flows are matched) then the value of its assets and liabilities will change by equal amounts as interest rates change, leaving the value of the bank (i.e., the value of shareholder equity) unchanged. If the lender is not perfectly matched, interest income and expense will change by different amounts as interest rates change, affecting market value and cash flow. For example, a bank makes a 20 year 10 million Ruble loan at a fixed 100 percent interest rate and its cost of funds is 60 percent. If, at the end of one year the cost of funds has increased to 110 percent, the value of the loan has decreased because its return, while constant in absolute terms, has declined relative to the cost of funds.

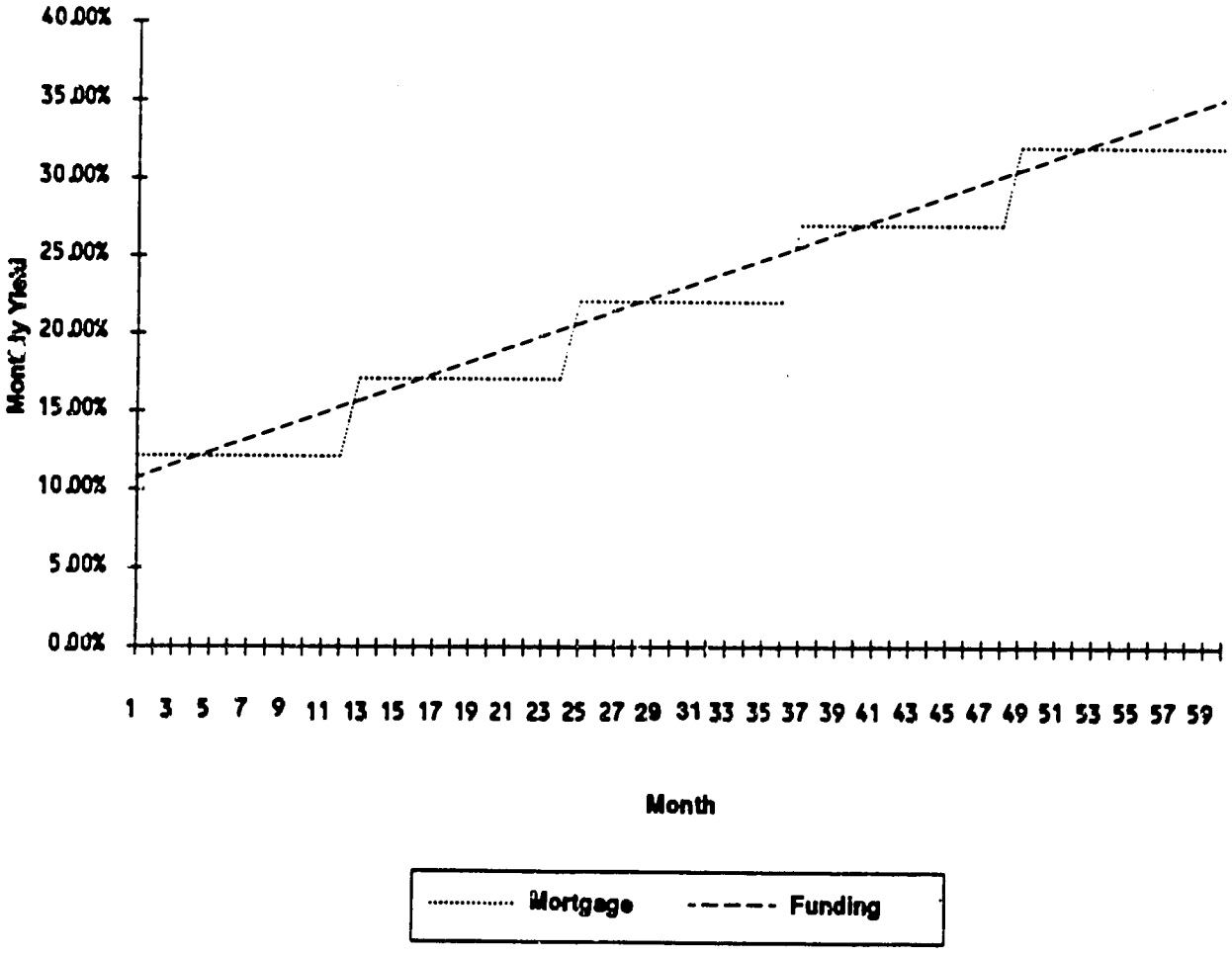
The effects of interest rate mismatches are demonstrated in Exhibits 5, 6 and 7. A perfectly matched lender can maintain a constant spread as interest rates change, as shown in Exhibit 5.

Exhibit 5
Match Funding



If the interest rate reset characteristics of the assets do not exactly match those of the liabilities (e.g., the rates of the asset and the liability are adjusted at different intervals or based on the values of different indices), the lender's earnings will vary with interest rates. For example, if the rate on the loan is adjusted annually, but funded with a liability that is repriced monthly, the loan rate may be below the liability rate much of the time in a rising interest rate environment (as depicted in Exhibit 6 with market rates rising at approximately 0.5 percent per month). Thus the net interest spread (interest income less interest expense) will be lower than the match funded example. Conversely, the spread would rise if interest rates fell. The risk lies in the volatility of earnings.[17]

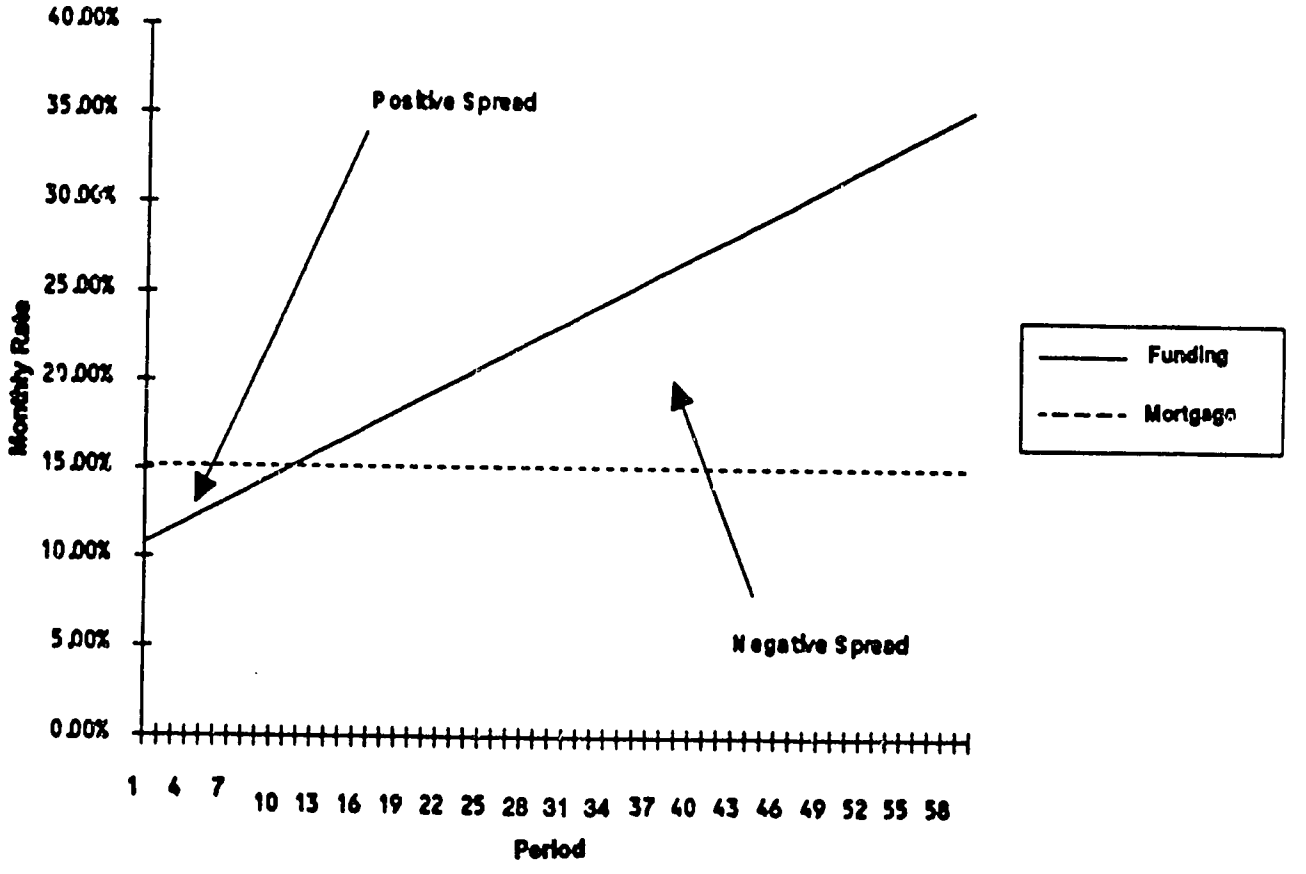
Exhibit 6
Mortgage and Borrowing Interest Rates



[17] Note an interest rate mismatch also can occur if the liabilities are reset less frequently than the loans. In that situation, the direction of effects above are reversed (e.g., net interest spread falls (rises) as interest rates fall (rise)).

In the extreme, a lender granting a loans with a fixed interest rate funded by monthly repricing liabilities can be left with an negative spread in a rising interest rate environment (Exhibit 7).

Exhibit 7
Fixed Rate Lending



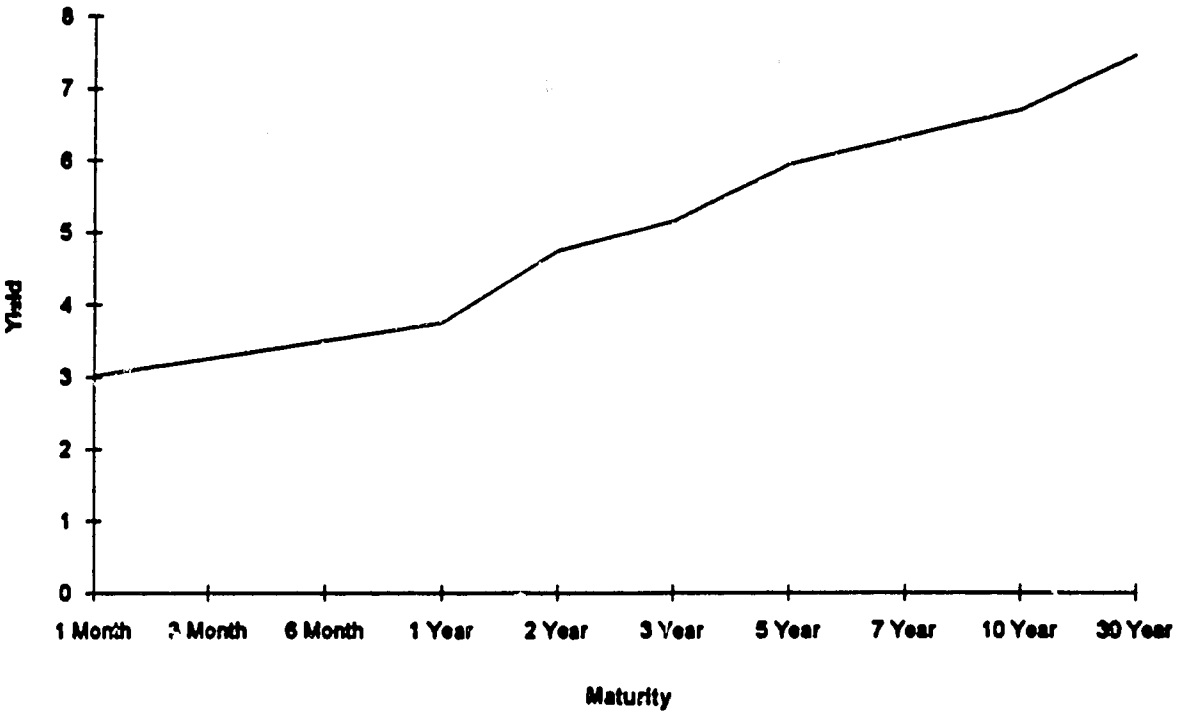
Management:

Interest-rate risk is typically managed by the treasury department of the bank, through the pricing and funding of assets purchased or originated. Interest-rate risk policies are set by the Asset-Liability Committee which reviews periodic reports of the exposure of the institution. Such reports include analysis of the periodic GAP, portfolio duration, mark-to-market and dynamic income simulation.[18] These reports

[18] Periodic GAP is defined as the ruble volume of assets that mature or reprice during a given period less the ruble volume of liabilities maturing or repricing during the same period. Mark-to-market analysis involves estimating the market value of assets and liabilities under different scenarios about the movement of interest rates over time. Dynamic income analysis involves simulation of the income

are used by institutions to adjust their funding mix (by maturity) to keep interest rate sensitivity of the portfolio within acceptable limits. One way of managing interest-rate risk is through matched duration funding.[19] Thus, a 15 year amortizing mortgage can be funded on a duration matched basis with a 7 year bullet (interest-only with principal paid at maturity) liability. The interest rates on government securities are used as reference rates as they are the securities with the greatest volume outstanding and the most secondary trading, allowing accurate determination of market value, and are regarded as default risk free. An example of the term structure of interest rates (also referred to as the yield curve) for U.S. government securities is shown in Exhibit 8.

Exhibit 8
U.S. Treasury Yield Curve (12/92)



and expense (and underlying cash flows) of the firm under different interest rate scenarios.

[19] Duration is the weighted average period of time over which the cash flows of an investment are expected to be realized (i.e., time periods are weighted by the volume of cash flows occurring in each period). Matching duration involves simulation of the projected cash flows of assets and funding them with liabilities with similar (ideally identical) cash flow characteristics.

Western Guidelines:

Lending institutions in some Western countries (notably the U.S.) have had adverse experience with interest rate risk under conditions of interest rate volatility. Problems typically arise with the funding of long-term fixed rate mortgages with short-term deposits. During periods of rising short-term rates, the net interest spread can become negative and the market value of the mortgages can fall well below the market value of the liabilities. Interest rate risk soon may become a factor in setting depository institution capital requirements. Both U.S. regulatory agencies and the Bank for International Settlements are considering requirements for lending institutions to have sufficient equity capital to withstand interest rate shocks of certain magnitude (e.g., the change in the value of shareholder equity due to a 200 or 400 basis point increase or decrease in interest rates).

Russia:

In an economy lacking a well-developed government securities market (particularly for long term securities) the best strategy for interest rate risk management is avoidance (e.g., investing in floating rate assets funded with floating rate debt). However, interest rate risk arising from differences in the frequency with which asset and liability rates are adjusted can be priced by examining the performance of a portfolio of mortgages under different interest rate scenarios and applying subjective weightings to the possible occurrence of the scenarios. This methodology is demonstrated in Exhibits 9 and 10.

Exhibit 9
Interest-Rate Risk Pricing
Annual Average Net Interest Spread
Under Alternative Asset/Liability Repricing Scenarios

	Mismatch[20]				
Interest-Rate Scenario[21]	**1 Mo-1 Mo**	**3 Mo-1 Mo**	**6 Mo-1 Mo**	**12 Mo-1 Mo**	**60 Mo- 1 Mo**
Constant	5.0	5.0	5.0	5.0	5.0
Up 3.0% per month	5.0	3.8	2.02	(1.45)	(25.92)
Up 5.0% per month	5.0	3.27	0.72	(4.2)	(38.2)
Down 3.0% per Month	5.0	6.47	8.71	13.33	69.21

Assumptions:

Net Interest Spread = [(Interest Income - Interest Expense)/Avg. Assets]*100
Rub. 200 million DAIR mortgage portfolio (average loan Rb. 5 million)
5 year loan term
Initial mortgage rate: 129%
Initial funding rate: 124%
Market rate changes monthly over the loan term
Leverage Ratio: 100% debt, 0% equity
Down Scenarios subject to annual interest rate floors of 7.0% mortgage and 2.0% liability rates
For the purposes of this example, we assume outstanding liabilities always equal outstanding assets

In Exhibit 9, the annual average net interest spread (interest income less interest expense divided by average assets) of the mortgage portfolio is calculated under different interest rate and reset frequency assumptions. The column headings represent different asset-liability reset mismatches (i.e. in the last column "60 Mo - 1 Mo" means that assets reprice every 60 months, and liabilities reprice every month). The row headings contain assumptions about monthly interest-rate change of assets and liabilities (in percentage points). The mortgages are funded completely with debt (e.g., interbank loan).

[20] Asset-Liability repricing frequency (e.g., "3 Mo - 1 Mo" means that assets reprice every 3 months and liabilities reprice every month).

[21] Changes in annual interest rate

With a matched portfolio (i.e., one in which asset and liability rates change with the same frequency), the annual average net interest spread is a constant 5 percent as interest rates increase and decrease. The net interest spread declines with greater mismatches in a rising interest rate environment (because the liability rate is rising on a monthly basis and the asset rate rises with a lag). With an increase of 3 percentage point per month in the interbank lending rate during the 60 month time horizon in this example (mortgage rate rising from 129 percent to 309 percent) the annual average net spread becomes negative with a 12 month to 1 month reset mismatch (annual average interest expense is greater than annual average interest earned). The opposite is true in a falling rate environment as the net interest spread rises with greater mismatches. However, with large monthly changes in interest rates, the effect is moderated as rates approach floor (i.e., non-negative) values.

Reducing the bank's leverage (i.e., its ratio of debt to equity) will significantly increase the magnitudes of the net interest spreads shown in Exhibit 9, because the bank is not required to pay interest to shareholders so its interest expenses are reduced. For a leverage of 95 percent debt and 5 percent equity, the annual average net interest spread in the constant interest rate scenario rises from 5 to 21 percent, as the differential reflecting leverage is compounded.[22]

A theoretical price (interest rate risk premium) for a mismatched funding strategy can be estimated. First the costs of different interest rate mismatches can be estimated for a number of different interest rate scenarios. A premium can be estimated by attaching probabilities to the interest rate scenarios. Exhibit 10 demonstrates this process for the DAIR. The spreadsheet model used to obtain the interest rate risk premiums for each timing scenario is available from the authors. A manual for this model is contained in Annex 2 of this document.

[22] This large increase in net interest spread is due to the assumption of a very high (129 percent) nominal interest rate. If the nominal interest rate were constant at 15 percent, reducing the leverage ratio from 100 to 95 percent would increase the net interest spread from 5 percent to only 6.2 percent. Also note that reducing leverage reduces the owner's return on equity since the bank must put up more equity to receive a given return on assets.

Exhibit 10
Interest Rate Risk Premium
(annual rate in percentage points)

		Mismatch			
Interest Scenario	Probability Weight	3 Mo-1 Mo	6 Mo-1 Mo	12 Mo-1 Mo	60 Mo- 1 Mo
Up 3% per month	.5	1.24	3.08	6.68	27.70
Up 5% per month	.4	1.87	4.67	10.22	44.64
Down 3% per month	.1	(1.70)	(4.16)	(8.75)	(31.28)
Weighted Average	1	1.20	2.99	6.55	28.58

In Exhibit 10, the monthly yield premiums necessary to equate the net present values of the mortgage interest cash flows between the matched and mismatched funding cases are calculated. If the bank believed that rates were going to rise by 3 percentage points per month and it had a 6:1 mismatch, it could add 3.08 percentage points to the initial annual rate to compensate for the mismatch. A pricing strategy taking into account the possibility of rising and falling interest rates can be formulated by attaching probabilities to possible rate scenarios. In the last row, a weighted average loss is calculated by summing the product of the probability weight and mortgage yield change for each column. For example, if the lender had a 6 month-to-1 month interest rate mismatch, a yield premium of 2.99 percentage points could be added to the annual mortgage yield to compensate for the earnings risk associated with the given interest rate scenarios. The lender can input different interest rate scenarios and probability weights depending on preferences and expectations.

V. OPTIONS RISK

Theory:

Mortgages contain options for the borrower and the lender.[23] The borrower may have the right to prepay the mortgage at a price equal to the outstanding balance.[24] The borrower also has the right to default on the mortgage (in effect selling the house to lender for the outstanding mortgage balance).[25] The lender has the option in a variable rate mortgage to change the interest rate on a periodic basis. Lenders also grant borrowers an option if they set the mortgage interest rate prior to funding a loan (which they may do for competitive reasons). If rates rise the borrower will take the loan (at a below market rate). If rates fall the borrower will go to another lender for the loan. Borrower options are typically exercised to the advantage of the borrower and the disadvantage of the lender. Thus, they involve a cost to the lender. The expected cost can be offset by incorporating a yield premium (i.e., an option fee).

Prepayment risk arises when the interest rate on the loan is fixed for a period of time and borrowers have a right to repay the loan prior to final maturity. If the market rate falls below the contract rate on the loan, the borrower has an incentive to refinance (i.e., repay the loan with proceeds from a new loan issued at the market rate of interest). A rational borrower will do so if the gains from a lower interest rate are greater than the transactions cost of refinance. The cost to the lender is the reinvestment of the loan proceeds at the (now lower) market rate. Because the incentive to prepay the loan depends on current and expected future interest rates, the option to prepay the mortgage is very difficult risk to price.[26] The expected cost of the option depends on the mortgage contract characteristics (i.e., the period during which the rate is fixed and the amortization pattern), and the expected direction and volatility of market rates.

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[23] An option gives the holder the right but not the obligation to buy or sell a contract at a predetermined price.

[24] In some instances this right can be precluded. Prepayment of fixed-interest mortgages is precluded in Germany. An alternative to preclusion is payment of a yield maintenance penalty wherein the borrower pays a penalty fee to the lender equal to the present value of the interest loss.

[25] In some countries, lenders retain the right to take legal action against the borrower if the proceeds from the sale of the house are less than the outstanding balance of the mortgage.

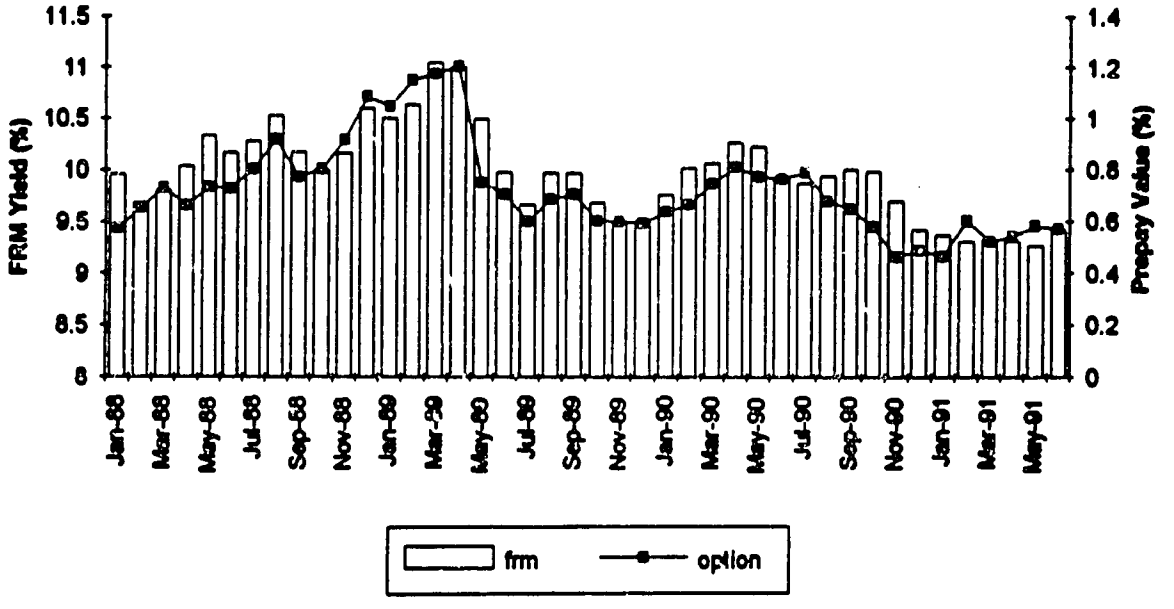
[26] Technically prepayment is a call option granted by the lender to the borrower allowing the borrower to call (i.e., repay) the loan away from the lender. Default is a put option allowing the borrower to put (i.e., give) the house to the lender (instead of repaying the mortgage). Valuation of mortgages options is very complex because interest rates and mobility behavior must be forecast and the response of borrowers to differentials between contract and market interest rates must be estimated.

A *commitment option* is granted when the lender commits to lend at a particular interest rate prior to the funding of the loan. It is similar to a prepayment option except that the period during which the option applies is much shorter.

Western Guidelines:

Considerable technology has gone into the pricing of the prepayment option in U.S. fixed-rate mortgages. An estimate of the value of the option in the U.S. mortgage market is shown in Exhibit 11. In the U.S., the value of the option during the 1988 to 1991 time period ranged between 50 and 120 basis points. The value of the option varied with the level of rates and their volatility.

Exhibit 11
U.S. Fixed Rate Mortgage Yields and Prepayment Option Values



Source: Diamond & Lea (1992)

Russia:

A prepayment option on a FRM would be impossible to price in Russia becau of the extreme uncertainty in the future course of interest rates and the lack experience with mortgage lending. Although prepayment can, in theory, contractually precluded, enforcement of such a provision in Russia would be high unlikely because of the high level of nominal interest rates. If inflation is reduced the future and market interest rates fall from current levels to 25 to 30 percent, tl bank would have to lower the rates on outstanding mortgages regardless of tl contractual provision.

Commitment options are typically granted for 30 to 60 day time periods in tl U.S. Although lenders frequently do not charge a fee for a commitment (due competitive pressure), it does have a cost to the lender. A reasonable estimate for tl costs of a 30 day commitment option in the U.S. is one-quarter to one-half of o percent of the loan amount. Because interest rate volatility is much higher in Russi the cost would be much higher.

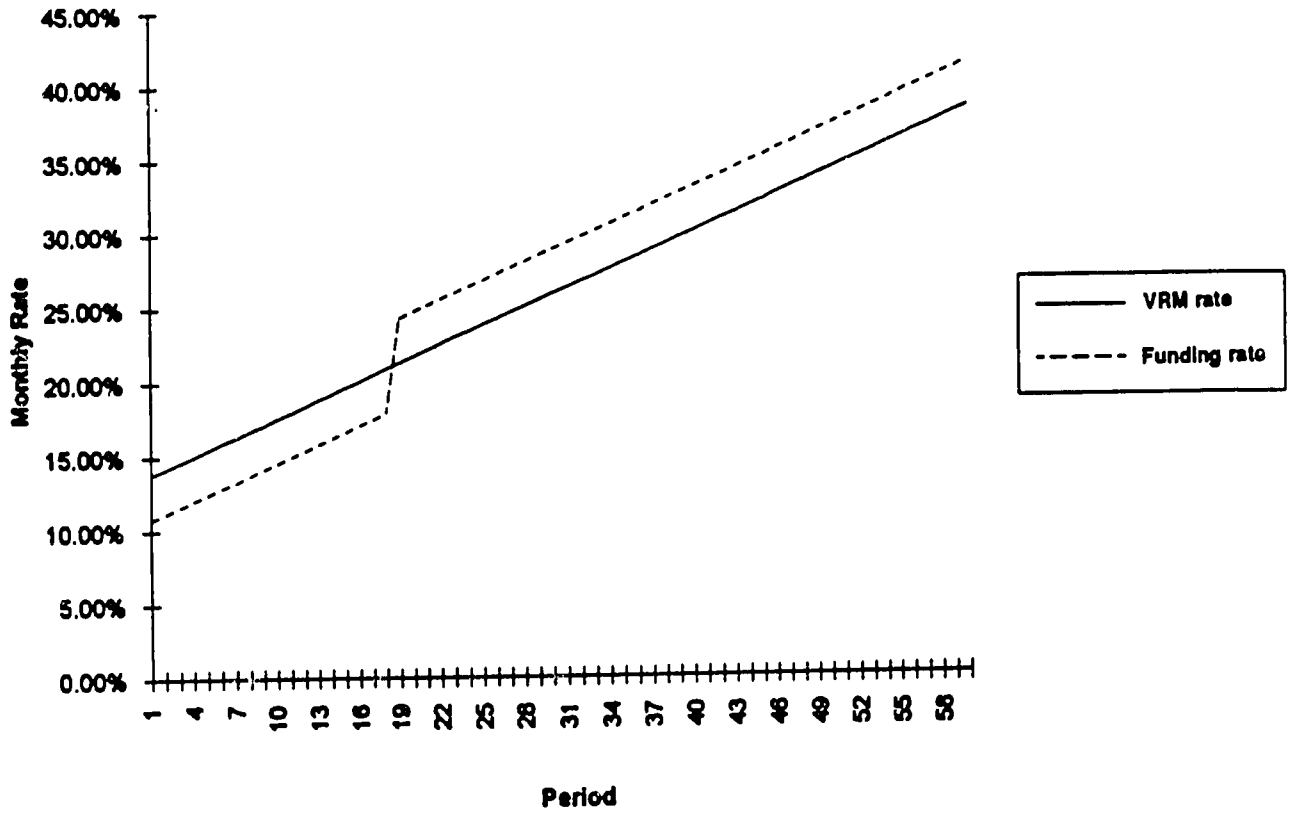
VI. SPREAD RISK

Theory:

Spread risk arises in the course of long-term variable-rate lending when tl spread (margin) on the loan is fixed and the spread on the funding source variable.[27] If the bank makes a 20 year mortgage loan with a yield equal to a fixe spread over the 1 month interbank rate, and funds the loan with a series of 1 mont loans at the interbank rate, it is exposed to the risk that the spread it must pay f its money may vary over time. Changes in funding spreads can take place due systemic reasons (i.e., general decline in credit quality in the economy) or due to no systemic reasons (i.e., decline in the relative credit quality of the bank such that must pay higher interest rates to attract funds than other banks). An example spread risk is shown in Exhibit 12 wherein the bank's net interest spread become negative because of an increase in its funding spread.

[27] Funding spread is the difference between the rate the bank must pay for funds of a particular maturity relative to a reference rate (usually government bonds of the same maturity).

Exhibit 12
Spread Risk



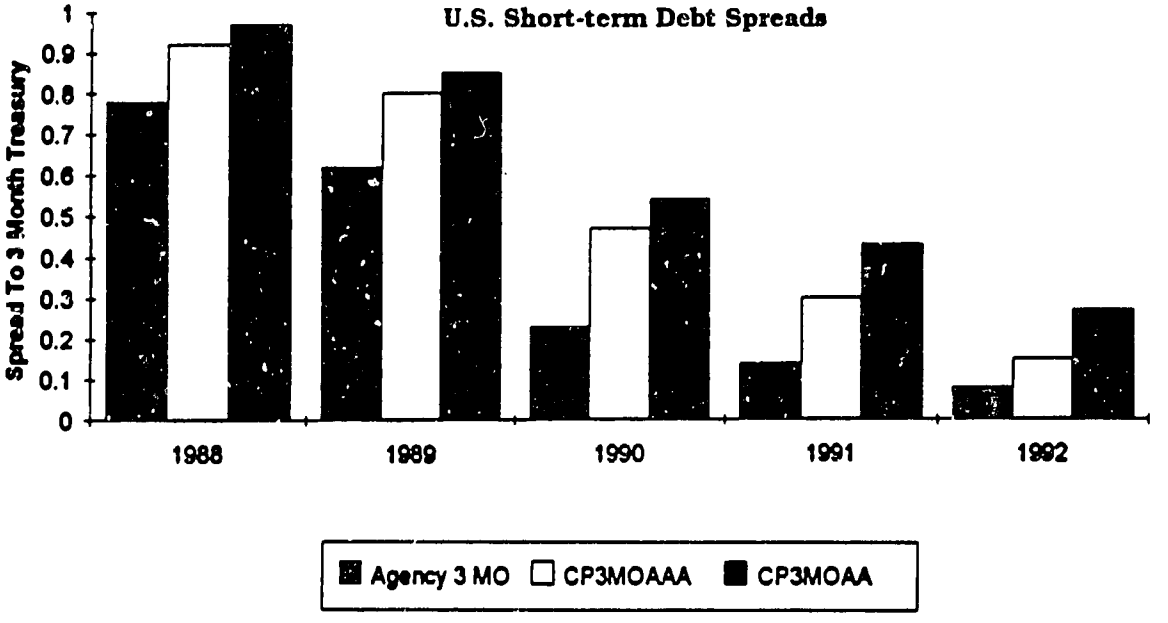
Management:

Spread risk can be managed through the issuance of long maturity, floating rate debt.

Western Guidelines:

As shown in Exhibit 13, the average spreads on floating rate debt have varied considerably in the U.S. over the past few years.

Exhibit 13
U.S. Short-term Debt Spreads



In the U.S., corporations can obtain short-term loans by issuing unsecured debt known as "commercial paper." The safety of these instruments is evaluated by independent rating agencies. Ratings of "AA" and "AAA" are the highest ratings, indicating that these instruments are very low risk for investors. Quasi-government agencies can issue similiar short-term debt instruments. Exhibit 13 compares yield spreads for corporations' 3 month commercial paper relative to 3 month government securities; and 3 month agency (quasi-government) yield spreads to 3 month government securities.[28] This exhibit shows that even in highly developed financial systems, funding spreads can vary across time and quality of issuer. For example, in 1988, commercial paper with a 3 month maturity and a rating of AAA (CP3MOAAA) had a yield about 0.9 percentage points above 3 month government securities. By 1992, its yield was only about 0.2 percentage points higher than government securities. Funding spreads in the U.S. relative to government bonds were high in the 1980s but have been extraordinarily low in recent years. The decline since 1988 reflects the slowdown in the economy (and debt issuance) and a greater emphasis on higher quality issuers.

Russia:

Conceptually, spread risk can be priced through time series analysis of the relationship between different classes of debt instruments across economic cycles. In Russia, such information is not likely to be available for a number of years. Nevertheless, yields on different securities and loans should be tracked so the

[28] Labeled in the graph as CP3MOAAA and CP3MAA for three month commercial paper with an AAA or an AA rating. Labeled in the exhibit key as Agency 3 MO.

analysis can be done in the future. Banks originating mortgage loans may be able to reduce spread rise through funding with long-term variable-rate deposits from enterprises.

VII. LIQUIDITY (MARKETABILITY) RISK

Theory:

Liquidity or marketability risk deals with the difficulty in being able to convert assets into cash at or near their market prices (e.g., to meet deposit outflows). Assets can be sold to raise cash or used to as collateral in obtaining a loan from another financial institution (or to back a line of credit used on a stand by or as-needed basis). For tradable assets (i.e., securities) marketability risk can be expressed in terms of the difference between the bid and the ask price for the asset. The bid price is the price that a willing buyer would pay for the asset. The asking price is the price at which a seller would be willing to sell. The cost of standby credit is the fee paid to the lender for the right to borrow at a future date.

Depository institutions are generally required to hold reserves at central banks to facilitate the operation of monetary policy and to help assure that sufficient funds are available to meet deposit outflows. Lending institutions also hold cash and short-term securities (liquidity portfolios) to manage short term cash flow fluctuations. Liquidity portfolios and reserves have relatively low interest rates and therefore involve an opportunity cost to the lender.

Management:

Liquidity management involves a number of financial activities. First, it involves detailed cash flow projections to determine the bank's likely cash needs. Second, it involves developing a liquidity strategy for raising cash, identifying sources and costs. Developed country financial institutions use a variety of funding sources to manage their cash needs. These include asset sales, maintenance of liquidity portfolios, deposits, collateralized and uncollateralized borrowing, stand-by lines of credit and eligibility to borrow from the Central Bank. Diversification of funding sources can reduce the cost and risk of asset illiquidity.

Western Guidelines:

Reserve requirements vary considerably across countries. Formal levels range from zero in several countries (e.g., Belgium and Canada) to 6.6 percent of demand deposits and 4 to 5 percent of time deposits in Germany.[29] Liquidity requirements

[29] Both Germany and the U.S. have higher reserve requirements on larger time deposits.

vary across country and type of institution but are typically in the range of 5 to 15 percent of assets. Such requirements are frequently informal (i.e., subject to regulatory discretion) and related to interest-rate risk exposure (e.g., an institution may be warned to increase liquidity when it has a significant excess of short-term liabilities over short-term assets). Several countries (e.g., France, Italy and Germany) have detailed requirements limiting exposure to long-term loans and investments.

Because mortgages are generally illiquid assets, specialized lending institutions have been created to refinance mortgage portfolios in several countries.[30] These institutions typically issue unsecured government guaranteed or supported debt in the capital markets and relend to mortgage institutions on a collateralized basis.

Russia:

Until financial markets develop in Russia, liquidity risk is a major risk associated with mortgage lending. As options develop for consumer and enterprise savings, Russian banks will be exposed to the risk of significant deposit outflows.[31] Perhaps reflecting this risk, the Central Bank reserve requirement against loans is 20 percent, a relatively high requirement.[32] The opportunity cost of these reserves represents the main cost of liquidity in Russia. This cost must be included in the mortgage rate or deducted from deposit rates.[33] The cost of reserves at different reserve requirements and interest rates can be calculated using the following formula:

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[30] For example the Federal Home Loan Banks in the U.S., the Landesbanken in Germany and the Caisse de Refinancement de Hypothecaire ("CRH") in France. The Federal Home Loan Banks were created in the Depression to encourage savings institutions to make long-term amortizing mortgages (prior to the Depression only 5 to 7 year bullet loans (interest only) were widely available). Specialized mortgage lenders in Europe were created to channel long-term savings (e.g., from insurance contracts and pension funds) to housing allowing depository institutions (with predominately short-term deposits) to concentrate on short-term commercial lending (particularly during the post-War period).

[31] If interest rates remain deeply negative in real terms, savers may turn to alternatives such as real assets or hard currency accounts outside of the country. Banks that fail to provide competitively priced investments for their customers will be exposed to significant liquidity risk.

[32] For commercial banks. Sberbank has a reserve requirement of 15 percent against long term (over 1 year) deposits and 20 percent against short term deposits.

[33] Because reserves primarily benefit depositors (helping to ensure the availability of funds to meet withdrawals) it may be more appropriate to allocate them to deposits. Doing so would be consistent with the observation that deposit rates in Russia are significantly below market and banks generate a significant proportion of their profits through accumulation of below market funds in their branch systems.

(1) Liquidity Risk Spread = {(LR - RR)/(1 - CBR)} - LR where

LR = Loan Rate (or targeted yield on assets)
RR = Rate paid by Central Bank on reserves
CBR = Central Bank reserve requirement

Thus, the current commercial bank reserve requirement of 20 percent of outstanding loan balances, with a 150 percent annual loan rate and a zero interest rate on reserves would necessitate a liquidity risk spread of 37.5 percentage points to compensate the lender for the lost earnings of the non-interest bearing deposits.[34]

The DAIR poses a significantly greater liquidity risk for lenders than other types of loans. In an inflationary environment, the outstanding balance for the DAIR rises significantly during the early years of the loan life. To offset a cash flow mismatch (i.e., that arising from having to pay depositors interest without receiving interest payments from borrowers) the bank will have to reduce its cash balances or issue new liabilities. In a high inflation environment, the outstanding balance on a DAIR can become several hundred times the initial balance (although it will be declining in inflation-adjusted terms). Thus, until inflation returns to moderate levels, only a small proportion of total assets should be invested in DAIR or other deferred payment loans.

The current application of reserve requirements on outstanding loan balances means that the volume of reserves held against a given DAIR loan would increase significantly over time and the opportunity cost of holding these reserves also would rise. However, if the reserve requirement can be imposed on liabilities instead of on loans, and if the interest payments to fund the DAIR are obtained by decreasing cash balances rather than increasing liabilities, then the growth in loan balances will not require increases in reserves.

An alternative approach to managing the liquidity risk of DAIR mortgages is to establish a liquidity facility (i.e., "Agency for Mortgage Finance") which could purchase the mortgages or make collateralized loans to lenders. This agency could fund its purchases or loans with bond issues. In a start-up phase, the agency could issue zero-coupon bonds (thus avoiding the cash flow mismatch problem). Once the Agency accumulates a portfolio of amortizing mortgages or payment streams, it could

[34] On all assets net of reserves. If the liquidity risk premium is obtained only from loans and 50 percent of assets are held in the form of loans, the required spread would be 18.75 percentage points. For variable-rate loans, the addition to the loan rate should be based on the average liquidity reserve requirement expected over the life of the loan. If the central bank pays interest on these reserves the opportunity cost of holding them is reduced, and the addition to the interest rate spread can similarly be reduced.

begin issuing interest paying securities.[35]

VIII. OPERATING COSTS

Theory:

The cost of obtaining funds (exclusive of interest costs), originating mortgages and servicing mortgages needs to be considered in mortgage pricing. The appropriate costs are the marginal costs of originating, funding and servicing mortgage loans.[36]

Management:

It is important to develop management information systems that will allow the lending institution to determine the costs of different functions associated with the lending process. Such information is necessary to effectively manage resources and determine which functional activities and lines of business are most profitable. This type of analysis has only recently been introduced in Western lending institutions.

Western Guidelines:

There are two major forms of funding for mortgages in Western housing finance systems: deposits and capital markets. Commercial banks and savings institutions have historically relied on deposits. Specialized mortgage lending institutions (mortgage banks or wholesale lenders) rely on the issuance of securities (mortgage bonds) for their funds.

Wholesale-funded lenders are typically more efficient than depositories, as evidenced by lower average costs of operation. Representative 1990 values are shown in Exhibit 14.

[35] In order to enhance the attractiveness of these bonds, they could be guaranteed for some finite period after creation of the Agency (e.g., until a cash flow balance was achieved). At that time the guarantee could be withdrawn. The French government followed this strategy when it created the CRH. An obvious danger of creating an agency that can issue government guaranteed debt is that it can distort the market (e.g., by underpricing mortgages and discouraging private investment).

[36] The fixed costs of running branch systems and developing the systems necessary to originate mortgages must also be accounted for. These costs can be spread out over time (in line with the depreciation of systems, branches and customer relationships) and apportioned between the bank's savings and borrowing customers. Because mortgage lending will account for only a small fraction of business during the next few years, this analysis focuses on marginal cost.

Exhibit 14
Average 1990 Operating Costs of Mortgage Lenders

Country	Lender	Average Cost (% of Assets)
Denmark	Mortgage Banks	22 bp
	Depository Institutions	189 bp
France	Mortgage Banks	150 bp
	Depository Institutions	250 bp
Germany	Mortgage Banks	23 bp
	Depository Institutions	210 bp
United Kingdom	Centralized Lenders	25 bp
	Building Societies	116 bp
United States	Mortgage Banks	27 bp
	Thrift Institutions	221 bp

Source: Diamond & Lea (1992)

The average costs in Exhibit 14 include costs of originating, servicing and funding loans (and securities) as well as institutional overhead (e.g., human resources, executive management, accounting and legal systems and staff). The higher average costs of depository institutions reflects the use of branch systems to gather funds, and a more diverse mix of activities (e.g., mortgage, consumer and commercial lending). Wholesale funded institutions lack the high fixed costs of depository institutions (particularly the deposit-taking branches). Thus their marginal costs are likely to be close to their average costs shown in Exhibit 14. Depository institutions offset their higher average costs of operation through obtaining deposits at low (e.g., relative to government securities) rates and selling a number of services (e.g., insurance, safe deposit boxes) to their customers on a fee basis. Their ability to obtain deposits at low rates depends on the alternatives available to depositors and the value they place on savings through depository institutions (e.g., convenience, small denomination accounts, safety).

Russia:

The lack of Western style accounting systems makes cost comparisons between Western and Russian banks difficult. In addition, the mortgage operations of Russian banks are in the formative stage and have not achieved the scale economies of their Western counterparts. Initially, the banks could estimate the labor costs (the major variable cost) of mortgage lending and servicing and calculate a ratio of these costs to expected loan balances.

An additional problem in pricing operating costs in Russia is inflation. Operating costs are likely to rise over time at a rate at least equal to average wage inflation. If a fixed interest rate spread is assigned to cover this cost, the nominal amount the bank receives from the operating cost spread will increase at roughly the inter-bank lending rate for the DAIR (until the later years of the loan life when the outstanding balance begins falling sharply). Alternatively, for a level payment mortgage the real value of the operating cost spread could fall sharply over time. In either case, at some future date, the funds from this spread will be inadequate to cover the bank's servicing costs.

To address this problem, the bank could charge origination and servicing costs as fees to the borrower. Because origination and servicing costs are independent of loan size, these fees should be independent of the size of the loan. An origination fee to cover all bank costs associated with underwriting and closing the loan could be charged at the time a loan is funded (similar to the U.S. system). A servicing fee could be charged on an annual basis and indexed to inflation or wage rates (i.e., a measure external to the bank).

For example, if in December 1993 the bank estimated that in 1994 its cost of servicing loans would be Rb. 5,000 per loan, then each borrower could be assessed this fee. If 1994 wages increased by 150 percent, then the bank could charge each customer a fee of Rb. 12,500 for servicing costs in 1995.

IX. THE PROFIT SPREAD

Theory:

Financial institutions use a mix of debt and equity to fund assets. Equity investors (shareholders) typically receive returns (or profits) after depositors and secured lenders receive interest payments and employees are paid. Equity investors also stand last in line to receive the proceeds of liquidation of a firm. As such, capital is the riskiest form of investment and investors require higher returns than depositors and secured lenders.

Market returns to equity investment will be determined by the marginal productivity of capital in the economy. The cost of equity for a particular investment will depend on its relative risk. In efficient markets, the return of a stock can be measured in terms of its risk (variability in returns) relative to the market portfolio (variability of the market as a whole). This approach is referred to as the capital-asset pricing model. Conceptually, the expected return on equity investment can be thought of as the investor's required risk premium over a market benchmark (e.g., the risk-free rate). Returns can be paid out in the form of dividends or retained by the bank.

Western Guidelines:

Because financial institutions are regulated and primarily engaged in lending as opposed to equity investment, they exhibit less variability in returns and thus require a lower risk premium than most other firms. In recent years, profitable banks in developed financial systems have earned after-tax spreads of 300 to 400 basis points over intermediate term government securities.[37]

Russia:

Per discussions with Russian banks, the equity weight is assumed to be 5 percent and the debt weight is assumed to be 95 percent. The cost of debt is assumed to be the interbank lending rate. The cost of equity can be assumed to be a spread over the interbank rate, depending on investor requirements. The profit spread can be expressed as:

(2)Profit Spread = (Equity/Assets)(Rs - Rd) where

Rs = Return to shareholders
Rd = Return to depositors (e.g., interbank rate)

Thus, if the shareholders require 140 percent when the interbank rate is 120 percent, the profit spread would be 1 percent. This profit spread is applied to the entire portfolio.

[37] The 1992 U.S. average after-tax return on equity for commercial banks was approximately 13 percent, that for savings institutions was approximately 10 percent, and government securities had a return of about 9 percent. The inflation rate was approximately 4 percent and the average tax rate was approximately 25 percent.

X. SUMMARY

Theory:

The price of an asset such a mortgage loan can be thought of as the sum of the weighted average cost of capital and the expected costs associated with funding, servicing and investment. The weighted average cost of capital reflects the required returns to the bank's debt holders (depositors) and equity investors (shareholder). A general formulation follows that can accommodate different benchmark rates and separate spreads to the benchmark rate for debt and equity holders. The yield can be expressed as follows:

(3) MORT = DY(D/A) + EY(E/A) + SPREAD where

MORT = Mortgage lending rate
DY = Debt Rate (spread over benchmark rate for depositors)
D/A = Debt to Assets ratio
EY = Equity Rate (spread over benchmark rate for shareholders, or profit spread)
E/A = Equity to Assets Ratio
SPREAD = Expected cost and risk adjustments and

(4) SPREAD = CR + IRR + BR + OR + LR + MC where

CR = Credit risk premium
IRR = Interest-rate risk premium
BR = Spread risk premium
OR = Options risk premium
LR = Liquidity risk premium
MC = Marginal operating cost

In a simplified form, the weighted average cost of capital can be expressed as the sum of the benchmark rate and the profit spread. The break-even risk adjusted mortgage yield formulation is shown in Exhibit 15.

Pricing mortgages anywhere is difficult; in Russia this is especially so, reflecting a lack of experience with this type of lending and the unstable economic environment. Exhibit 15 contains example values for the various components of the mortgage rate for a prototypical Russian commercial bank as of May 1993. The sources and magnitudes of these values are discussed in Exhibit 16.

Exhibit 15
Required Initial Mortgage Interest Rate

Component	Cost (Percent)
(1) Benchmark (Interbank) Rate	124.0
(2) Bank Borrowing Spread*Debt Weight	0.0
(3) Equity Funding (Profit)Spread*Equity Weight	1.0
(A) WEIGHTED COST OF CAPITAL (1+2+3)	125.0
(4) Credit Risk	2.1
(5) Interest-rate Risk	0.0
(6) Spread Risk	NA
(7) Liquidity Risk	18.4
(8) Options Risk	NA
(9) Administrative Cost	5.0
(B) SPREAD (4+5+6+7+8+9)	25.5
(C) REQUIRED INTEREST RATE (A+B)	150.5

Exhibit 16
Explanation of Mortgage Pricing Components

Component	Value (%)	Comments
Interbank lending Rate	124.0	Current interbank rate (closest proxy for a market rate of interest)
Liability Spread	0.0	Derived from the assumption that the bank borrows at the interbank lending rate
Equity (profit) Spread	1.0	Based on a 5% Equity to Assets ratio for loans and a required return on equity 20 percentage points above the interbank lending rate.
WEIGHTED COST OF CAPITAL	125.0	Interbank lending rate plus liability spread plus profit spread
Credit Risk	2.1	Based on a 20% default rate and 100% severity of loss forecast (Exhibit 2)
Interest Rate Risk	0.0	Based on the assumption that the rate on the mortgage and the rate on the funding source are both adjusted monthly. If the Central Bank discount rate is used, an interest rate risk premium may be advisable to account for the non-market nature of central bank rate adjustments. A premium of 26 percent over the interbank rate would be necessary if the mortgage rate is fixed for a 5 year period, and rates rise by 3 percent per month.
Spread Risk	NA	No historical experience with which to estimate.
Liquidity Risk	18.4	Based on a 20 percent reserve requirement on loans with reserves at the Central Bank earning 0% interest and the target loan rate of 132.1% (132.1% is the total loan rate calculated in this section excluding liquidity costs).
Options Risk	NA	There is no prepayment risk applicable if a variable rate mortgage is used. It is assumed that there will be no commitment risk because the bank will not commit itself to a starting interest rate until the loan is issued.
Administrative Costs	5.0	Estimate of the average administrative costs of total assets.
SPREAD	25.5	Credit risk premium plus interest rate risk premium plus spread risk premium plus liquidity risk premium plus options risk premium plus administrative costs
REQUIRED INTEREST RATE	150.5	Weighted cost of capital plus spread

Adjustments:

Using this methodology, an example mortgage contract rate (the payment rate to the borrower would be less if an indexed mortgage instrument is used) would be 150.5 percent (a 25.5 percentage point spread over the April 1993 interbank rate of 124 percent). In the short run, this rate would generate enormous nominal profits for Russian lenders as their cost of funds is considerably less than the interbank rate. Alternatively, the costs of maintaining reserves against deposits and operating a bank could be charged against liabilities (i.e., recognizing that a bank generates its profits through accumulation of below-market funding through a branch system). With these adjustments, the spread calculation becomes:

Exhibit 17
Adjustments to Mortgage Interest Rate

Component	Spread	Adjustment
Total Spread	25.5	
Liquidity Cost	(18.4)	Reserve allocated to deposits under assumption that they benefit depositors
Administrative Costs	(4.0)	Branch and overhead costs allocated to deposits as mortgage lending is a small portion fo the bank's business with low marginal costs.
Net Spread	3.1	Total spread minus liquidity and administrative costs

The net spread of 3.1 percent, added to the interbank rate of 124 percent and the profit spread of 1 percent generates a mortgage rate of 128.1 percent. The payment rate on a DAIR would be much less than this, and can be adjusted to allocate the amount of loans granted.

XII. REFERENCES

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XIII. ANNEX I: MANUAL FOR DAIR DEFAULT RISK PRICING MODEL

Introduction

This paper summarizes the use of the DAIR Default Risk Pricing Model. The model calculates the addition to the DAIR's interest rate required given alternative assumptions about future levels of loan default.

The model is divided into three parts. Part I is the General Inputs Part (cells A5 through G36) in which the user inputs loan portfolio characteristics, inflation and interest rate assumptions, and some default assumptions. Part II is the Summary of Loan Inputs, Additional Default Inputs and Results Part (cells K6 through Q29) which contains the summary of general inputs, the additional inputs related to defaults, and the summary of results. Part III is the Mechanics Section (Cells I37 through V278) in which the model performs the calculations necessary to obtain the default risk premium.

Part I. General Inputs

In this section, the user inputs assumptions about the loan portfolio (cells G5 through G11), and future expectations for inflation and the inter-bank lending rate (cells B17 through C36). In addition, the user inputs assumptions about the percent of total defaults that will occur each year (cells D17 to D36). Part I of the spreadsheet is displayed in Table 1 below. Numbers down the left side of the page and letters along the top of the page refer to cell numbers and letters in the spreadsheet program.

i. Loan Characteristics. Cells G5 through G11 describe characteristics of the portfolio of loans for which an interest rate is being calculated. Average Loan Size (G5) and Number of Loans in Portfolio (G6), make the model more realistic, but will not affect the results of the analysis. Total Volume of Loan Portfolio (G7) is calculated from cells G5 and G6.

The Payment Rate (G8) should be the borrower payment rate for the loans in this loan portfolio. Note that a higher payment rate will result in a lower required default premium all other factors held constant. A higher payment rate means that a larger share of the total value of the loan is repaid in the early years of loan amortization. If most of the loan is repaid in the first few years of the amortization period, then defaults occurring later in the life of the portfolio will not have a significant influence on pricing. The loan term for loans is entered into cell G9. The loan term must be between 1 and 20 years. The Interest Rate Spread Over Interbank rate at 0% Default (G10), reflects the addition to the interbank lending rate to cover operating costs, other risks and profits assuming no defaults occur over the

repayment period. Frequency of Payment Adjustments (G11) is the number of months for which borrower repayments remain constant. This figure can be from 1 to 12 months.

ii. Inflation, Interbank Lending Rate and Default Scenarios. In cells B17 through D36, the model user inputs annual projections for inflation, interbank lending rates, and defaults for the period of loan repayment. Note that inflation assumptions (cells B17 to B36) will not affect the outcome of this analysis. Their sole purpose is to help the model user formulate assumptions about the interbank rate (Cells C17 through C37) over time. In the example included in the worksheet, it is assumed that inflation declines first rapidly and then more gradually over the period. The interbank lending rate is assumed to increase up to the inflation level, and then move approximately in line with inflation.

Cells D17 through D36 contain assumptions about how defaults occur over the repayment period. In each cell, the model user inputs the percent of total defaults that he estimates will occur in that year. In the initial example, it is assumed that of the total defaults that occur over the life of the loan portfolio, none occur in the first year of mortgage repayment, 12.5 percent occur in the second year, 25 percent in each of the next three years, and 12.5 percent in year 6. By the end of year 6, 100 percent of all the defaults that will take place over the life of the loans have occurred.

Table 1: General Inputs Section of Sample Worksheet

	A	B	C	D	E	F	G
				I. GENERAL INPUTS			
	I. LOAN CHARACTERISTICS						
5	Average Loan Size (Rb. MM)						5
6	Number of loans in portfolio						40
7	Total volume of loan portfolio (Rb. MM)						200
8	Annual payment rate (%)						7
9	Loan term (years)						15
10	Annual interest rate spread over interbank at 0% default (%)						5
11	Frequency of payment adjustments (1 to 12 months)						3
	II. ANNUAL INFLATION, INTERBANK LENDING RATE, & DEFAULT DISTRIBUTION						
	Years	Inflation (%)	Interbank Int Rate (%)	% of Total Defaults			
17	1	1,500	124	0.0			
18	2	1,000	188	12.5			
19	3	900	222	25.0			
20	4	800	262	25.0			
21	5	700	302	25.0			
22	6	600	342	12.5			
23	7	500	390	0.0			
24	8	400	330	0.0			
25	9	319	329	0.0			
26	10	222	230	0.0			
27	11	113	120	0.0			
28	12	88	95	0.0			
29	13	67	73	0.0			
30	14	57	62	0.0			
31	15	47	51	0.0			

Part II. Summary of Loan Inputs, Additional Default Inputs and Results

Part II summarizes the inputs from Part I, prompts the user for additional default information and summarizes results of the program. Part II of the spreadsheet is displayed in Table 2 below. Numbers down the left side of the page and letters along the top of the page refer to cell letters and numbers in the spreadsheet program. Only those items with a box drawn around them require inputs from the user.

i. Summary of Loan Characteristics. This Section (cells O6 through Q12) summarizes the General Inputs section and does not require additional user inputs.

ii. Additional Default Inputs. In this section (cells Q15 through Q18 and P19), the user provides additional information about the portfolio's likely default pattern.

Cell Q15 is the share of total loans that is likely to default over the entire repayment period. The higher the share of total loans that default, the higher the required interest rate premium to compensate the bank for these losses. If none of the loans default (i.e. Q15 is set to "0"), the computer will ignore cells Q16 through Q18 which deal with recovery of default loans.

In cell Q16, the user makes a judgement about whether, once default occurs, the bank will have any possibility of recouping some of its loss. For example, if the user assumes that once a loan goes into default, the bank will never be able to recover any further principal or interest then the user would input a "2" into cell Q16. If, on the other hand, the lender will be able to recover at least some portion of the outstanding interest and principal then a "1" should be entered into cell Q16. If recovery will be partially successful, the bank will require a lower default risk premium than if recovery is never successful.

In cell Q17, the user inputs an estimate of the average percent of the default principal and interest that would be recovered if recovery will be at least partially successful (i.e. if a "1" was entered into cell Q16). If recovery is not at least partially successful (i.e. if a "2" is entered into cell Q16), the computer will ignore cell Q17.

If recovery is unsuccessful, the bank will lose the outstanding loan balance. In addition, it may incur administrative and legal costs associated with the unsuccessful attempt to recover the loan. In cell Q18, the user inputs the expected loss that will result ***in addition to*** the lost principal if recovery is unsuccessful. This expected loss is expressed as a percentage of the outstanding principal.

For example, if on average the lender expect that it will recover none of the lost principal when a default occurs, and, in addition, will incur legal fees equal to 10 percent of the outstanding loan balance at the time of default, the user should input

"10" in cell Q18. If the user assumes that over the life of the portfolio, 20 percent of all loans default, and he assumes that 12.5 percent of total defaults occur in year 2 of loan repayment, then 2.5 percent of the total loans in the initial portfolio will default in year 2 of repayment. If there are 40 loans in this portfolio, 1 will default in year 2. Cells O37 through O278 of the spreadsheet display the outstanding balance of the loan portfolio for each year of loan amortization. If at the end of November of year 2 the outstanding loan balance of the portfolio is Rb. 1,273.7 million, there are 40 loans outstanding, and 1 defaults, the bank will suffer a loss of 2.5 percent of the total outstanding loan volume or Rb. 31.84 million. If we assume the bank incurs court costs equal to 10 percent of the defaulted loan volume, the bank's additional loss will be Rb. 3.18 million.[38]

If recovery is at least partially successful (i.e. if a "1" is entered into cell Q16), the computer will ignore cell Q18.

In cell P19 the user inputs guesses about the addition to the annual interest rate required to compensate the lender for the default assumptions made in cells Q15 through Q18. How the user makes these guesses is discussed below under Results. Initially, this cell should be set to "0" indicating that no addition to the spread is made.

iii. Results. To determine the interest rate premium required to compensate the lender for default risk, the model requires an iterative process whereby the user experiments with possible values for the default risk premium until the correct one is identified.

Step 1: Discounted Value of Payments Assuming No Default. After all initial assumptions have been input, the user runs the model assuming that no loans default over the period, and that there is no addition to the interest rate spread to compensate for default. This is done by verifying that "0" is registered in cells Q15 and P19, and then pushing the recalculation key (F9) on the computer keyboard. The result displayed in cell Q23 is the total discounted value of payments the bank will receive over the life of the loan portfolio assuming that no defaults occur.

This figure in cell Q23, (Rb 278.4 million in the example contained in the worksheet) is the value of repayments the bank would like to receive even assuming that defaults take place. The user should input into cell Q24 the number displayed in cell Q23. Note that the user should manually input into cell Q24 the value displayed in cell Q23. The user ***should not*** use the copy command since it is the value displayed in cell Q23 that is of interest, not the formula.

[38] Because legal fees and other expenses associated with loan default will accrue during a period of months or years after the default occurs, this model assumes that on average these costs are incurred 12 months after the loan defaults.

Step 2: Discounted Value of Payments Assuming Default. After the value in cell Q23 has been entered into cell Q24, the user should input into cells Q15 though Q18 assumptions about expected default and recovery rates as described above. After these inputs have been made, the user should recalculate the results (push "F9").

Note that a new number is now displayed in cell Q23. This new number represents the discounted value of repayments the lender will receive assuming that the default and recovery pattern specified occurs. This actual discounted value of payments will be less than the target value (cell Q24).[39]

At this point, the user should enter into cell P19 a guess as to the likely addition to the monthly interest rate required for the bank to obtain the target discounted value of payments displayed in cell Q24. The larger the gap between the actual and target value of payments, the larger the required addition to the interest rate.

A very general rule of thumb is that every Rb. 10 million reduction in the discounted value of payments requires an addition of 0.4 to 0.8 percentage points to the annual interest rate. For example, if the default pattern specified by the user results in a Rb. 50 million reduction in the discounted value of payments relative to the 0 percent default scenario, then the lender would probably require an addition of from 2.0 to 4.0 percentage points to the monthly interest rate to compensate for this default level.

Each time a guess is entered into the addition to monthly interest rate cell (cell P19), the model should be recalculated to observe the new Actual Discounted Value of Payments (cell Q23). If the actual value is below the target value then the addition to the interest rate spread is too small. If the actual value is above the target value, the addition is too large. Through a process of trial and error, the user should adjust the addition to interest rate until the actual value of payments equals the target value. When this occurs, the figure entered in the addition to interest rate cell is the amount that would have to be added to the monthly interest rate to compensate the lender for the specified level of default and recovery.

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[39] Even if the recovery attempt is partially successful (Cell Q16 is set to "1") and 100 percent of the default principal and interest is recovered (cell Q17 is set to 100) implying that for every default, the lender eventually recovers all lost principal and interest, the bank's actual discounted value of payments (cell Q23) will be less than the target discounted value of payments (cell Q24). This occurs because we assume the bank obtains the recovery in a lump sum payment which is then discounted back to year 0 in rubles. The discount rate used is the interbank lending rate. If the default had never occurred, the bank would continue to receive interest on the outstanding loan for the remainder of the loan term. Since the interest rate charged on the loan is higher than the discount rate, the bank is always better off having an outstanding loan than receiving the outstanding value of the loan in cash.

For the example displayed in the spreadsheet, a 20 percent default rate with a recovery of 50 percent of principal and interest will require a 1.23 percent addition to the annual interest rate.

Cell P25 displays the total initial monthly interest rate that will result given the specified interbank lending rate, interest rate spread at 0 percent default, and addition to interest rate to compensate for default. It is the sum of cells P11, P12, and P19.

Cells Q27, Q28, and Q29 display what percentage of the total discounted value of payments will be repaid in the first third, second third and last third of the repayment period. In the example contained in the initial worksheet, about 31 percent of the total discounted value of payments are made in the first one-third of the repayment period.

Table 2
Summary of Loan Inputs, Additional Default Inputs and Results

	K	L	M	N	O	P	Q
	II. SUMMARY OF LOAN INPUTS, ADDITIONAL DEFAULT INPUTS AND RESULTS						
	I. SUMMARY OF LOAN CHARACTERISTICS				**Monthly**	**Yearly**	**General**
6	Total volume of loan portfolio (Rb. MM)						200
7	Annual payment rate (%)					7.0	
8	Loan term (years)					15	
9	Payment adjustments (1 to 12 months)				3		
10	INITIAL CONTRACT INTEREST RATE						
11	Initial annual inter-bank lending rate (%)					124.0	
12	Annual interest rate spread over interbank at 0% default (%)					5.0	
	II. ADDITIONAL DEFAULT INPUTS						
15	Share of Loans Defaulting Over Period (%)						0
16	Is recovery attempt at least partially successful? (yes=1; no=2)						1
17	If Recovery Successful, Share of Default Principal and Interest Recovered (%)						0
18	If recovery unsuccessful, max loss in addition to principal as a % of default principal						100
19	Addition to annual interest rate to compensate for defaults (%)					0.00	
	III. RESULTS						
23	Actual Discounted Value of Payments (Rb. MM)						278.4
24	Target Discounted Value of Payments (Rb. MM)						
25	Initial annual contract rate including default risk premium (%)					129.0	
26	Distribution of Discounted Value of Cash Flows:						
27	First Five Years						31.1
28	Second Five Years						31.0
29	Third Five Years						38.0

Part III: Mechanics

Part III is the Mechanics Section (Cells I37 through V278) in which the model uses the information provided in Parts I and II to perform the calculations necessary to obtain the default risk premium. This part requires no user inputs. In this Part, the portfolio of loans is amortized monthly[40] over the specified loan term taking into account all of the user's earlier inputs in Parts I and II. Also in Part III, borrower payments are discounted to their value in year 0 rubles.[41]

[40] Note that the monthly interest rate is the sum of the monthly interbank lending rate, the monthly interest rate spread at 0 percent default and the monthly default risk premium. Each of these monthly rates is the monthly rate which, when compounded monthly would produce the annual rates specified in Sections I and II of the model. For example, the initial annual interbank rate is 124 percent, the monthly interbank rate would be [(1+124/100)^(1/12)-1]*100 or 6.95 percent. If the annual interest rate spread at 0 percent default is 5 percent on an annual basis, the monthly spread would be [(1+5/100)^(1/12)-1]*100 or 0.407 percent. If the initial default risk premium is 0 percent, the total initial monthly contract interest rate in the first month of loan amortization is 6.95 percent + 0.407 percent or 7.357 percent.

[41] The interbank lending rate is taken as a proxy for the lender's opportunity cost of lending, and so is used here as the discount rate.

XIV. ANNEX 2: MANUAL FOR DAIR INTEREST RATE RISK PRICING MODEL

Introduction

This paper summarizes the use of the DAIR Interest Rate Risk Pricing Model. The model calculates the addition to the DAIR's interest rate required given alternative assumptions about the timing of asset and liability repricing.

The model is divided into three parts. Part I is the General Inputs Part (cells A5 through G38) in which the user inputs loan portfolio characteristics, and inflation, interest rate, and lender cost of funds assumptions. Part II is the Summary of Loan Inputs, Repricing Inputs and Results Part (cells K6 through Q23) which contains the summary of general inputs, additional inputs related to the timing of asset and liability repricing, and the summary of results. Part III is the Mechanics Section (Cells I34 through X275) in which the model performs the calculations necessary to obtain the interest rate risk premium.

Part I. General Inputs

In this section, the user inputs assumptions about the loan portfolio (cells G5 through G13), and future expectations for inflation, the inter-bank lending rate, and the lender's cost of funds (cells B19 through D38). Part I of the spreadsheet is displayed in Table 1 below. Numbers down the left side of the page and letters along the top of the page refer to cell numbers and letters in the spreadsheet program.

i. Loan Characteristics. Cells G5 through G13 describe characteristics of the portfolio of loans for which an interest rate is being calculated. Average Loan Size (G5) and Number of Loans in Portfolio (G6), make the model more realistic, but will not affect the results of the analysis. Total Volume of Loan Portfolio (G7) is calculated from cells G5 and G6.

The Payment Rate (G8) should be the borrower payment rate for the loans in this loan portfolio. Note that a higher payment rate will result in a lower required default premium all other factors held constant. A higher payment rate means that a larger share of the total value of the loan is repaid in the early years of loan amortization. If most of the loan is repaid in the first few years of the amortization period, then defaults occurring later in the life of the portfolio will not have a significant influence on pricing. The loan term for loans is entered into cell G9. The loan term must be between one and 20 years.

The Annual interest rate spread over interbank rate with no timing mismatch (G10), reflects the addition to the interbank lending rate to cover operating costs,

other risks, and profits assuming the interest rate on assets would only change when the interest rate on liabilities changed and visa versa.

Frequency of Payment Adjustments (G11) is the number of months for which borrower repayments remain constant. This figure can be from 1 to 12 months.

The Funding Strategy (G13) refers to how the lender is assumed to fund the liability over time. Strategy "1" assumes that the lender funds this portfolio entirely from liabilities. In this case, every increase in the size of the assets (caused by negative amortization over most of the life of the loans) results in an increase in the size of this portfolio's liabilities. In the same vein, every decrease in the asset size results in a corresponding decrease in liabilities. The rational for this strategy is that the laws of accounting require that in aggregate assets equal liabilities plus equity, and we are assuming that this portfolio is funded entirely with debt. If this strategy is employed, a "1" should be entered into cell G13. This strategy is used in the interest rate risk example in the text.

Strategy "2" refers to a case in which the portfolio is again funded entirely by liabilities, but these are repaid over the life of the loan. Specifically, we assume that for each payment received from a borrower, the bank subtracts its operating costs[42] and uses the remainder of the cash received to pay down the liability issued to originally fund the loan. The rational for this strategy is that a lender is unlikely to fund DAIR assets with matching DAIR liabilities. Thus, it is unreasonable to expect that the liabilities issued will always have the same outstanding balance as the assets they initially funded. If this strategy is employed, a "2" should be entered into cell G13.

The matched asset/liability strategy (Strategy 1) will result in a larger interest rate risk premium than the strategy in which the liability is repaid explicitly from asset cash flows (Strategy 2). This occurs because after loan amortization begins, the outstanding liability under Strategy 1 is always larger than the liability under Strategy 2. The larger the outstanding value of the liabilities, the larger the impact on income of the interest rate paid on these liabilities.

ii. Inflation, Interbank Lending Rate and Default Scenarios. In cells B19 through D38, the model user inputs annual projections for inflation, interbank lending rates, and the lender's cost of funds for the period of loan repayment. Note that inflation assumptions (cells B19 through B38) will not affect the outcome of this analysis. Their sole purpose is to help the model user formulate assumptions about the interbank rate (Cells C19 through C38) over time. In the example included in the worksheet, it is assumed that inflation declines first rapidly and then more gradually

[42] Assumed to be equal to the interest rate spread over the interbank rate multiplied by the outstanding loan balance.

over the period. The interbank lending rate is assumed to increase up to the inflation level, and then move approximately in line with inflation. In the example included in the worksheet, the bank's cost of funds (Cells D19 through D38) are assumed to always equal the interbank lending rate.

The pattern of interest rate changes will affect the portfolio earnings stream associated with a given mismatch in repricing frequency. For example, if assets reprice less frequently than liabilities, and interest rates rise, the bank's earnings will be reduced relative to a constant interest rate scenario. For the same mismatch, the bank will benefit if interest rates fall. Note that the pattern contained in the sample worksheet (first increasing and then declining interest rates) will greatly reduce the lender's interest rate risk relative to a constantly increasing or declining interest rate scenario. If assets reprice less frequently than liabilities, the bank will first lose money when it must increase the interest rate it pays on liabilities before it can increase the rate it receives on assets. However, when interest rates begin to decline, the bank will benefit from asset interest rates declining slower than liability rates.

Table 1: General Inputs Section of Sample Worksheet

	A	B	C	D	E	F	G
				I. GENERAL INPUTS			
	I. LOAN CHARACTERISTICS						
5	Average Loan Size (Rb. MM)						5
6	Number of loans in portfolio						40
7	Total volume of loan portfolio (Rb. MM)						200
8	Annual payment rate (%)						7
9	Loan term (years)						15
10	Annual interest rate spread over interbank with no interest rate risk (%)						5
11	Frequency of payment adjustments (1 to 12 months)						3
12	Funding strategy (1=liability volume always equals asset volume;						
13	2 = liability repayment through DAIR payments net of bank expenses)						2
	II. ANNUAL INFLATION, INTERBANK LENDING RATE, & COST OF FUNDS						
	Years	Inflation %	Interbank Int Rate %	Cost of Funds			
19	1	1500	124	124			
20	2	1000	188	188			
21	3	900	222	222			
22	4	800	262	262			
23	5	700	294	294			
24	6	600	310	310			
25	7	500	390	390			
26	8	400	330	330			
27	9	319	329	329			
28	10	222	230	230			
29	11	113	120	120			
30	12	88	95	95			
31	13	67	73	73			
32	14	57	62	62			
33	15	47	51	51			

Part II. Summary of Loan Inputs, Repricing Inputs and Results

Part II summarizes the inputs from Part I, prompts the user for repricing information and summarizes results of the program. Part II of the spreadsheet is displayed in Table 2 below. Numbers down the left side of the page and letters along the top of the page refer to cell letters and numbers in the spreadsheet program. Only those items with a box drawn around them require inputs from the user.

i. Summary of Loan Characteristics. This Section (cells O6 through Q12) summarizes the General Inputs section and does not require additional user inputs.

ii. Repricing Inputs. In this section (O15, O16 and P17), the user provides information about the portfolio's repricing strategies.

In cell O15, the user inputs how frequently liabilities will reprice, and in cell O16 the user inputs how frequently assets will reprice. If the interbank lending rate and the cost of funds are increasing for most of the loan amortization period, then the lender's discounted value of net payments will increase if assets reprice more frequently than liabilities, and will decrease if assets reprice less frequently than liabilities. If the interbank lending rate and the cost of funds are decreasing for most of the loan amortization period, the bank's net discounted value of payments will decrease if assets reprice more frequently than liabilities, and will increase if assets reprice less frequently than liabilities.

In cell P17 the user inputs guesses about the addition to the annual interest rate required to compensate the lender for the interest rate risk created by the repricing frequencies input in cells O15 and O16. How the user makes these guesses is discussed below under Results. Initially, this cell should be set to "0" indicating that no addition to the spread is made.

iii. Results. To determine the interest rate premium required to compensate the lender for interest rate risk, the model requires an iterative process whereby the user experiments with possible values for the interest rate risk premium until the correct one is identified.

Step 1: Discounted Value of Payments Assuming No Timing Mismatch. After all initial assumptions have been input, the user runs the model assuming that there is no timing mismatch between asset and liability repricing. This is done by setting liability and asset repricing (cells O15 and O16) to the same number. This number should be the frequency envisioned for asset repricing. Cell P17 should be set to "0". When this has been done, the user should push the recalculation key (F9) on the computer keyboard. The result displayed in cell Q21 is the total discounted value of

net payments[43] the bank will receive over the life of the loan portfolio assuming that there is no timing mismatch in the repricing of liabilities and assets.

This figure in cell Q21, (Rb 78.4 million in the example contained in the worksheet) is the value of repayments the bank would like to receive even assuming that a timing mismatch takes place. The user should input into cell Q22 the number displayed in cell Q21. Note that the user should manually input into cell Q22 the value displayed in cell Q21. The user ***should not*** use the copy command since it is the value displayed in cell Q21 that is of interest, not the formula.

Step 2: Discounted Value of Net Payments Assuming Repricing Timing Mismatch. After the value in cell Q21 has been entered into cell Q22, the user should input into cells O15 and O16 assumptions about expected repricing frequency as described above. After these inputs have been made, the user should recalculate the results (push "F9").

Note that a new number is now displayed in cell Q21. This new number represents the discounted value of net payments the lender will receive assuming that the repricing frequency described above occurs. This actual discounted value of net payments will be different from the target value (cell Q22).

At this point, the user should enter into cell P17 a guess as to the likely addition to the annual interest rate required for the bank to obtain the target discounted value of net payments displayed in cell Q22. Under most interest rate scenarios, the target value will be greater than the actual value, indicating that the interest rate should be increased (a positive number should be entered into cell P17).[44] The larger the gap between the actual and target value of payments, the larger the required addition to the interest rate.

A very general rule of thumb is that every Rb. 10 million reduction in the discounted value of payments requires an addition of 0.04 to 0.12 percentage points to the annual interest rate. For example, if the timing mismatch pattern specified by the user results in a Rb. 50 million reduction in the discounted value of net

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[43] Net payments are loan repayments made by the borrower net of interest payments the lender makes to depositors.

[44] Note that in rare interest rates scenarios a mismatch in repricing frequency may greatly work to the bank's advantage. For example, if interest rates are predicted to rise steadily for most of the repayment period, and assets reprice more frequently than liabilities, the bank will benefit. If interest rates fall steadily over the period and assets reprice less frequently than liabilities, the lender will also benefit. This model provides an opportunity for the bank to actually reduce its interest rate to compensate borrowers for this anticipated windfall. In practice however, interest rate movement is hard to predict and the lender should not count on a favorable timing mismatch to generate significant revenue. Thus, in practice the interest rate risk premium should not be set lower than 0.

payments relative to the no timing mismatch scenario, then the lender would probably require an addition of from 0.2 to 0.6 percentage points to the annual interest rate to compensate for this mismatch.

Each time a guess is entered into the addition to monthly interest rate cell (cell P17), the model should be recalculated to observe the new Actual Discounted Value of Net Payments (cell Q21). If the actual value is below the target value then the addition to the interest rate spread is too small. If the actual value is above the target value, the addition is too large. Through a process of trial and error, the user should adjust the addition to interest rate until the actual value of payments equals the target value. When this occurs, the figure entered in the addition to interest rate cell is the amount that would have to be added to the monthly interest rate to compensate the lender for the specified frequency of liability and asset repricing.

For the example displayed in the spreadsheet, if liabilities reprice monthly and assets reprice only every 6 months, the lender will require a 1.87 percent addition to the annual interest rate to be compensated for the probable losses that will result from this timing mismatch.

Cell Q23 displays the total initial annual interest rate that will result given the specified interbank lending rate, interest rate spread in the absence of timing mismatch, and addition to interest rate to compensate for timing mismatch. It is the sum of cells P11, P12 and P17.

In practice, it is impossible to predict the pattern of future interest rates with great accuracy. Thus, it is suggested that the user establish the interest rate risk premium required under several likely interest rate scenarios and then use a weighted average of these. For a more complete description of this process, see Section IV of the text.

Part III: Mechanics

Part III is the Mechanics Section (Cells I34 through X275) in which the model uses the information provided in Parts I and II to perform the calculations necessary to obtain the default risk premium. This part requires no user inputs. In this Part, the portfolio of loans is amortized monthly[45] over the specified loan term taking into

[45] Note that the monthly interest rate is the sum of the monthly interbank lending rate, the monthly interest rate spread assuming no asset/liability mismatch and the monthly interest rate risk premium. Each of these monthly rates is the monthly rate which, when compounded monthly would produce the annual rates specified in Sections I and II of the model. For example, the initial annual interbank rate is 124 percent, the monthly interbank rate would be [(1+124/100)^(1/12)-1]*100 or 6.95 percent. If the annual interest rate spread with no mismatch is 5 percent on an annual basis, the monthly spread would be [(1+5/100)^(1/12)-1]*100 or 0.407 percent. If the initial interest rate risk premium is 0

account all of the user's earlier inputs in Parts I and II. Also in Part III, borrower payments net of interest payments made to depositors are discounted to their value in year 0 rubles.[46]

percent, the total initial monthly contract interest rate in the first month of loan amortization is 6.95 percent + 0.407 percent or 7.357 percent.

[46] The interbank lending rate is taken as a proxy for the lender's opportunity cost of lending, and so is used here as the discount rate.

Table 2:
Summary of Loan Input, Repricing Inputs, and Results

	K	L	M	N	O	P	Q
	II. SUMMARY OF LOAN INPUTS, REPRICING INPUTS AND RESULTS						
	I. SUMMARY OF LOAN CHARACTERISTICS				Monthly	Yearly	General
6	Total volume of loan portfolio (Rb. MM)						200
7	Payment rate (%)					7.0	
8	Loan term (months)					15.0	
9	Frequency of payment adjustments (1 to 12 months)				3		
10	Initial Contract Interest Rate:						
11	Initial annual inter-bank lending rate (%)					124.0	
12	Annual interest rate spread over interbank at 0% default (%)					5.0	
	II. ADDITIONAL DEFAULT INPUTS						
15	Frequency of liability repricing (in months)				1		
16	Frequency of asset repricing (in months)				1		
17	Addition to annual interest rate to compensate for Interest Rate Risk (%)					0	
	III. RESULTS						
21	Actual Discounted Value of Payments (Rb. MM)						78.4
22	Target Discounted Value of Payments (Rb. MM)						
23	Initial annual contract interest rate including						
24	interest rate risk premium (%)					129.0	
25	Average annual interest spread (%)					5.0	