THAI JOURANL OF DEVELOPMENT ADMINISTARATION VOL.37, NO.3, July-September 1994 (March, 1999)

Information Technology in Financial Risk Management

Watana Patanapongse *

1. Introduction

Entering the age of globalization, countries are adopting a policy of free trade in financial transactions, including decontrol of interest and exchange rates, prices and stockmarkets. To do business now management must understand financial risk management. Risk management seeks to minimize the adverse effects of risk, while at the same time maximizing the benefits of incurring the risk.

Risk is the awareness that the future is unpredictable. However, while the actual occurrence of a future event cannot be predicted, the probability of its occurrence can be estimated, sometimes with great accuracy.

2. Modern Risk Management

Two fundamental changes have made a major impact on the business sector during the past two decades:

2.1 Globalization

Globalization of the economy has had a profound impact on the nature of the risks to be managed. A bank, for instance, operates today in a multi-currency environment. It must be aware of changing trends, which affect the risk management scenario:

1. Increased market volatility.
2. New instruments developed by financial institutions and governments.
3. Increased competition from other financial institutions.
4. Increased global interaction.
5. More sophisticated clients.

* Research Center, National Institute of Development Administration

6. The breakdown of barriers distinguishing different types of financial institution.
7. Round-the-clock trading in the world's major financial markets.
8. New developments in information technology (IT) and telecommunications.

2.2 Information Technology

Risk management strategies, that embrace asset allocation, hedging, portfolio insurance and trading strategies, now demand IT. New developments in IT and telecommunications have momentous implications for global risk management, increasing the ability to handle a wide variety of disparate information and creating new opportunities to gain competitive advantage. Risk managers who have an understanding of how IT is developing are in the best position to deploy it for competitive advantage. Trends that can be perceived are:

1. Increasing use of technology by risk managers to gain competitive advantage.
2. Increasing demand for risk management systems to handle more incoming data and perform more extensive analyses.
3. Advances allowing a wider range of information to be digitized and thus entered into a system.
4. Integrated risk management systems which can operate with different risk management objectives in each individual market; and a facility for showing the totality of the organization's risks and positions "across the board" at any one time.
5. Ever more powerful processors allowing more rapid processing of data. Parallel processing is likely to overtake serial processing for numerically-intensive computing (NIC) applications.
6. It will be essential for IT departments to customize disparate vendor applications and integrate propriety systems into in-house programs.
7. Risk managers will insist on purchasing systems that conform to industrywide standards and open system architecture.
8. Relational databases will handle video, sound, graphics and other types of non-textual data.

9. Distributed processing via networks of independent workstations, within and between organizations, will make real-time information available to all users.

10. Artificial intelligence (AI) systems will become important to the risk manager. Possible implementations of AI include:

(a) Voice input,

(b) Natural language processing,

(c) Selection of information around "key concepts" rather than merely by "keywords".

(d) The "intelligent" analysis of, for instance, stock trading and customer credit levels.

11. High priority will be placed on computer security.

3. Classification of Financial Risks

Financial risk means the possibility that a loss will be made on a transaction or investment. With the globalization of business, its relevance to a decision maker considering expansion abroad has taken on a special interest.

Risk categories are as follows:

3.1 Credit risk

Credit involves an element of risk in that the debtor may fail to repay, or delay payment beyond the agreed time schedule. Assessing such risks and minimizing them, while maximizing sales, is the task of credit management.

3.2 Interest rate risk

A firm or an individual faces an interest rate risk when there is a need to borrow or lend money at a future date. Interest rates are volatile. If a firm needs to borrow money at a future point in time there are various ways in which it can "hedge" its exposure to an increase in rates.

3.3 Exchange rate risk

The extent to which a company may lose or gain on its overseas operations as a result of exchange rate changes is its exchange rate exposure. To protect itself from possible exchange rate losses a firm may resort to currency matching,

matching foreign currency holdings with equal foreign currency borrowings; accelerating or delaying foreign currency payments when the rate is expected to change; and offsetting receipts and payments among subsidiaries of a multinational company. Alternatively, a firm may hedge risks by forward exchange contracts; factoring, that is selling the firm's trade debts; foreign currency sales options and borrowing, export credit guarantees and currency swaps.

3.4 Stockmarket risks

Stock prices fluctuate in a manner which is difficult to predict. However, globalization of securities markets has achieved a better spread of economic risk worldwide and a better trade-off between risk and return.

The most fruitful way to view risk management is as a general technique for maximizing the return and minimizing the risks of a trading or investment decision involving assets held in financial instruments. This requires considering how the risk involved in holding portfolios of securities varies with fluctuation of interest and exchange rates. Risk management is an extremely important means of trying to minimize the impact of real hazards that could lead to serious financial loss.

4.1 Mathematical Analysis

The risk and return relating to a series of trading or investment decisions can be analyzed mathematically. Obtaining figures for the percentage return and percentage risk at any particular time in holding a portfolio of financial instruments, or of an individual instrument, is a matter of obtaining a figure for the percentage return on the portfolio or single holding; and then expressing the percentage risk as the expected variation around this percentage. The risk percentage is a useful measure of what might be expected to happen. Thus, a return percentage of 10% and a risk percentage of 2% means that the risk manager expects a return of $10 \pm 2\%$. The percentage return of an instrument, a portfolio, or an entire market, assessed over a period such as a year, will fluctuate over time. To calculate the percentage risk of a portfolio, the usual way is to calculate the standard deviation of the percentage returns of the instruments in the portfolio. The risk manager is also

interested in the relationship between the prices of different instruments; and between the particular instrument or portfolio and the market as a whole.

Regression analysis measures the relationship between the return on one instrument and the return on another. There is nearly always some relationship, at least to the extent that macroeconomic factors affect every item in a portfolio. The correlation is usually positive. The rarer, negative correlations, when they are found, offer interesting opportunities to maximize returns and minimize risk.

4.2 Modern portfolio theory

Modern portfolio theory (MPT) provides a framework for basing risk management decisions on the elements of risk assessment. It contains three major theoretical elements:

1. Any asset held has different risk implications when: (a) held by itself, and (b) held within a portfolio.
2. Some portfolios are preferable to others, because they offer: (a) a greater return for a given level of risk, or (b) a lower risk for a given level of return.
3. The most significant factor in reducing risk is the way in which the risk and return of the entire portfolio change according to how the size and nature of the individual instruments change in relation to one another.

The "optimal" portfolio can only be identified by effectively testing every possible combination of assets and asset weightings. It changes from moment to moment. It is not usually practicable to make significant change to a portfolio more than once a day - a period of once a week is more usual. Mathematical techniques can make the process highly efficient. It is here where IT can be employed.

5. Practical Risk Management

5.1 Financial instruments

A financial risk management system may be required to handle any or all of the following functions: (1) *Arbitrage*: Exploiting discrepancies between prices of instruments in different markets, so as to gain an automatic profit; (2) *Hedging*: Insuring against unfavorable movements in the price of investments by

acquiring derivatives in these instruments; (3) *Trading*: The buying and selling of financial instruments; and (4) *Investment management*: Managing the risks of holding an asset or portfolio of assets. Factors likely to affect the performance of each asset involved can be input into the management system.

The instrument categories to be considered are as follows:

(1) *Equities*: Commonly known as "shares," represent portions of the issued capital of a commercial organization. The performance of an equities market is assessed by an "index," which represents the performance of a hypothetical basket of different equities. The return on equities comprises (a) dividend paid to holders by the issuing organization; and (b) profit from purchase and sale, in consequence of the fact that the price of equities rises and falls. The yield of an equity is the ratio of dividend over one year to the current price.

(2) *Bonds*: Issued by governments and large institutions, essentially constitute a loan made by the buyer to the issuing organization. They carry a fixed interest rate and usually a specific maturity date and value at maturity. They are issued at a fixed price and are freely marketable. Convertible bonds are convertible into equities of the issuing organization at a specified time. The current yield of a bond is the interest that will accrue over one year divided by the current market price.

(3) *Derivatives*: These are instruments which derive their value from an underlying more elementary instrument. There are two types:

(a) Futures are contracts to buy or sell an asset at a specified future date, at a price specified now. Opportunities for speculation arise because the price depends on future expectations. A futures contract purchased today may be worth considerably more if subsequent expert forecasts indicate that the price of the asset is likely to rise. Futures contracts may be in tangible commodites or in any kind of financial instruments.

(b) Options are futures contracts that are binding only upon the seller of the option. The buyer of the contract has the right to buy (call option) the asset at the agreed price, but may abandon the option if subsequent market changes have been in the buyer's favor.

The risk of a derivative contract reflects that of the underlying asset. In the case of an option, the risk manager must also estimate the probability that the option will be excercised. Derivatives are often purchased as part of the risk management strategy themselves, as hedging devices. They remain high-risk, high-return items.

4. *Money market instruments*: Instruments traded on the short term money market, as a source of funding to the issuing organization, a bank or financial institution. They have a fixed rate of interest. Their most important risk factor is the overall interest rate, affecting the market price of the instrument.

5. *Foreign exchange (forex)*: The international forex market is probably the largest financial market in the world. Forex trading is a high-risk, highly volatile activity. To any risk manager concerned with overseas assets, risks due to changes in exchange rate of the currency in which these assets are held are of very great importance: exchange, interest rate and credit risk are all involved.

5.2 Risk management systems

(1) Mathematical analysis systems apply a specific mathematical theory to current market data and draw inferences regarding the likely future development of the market or financial instrument being considered.

As an example we may consider the arbitrage pricing theory (APT). The basic principle of APT is that individual asset prices fluctuate because they are subject both to "idiosyncratic" sources of risk and to "systematic" sources. Idiosyncratic risks are peculiar to a particular security or group of securities. Systematic risks apply to the whole market and affect all securities on the market. If a sufficiently large portfolio is held, individual idiosyncratic risks can be made to cancel out. The market value of the portfolio then fluctuates almost entirely because of systematic risk. The market then offers rewards only for taking systematic risk.

APT measures the sources of systematic risk, of which it identifies five: (a) the business cycle, (b) interest rates, (c) investor confidence, (d) short-term inflation, and (e) long-term inflationary expectations. In accordance with these principles, investment portfolios can be structured to comply with the investor's own risk or growth requirements.

(2) Many risk management systems now incorporate some elements of artificial intelligence (AI). Two programming techniques developed out of AI research are proving useful to the financial manager:

(a) Expert systems attempt to replicate human performance in a computer by programming it with the rules and decision procedures used by an expert when coming to conclusions in a specific field of expertise. It is then hoped that the system will draw commercially useful conclusions when confronted with data on a particular case.

(b) Neural nets attempt to simulate some aspects of what is known about the structure of the brain, The system "learns" to associate particular outcomes with particular inputs; and can thus be "trained" to make useful decisions when confronted with a completely new input.

Commercial systems for facilitating the functions of arbitrage, hedging, asset trading and investment management are now available to assist the organization to operate at maximum profitability (Essinger and Rosen, 1991, pp.146-161). We may consider some of the specific situations in which these systems might be applied.

6. Management of Interest Rate Risk

The three-month $LIBOR is the average quote from five major international banks, lending US dollars, in the London interbank market. Many corporate loan agreements are linked to $LIBOR and most derivative contracts have payoffs that depend on this rate. Here:

Real interest rate = $LIBOR – CPI inflation rate

where the inflation rate is measured by the consumer price index (CPI) in the United States.

The real interest rate is an *ex post facto* measure of the real rate of return earned by investors from investing at $LIBOR for each three-month period, given the inflation that subsequently occurred over that period.

6.1 Hedging interest rate risk

When a company borrows at a rate of $LIBOR + p to finance its operations, the premium, p, that it has to pay depends upon its credit status.

Since the three-month interest rate varies considerably over time the company faces the prospect of unknown borrowing costs. The financial management of such interest rate risks often takes the form of hedging. A good hedge for the borrowing company will pay off if interest rates rise, and the resulting profit will offset to some extent the rise in the firm's borrowing costs.

6.2 Long-term loan contracts

The traditional way of hedging against changes in short-term interest rates is to borrow or lend on a long-term basis. However, it may be difficult for and investor to sell a long-term bond if the money is needed for other purposes. Secondly, buying a long-term bond involves an increased risk that the borrower may not be able to repay the capital at maturity date. Long-term loans tend to require higher rates of interest because of these risks. Moreover, in a world of uncertain inflation, a long-term, fixed-rate loan becomes a high-risk security in terms of real purchasing power.

6.3 Interest rate derivatives

These are contracts whose payoff and value depend upon an underlying rate or bond price. One of the main features of a derivative is that the contract is detachable from the underlying asset. For the hedger, the loan cost, including the payoff from the derivative, will be:

Net Borrowing Cost/ Lending Return –

Market interest rate at future date + / - payoff on interest rate derivative

6.4 Futures or options

Futures contracts are made between a hedger and the "futures exchange." The default risk problem is minimized by requiring the contract holder to put up margin. The holder of a "long" futures contract receives the difference between the market rate of interest and the futures rate agreed in the contract. The holder of a "short" futures contract pays the difference between the market interest rate and the agreed futures rate. In contrast, an "option" contract is a one-sided futures

contract. A call option confers the right, but not the obligation, to enter the futures contract. The option payoff can only be positive. Hence, it must cost money to enter the options contract. This entry price is called the option premium. The net profit from the contract is payoff minus premium. Interest rate risk can be hedged either by entering a futures contract or an option contract.

6.5 Forward contracts

Firms and other large organizations often hedge their interest rate exposure by making forward contracts directly with banks. The two most important contracts in this market are the "forward rate agreement" (FRA) and the "interest rate swap." An FRA is an agreement to receive the difference (positive or negative) between a given market rate, say three-month $LIBOR, and a pre-set fixed rate based on a given underlying loan principal. An interest rate swap is a series of FRAs covering a series of future borrowing dates.

6.6 Forward rate agreements

The contract details of a FRA are shown in Table 1.

Table 1 Contract details of a FRA

Contract type	Forward rate agreement
Maturity	12 months
Underlying interest rate	3-month $LIBOR
Forward rate agreed	7%
Face value	$ 10 million
Position	Long

In this example, the FRA will pay the difference between $LIBOR in twelve months and a fixed rate of 7% on a principle of $ 10 million. The contract holder is long with regard to the contract, so that he or she receives $LIBOR and pays 7%. This results in the cash flow diagram shown in Figure 1.

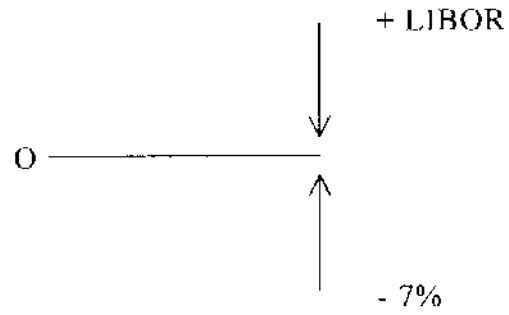

Figure 1 Payoff on forward rate agreement

If $LIBOR turns out to be 9%, the contract gains 2%. If it turns out to be 6%, however, the contract holder loses 1%. If the FRA is held together with a borrowing requirement it is an effective hedge. On the other hand, the contract may be used purely as a speculation on the future interest rate, since it is largely separate from any loan that is required.

A long position in a FRA contract is appropriate for hedging a borrowing requirement. A lender might be interested in a short position in a FRA. As an example, a short FRA at the rate of 7% will pay 7% minus the future $LIBOR rate. The short holder of the FRA contract makes a profit on the contract if interest rates fall. It follows that the profits or losses of the short contract, added to the rate of return from the lending arrangement, can be used to guarantee a future lending return of 7%

6.7 Interest rate options

Suppose the firm negotiates an option to receive the difference between $LIBOR and 7%. Table 2 shows the contract details.

Table 2 A one-sided forward contract

Contract type	Interest rate call option
Maturity	12 months
Underlying interest rate	3-month $LIBOR
Strike rate	7%
Face value	$ 10 million
Position	Long
Option premium	0.5%

Here the option payoff is again the difference between LIBOR and 7%. However, it is paid only if the difference is positive. The payoff diagram in the case of the long call option is shown in Figure 2.

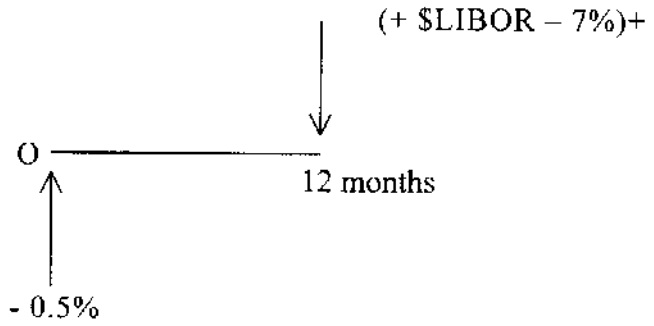

Figure 2 Payoff on caplet

Here, the notation ( )+ means that the payoff is only received if it is positive

The interest rate option (IRO) gives a protection to the borrower against a rise in interest rates. The contract is a form of insurance. The borrower pays a premium of 0.5% which confers the right to borrow at 7%. This means that the borrower's loan costs are capped at approximately 7.5%. If interest rates go down in twelve months' time, to say 5%, the option

contract is worthless at maturity, but the borrower can take advantage of the low market borrowing costs.

The call option contract illustrated above is known as a caplet. It is therefore suitable for a borrower who will need to raise funds at or related to the $LIBOR rate in the future

Interest rate options can be arranged also to protect a lender's position, where the lender faces an uncertain future return. Such a lender can protect against a fall in $LIBOR by arranging an interest rate "floorlet." The floorlet pays a fixed rate (say 7%) minus the $LIBOR rate in the market in twelve months' time. It provides insurance against a fall in market rates. The payoff diagram for the floorlet is shown in Figure 3.

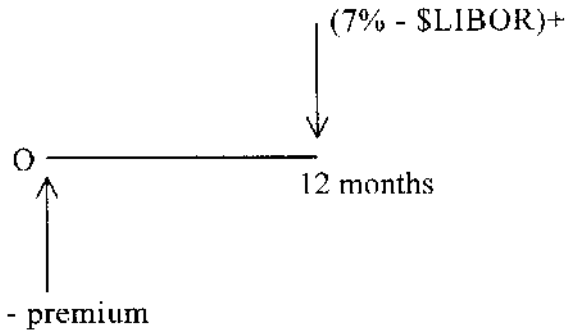

Figure 3 Payoff on a floorlet

6.7 An interest rate swap

Firms often borrow money on a "rolling" contract basis: Every three months, the interest rate is adjusted in line with market rates, but the money will be outstanding for a longer period of, say, five years. The firm will be exposed to increases in the $LIBOR rate at future points in time. A possible strategy is to arrange an interest swap: This is a contract whereby the firm agrees to pay a fixed rate of interest and receive $LIBOR at the end of each three-month period over the five-year term of the loan.

The contract details of an interest rate swap are shown in Table 3.

Table 3 Example of an interest rate swap

Contract type	Interest rate swap
Term	5 years
Underlying interest rate	3-month $LIBOR
Swap rate agreed	7%
Face value	$ 10 million
Position	Long

The payoff diagram in the case of the long position in the swap is shown in Figure 4.

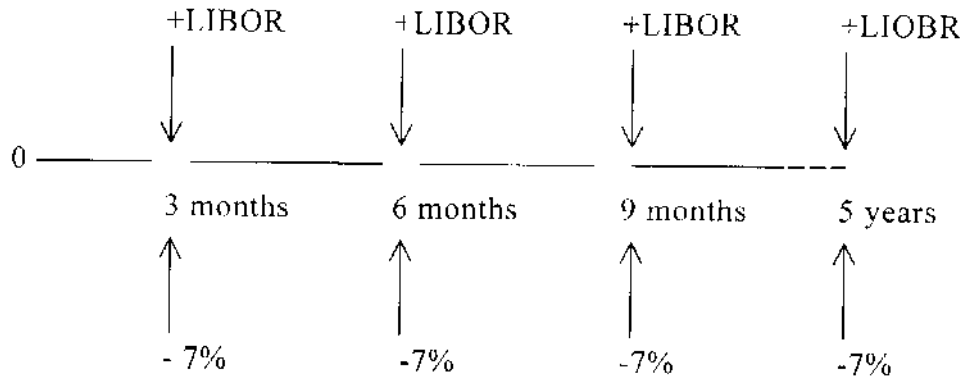

Figure 4 Payoff on an interest rate swap

For a lender, a series of short forward contracts could be arranged. These would involve paying $LIBOR and receiving a fixed rate of interest. This arrangement would be what is called a "short" interest rate swap contract. It has the reverse payments to those above. The short holder receives 7% and pays $LIBOR-related interest.

6.8 Interest rate caps and floors

An alternative way to hedge a long-term borrowing need is to buy an interest rate cap. This contract is a portfolio of interest rate options with maturities coinciding with future roll-over dates for the $LIBOR-related loans. For example, a five year cap on three-month $LIBOR consists of twenty individual IROs

covering each three month period over the five year period. Each options gives the right to exchange $LIBOR payments for the strike rate, on a specified principle amount. An interest rate cap is an alternative to a swap for hedging $LIBOR borrowing requirements. It provides a series of insurance contracts, placing a maximum on the rate to be paid on any three-month loan while at the same time allowing the borrower to benefit from lower market rates if and when they occur.

An interest rate floor is a portfolio of interest rate put options, each of which gives the right to receive a fixed rate and pay $LIBOR. The floor can be used by a lender who wishes to ensure a minimum return on a $LIBOR-related investment.

7. Management of exchange rate risk

Foreign exchange rates cannot be forecasted with great accuracy, which makes it imperative to manage exposure to foreign exchange risk. There are three basic foreign exchange risk exposure concepts: transaction, translation, and economic exposure, for handling each of which there are available hedging techniques.

7.1 Transaction exposure risk

Transaction exposure arises in import/export transactions where an invoice for future payment is in a currency that is foreign to at least one of the participants. By the time the invoice is to be repaid, the rate of exchange may have changed, exposing this party to loss or gain.

Transaction exposure may be hedged by a forward contract to purchase the foreign currency at a future date at the present prevailing rate of exchange. The buyer may obtain a loan in the home currency, to be exchanged immediately into the foreign currency, thus ensuring a cash balance sufficient to meet the future obligation. The buyer may decide on a forward option: a forward contract in which the buyer is not obliged to accept the agreed price, if the exchange rate change turns out to be in the buyer's favor - for this however a premium must be paid.

7.2 Translation exposure risk

A multinational company will have subsidiaries aboard, each of whose accounts will be held in its local currency. Translation exposure arises when these must be integrated into the parent company's overall balance sheet and income statement, from which earnings per share can be extracted.

When the foreign subsidiary's balance sheet is translated into the reference currency at the exchange rate prevailing on the date of closing of accounts, the net translation exposure is simply the net value of the subsidiary. If the exchange rate of the foreign currency against the reference currency were to depreciate over the next accounting period this would, from the point of view of

the parent company, represent a decrease in value of the subsidiary, which would be reported in the balance sheet, though it does not represent an actual cash flow in the income statement. Repeated translation losses would cause the debt/equity ratio to deteriorate, which may result in higher costs of capital with bank creditors and generally lower credit ratings.

Translation exposure can be hedged by a forward contract. The company may sell forward an amount equal to the translation exposure.

Alternatively, the company may hedge by borrowing the present amount of the translation exposure from a bank abroad, and immediately transferring the amount into an unexposed home country currency.

7.3 Economic exposure risk

Economic exposure is more difficult to quantify and is best illustrated by an example. In the 1980s a leading US supplier of durable consumer goods found its market being invaded by cheaper, imported Italian goods, in consequence of the appreciating value of the US dollar against the Italian lira. In general, economic exposure arises when a change in exchange rate puts the firm at a disadvantage relative to its potential foreign competitors.

In the above case, in order to maintain market share, the manufacturer had to match its price to the value of the lira. This could be partially achieved by procuring components from Italian, rather than US, suppliers. Another approach would have been to borrow Italian lira so as to take advantage of exchange rate gains to subsidize its domestic sales while matching prices of imported goods.

7.4 A Currency SWAP: A Case Study of the Expressway and Rapid Transit Authority of Thailand*

7.4.1 Introduction

Observing the foreign debt structure of the public sector and state enterprises in Thailand, it is seen that loans in yen currency for Japanese projects have been contracted since 1968 up to the end of 1994. There were then 28 agencies undertaking loan projects. Among these, 13 agencies were in the public sector while 16 were state enterprises. This loan currency was to be spent on 183 varied development projects. The total loans amounted to 912,898 million yen or 76.21% of the total of contracted loans from abroad. However, at this time the yen currency value increased in comparison to other currency families, especially the US dollar, which changed from 260 yen per 1 US$ in 1985 to 100 yen per 1 US$ in

---

* Summarized and simplified from Nongku, Thassanavilai. (1996). **SWAP: The Tools for Risk Management**. Bangkok: Term Thesis, Graduate School of Development Economics, National Institute of Development Administration (NIDA).

1996. In comparison the Thai baht exchange rate in 1984 was 10 baht per 100 yen, changing to 23 baht per 100 yen in 1996, while the exchange rate between the Thai baht and US dollar hardly changed, as is shown in Table 6 below.

Table 6 Exchange rate between Thai baht and US$ and Japanese yen.

Year		1 US$*	100 Yen
1984		23.69	10.00
1985		27.21	11.50
1986		26.35	15.78
1987		25.79	17.94
1988		25.34	19.87
1989		25.75	18.75
1990		25.64	17.79
1991		25.57	19.05
1992		25.42	20.15
1993		25.37	22.94
1994		25.20	24.74
1995		24.96	26.77
1996	January	25.34	23.99
	February	25.29	23.97
	March	25.28	23.93
	April	25.32	23.67
	May	25.34	23.88
	June 5	25.40	23.99

*Selling rate at the end of period.
Source: *Economic Situation*, Volume 2, Number 10, October, 1996, p. 18.

In order to reduce the financial risk which might arise from the continuous increase in value of the yen currency, the Thai cabinet, with the Ministry of Finance, tried to reduce the financial obligation in yen currency by a SWAP. This was to change the tie with yen currency to one with US$, which showed less fluctuation in exchange rate.

The OECF* loan contract serial number TIX-1 was a loan contract by the Expressway and Rapid Transit Authority of Thailand (ERTAT) which was made with the Japanese cabinet in 1982. This was a loan of which the purpose was to be spent in the construction project for the Daokanong - Tharue (Klongtoey) expressway, loaning a total amount of 25,900,000,000 yen. The loan contract was for 30 years (the period of free debt was 10 years). The interest was to be paid semiannually at the interest rate of 3% per year. According to the contract, the loanee should gradually pay back the capital, amounting to 270,655,000 baht, in equal amounts at every phase throughout the course of the contract beginning from the free debt period. At the time of study, the debt remaining was for 15 years and the total debt not paid was 8,660,960,000 yen (in October 1996). ERTAT planned to make a SWAP by changing the obligation for payment of interest in yen to one in US$. The SWAP would be extended over 10 years under the following process of operation:

1. Coordination between ERTAT and the Fiscal Policy Office (FPO), the Ministry of Finance, following up market conditions for the exchange rate of yen and US dollars.

2. Preparation of a table for repayment of principle and repayment of interest, for the purpose of having a definite table of payment to be sent to various financial institutes in order to submit indicative proposals for undertaking currency SWAPs. In making the table of repayment of principle and interest, ERTAT prepared this according to the OECF loan contract, as is shown in detail in the following Table 7:

2.1 Determining the period and amount of money for a currency SWAP contract. The OECF loan contract still had a remaining 16 years with 3% interest per year. This should be paid every half year. The first remaining amount was 8,660,960,000 yen. ERTAT planned to undertake a SWAP project for a period of 10 years, starting the SWAP from January 20, 1997, up to the final date of January 20, 2006. (Because the period for repayment of interest was every half year, the amount of cash was to be covered in 20 periods.)

2.2 The amount of principal for repayment in each period would be 270,655,000 yen according to the conditions of the OECF loan contract.

2.3 The principal balance at the starting point was 8,660,960,000 yen and would decrease by the amount of principal which was repaid in each period. It was the remaining unrepaid principal that was to be used as a base in calculating the interest for repayment at the next phase.

---

* OECF stands for Overseas Economic Cooperation Fund, an agency in Japan that provides concessional loans, development project grants, and equity investments for foreign enterprises. OECF usually procures from recipient countries, although some independent agencies, including the United Nations Development Programme, are authorized to manage united aid. OECF is based in Tokyo.

2.4 Interest payment was calculated from the principal remaining from the previous phase multiplied by the interest rate of 3%, determining interest payment semiannually. Therefore repayment of interest must be calculated semiannually (according to the one year, 365 days contract). For example, the repayment of interest for the first phase (January 20, 1997) was 130,982,189 yen (866,960,000 × 3% × 184/ 365).

2.5 The amount of total payment at each phase equals the repayment of principal plus payment of interest. For example, in the first phase this equaled 401,637,189 yen. This amount of money would be the total amount to be used for the SWAP.

3. Selection of the indicative proposal from the financial institute.

Table 7 Amortization and interest schedule

Amortization and Interest Schedule
TIX –1
Outstanding Loan Balance: JPY 8,660,960,000
Interest Rate at 3.00% Semiannually
Expressway and Rapid Transit Authority of Thailand (ERTAT)

Date	Principal	Day	Principal	Interest	Total
			8,660,960,000		
20-Jan-97	270,655,000	184	8,390,305,000	130,982,190	401,637,190
20-Jul-97	270,655,000	181	8,119,650,000	124,820,154	395,475,154
20-Jan-98	270,655,000	184	7,848,995,000	122,795,803	393,450,803
20-Jul-98	270,655,000	181	7,578,340,000	116,767,241	387,422,241
20-Jan-99	270,655,000	184	7,307,685,000	114,609,416	385,264,416
20-Jul-99	270,655,000	181	7,037,030,000	108,714,328	379,369,328
20-Jan-00	270,655,000	184	6,766,375,000	106,423,029	377,078,029
20-Jul-00	270,655,000	182	6,495,720,000	101,217,555	371,872,555
20-Jan-01	270,655,000	184	6,225,065,000	98,236,642	368,891,642
20-Jul-01	270,655,000	181	5,954,410,000	92,628,501	363,263,501
20-Jan-02	270,655,000	184	5,683,755,000	90,050,255	360,705,255
20-Jul-02	270,655,000	181	5,413,100,000	84,555,588	355,210,588
20-Jan-03	270,655,000	184	5,142,445,000	81,863,868	352,518,868
20-Jul-03	270,655,000	181	4,871,790,000	76,502,675	347,157,675
20-Jan-04	270,655,000	184	4,601,135,000	73,677,482	344,332,482
20-Jul-04	270,655,000	184	4,330,480,000	68,827,937	339,482,937
20-Jan-05	270,655,000	184	4,059,825,000	65,491,095	336,146,095
20-Jul-05	270,655,000	181	3,789,170,000	60,396,849	331,051,849
20-Jan-06	270,655,000	184	3,518,515,000	57,304,708	327,959,708
20-Jul-06	270,655,000	181	3,247,860,000	52,343,935	322,998,935
Total	5,413,100,000			1,828,189,250	7,241,289,250

The Union Bank of Switzerland (UBS) submitted a proposal to ERTAT according to Table 8 below.

Table 8 Indicative proposal for a 10-year JPY 5,413,100,000/ USD cross currency SWAP.

Indicative terms on the captioned structure calculated on the basis of Yen 111.88/US$	
Counterparties:	Expressway and Rapid Transit Authority of Thailand (ERTAT) and the Union Bank of Switzerland (UBS)
Initial Principal Amount:	The JPY 8,660,960,000 and the USD equivalent calculated on the basis of the effective exchange rate.
Effective Exchange Rate:	The JPY/USD spot exchange rate prevailing at the time of commitment
Principal Amortization:	In 20 equal semi-annual repayments of JPY 270,655,000 each and their USD equivalent commencing on January 20, 1997 and ending on the maturity date, as per the amortization schedule provided by ERTAT.
Effective Date:	July 19, 1996.
Maturity Date:	July 20, 2006, subject to adjustment in accordance with the prevailing business day convention.
Payment Date:	January 20 and July 20 of each year, commencing on January 20, 1997 and ending on the maturity date, subject to adjustment in accordance with the prevailing business day convention.
Initial Principal Exchange:	None.
Principal Exchange:	UBS pays JPY principal amortization amount on each payment date. ERTAT pays USD principal amortization amount on each payment date.
Interest Settlement:	UBS pays 3.00% in JPY, semi-annually, Act/365 unadjusted day basis.
Documentation:	Standard ISDA documentation, to be mutually agreed.
Note that price quoted herein is purely indicative subject to fluctuations in market conditions and credit approval.	

Source: Expressway and Rapid Transit Authority of Thailand (ERTAT)

Following the proposal by the Union Bank of Switzerland, a comparative table of cashflow as between JPY and USD can be made as shown in Table 9.

Table 9 JPY/USD Cross Currency SWAP: ERTAT vs UBS

Total Principal Amount					JPY 8,660,960,000
Interest Rate					3.00% Semiannually
Day basis					Act/365
Date	Principal Repayment	Day	JPY Principal Outstanding	JPY Interest	Yen Total Payment
			8,660,960,000		
20/Jan/97	270,655,000	184	8,390,305,000	130,982,190	401,637,190
20/Jul/97	270,655,000	181	8,119,650,000	124,820,154	395,475,154
20/Jan/98	270,655,000	184	7,848,995,000	122,795,803	393,450,803
20/Jul/98	270,655,000	181	7,578,340,000	116,767,241	387,422,241
20/Jan/99	270,655,000	184	7,307,685,000	114,609,416	385,264,416
20/Jul/99	270,655,000	181	7,037,030,000	108,714,328	379,369,328
20/Jan/00	270,655,000	184	6,766,375,000	106,423,029	377,078,029
20/Jul/00	270,655,000	182	6,495,720,000	101,217,555	371,872,555
20/Jan/01	270,655,000	184	6,225,065,000	98,236,642	368,891,642
20/Jul/01	270,655,000	181	5,954,410,000	92,628,501	363,263,501
20/Jan/02	270,655,000	184	5,683,755,000	90,050,255	360,705,255
20/Jul/02	270,655,000	181	5,413,100,000	84,555,588	355,210,588
20/Jan/03	270,655,000	184	5,142,445,000	81,863,868	352,518,868
20/Jul/03	270,655,000	181	4,871,790,000	76,502,675	347,157,675
20/Jan/04	270,655,000	184	4,601,135,000	73,677,482	344,332,482
20/Jul/04	270,655,000	184	4,330,480,000	68,827,937	339,482,937
20/Jan/05	270,655,000	184	4,059,825,000	65,491,095	336,146,095
20/Jul/05	270,655,000	181	3,789,170,000	60,396,849	331,051,849
20/Jan/06	270,655,000	184	3,518,515,000	57,304,708	327,959,708
20/Jul/06	270,655,000	181	3,247,860,000	52,343,935	322,998,935
Total	5,413,100,000			1,828,189,250	7,241,289,250

Table 10 JPY/USD Cross Currency SWAP: ERTAT vs UBS (cont.)

Total Principal Amount				YEN 111.88: 1 USD		
Interest Rate				USD 77,412,942		
Day basis				5.355% Semiannually Act/365		
Date	Principal Repayment	Day	$ Principal Outstanding	$ Principal Repayment	USD Interest	Total USD Payment
			77,412,942			
20/Jan/97	270,655,000	184	74,993,788	2,419,154	2,118,792	4,537,947
20/Jul/97	270,655,000	181	72,574,634	2,419,154	2,019,114	4,438,268
20/Jan/98	270,655,000	184	70,155,479	2,419,154	1,986,368	4,405,522
20/Jul/98	270,655,000	181	67,736,325	2,419,154	1,888,849	4,308,003
20/Jan/99	270,655,000	184	65,317,170	2,419,154	1,853,943	4,273,098
20/Jul/99	270,655,000	181	62,898,016	2,419,154	1,758,583	4,177,738
20/Jan/00	270,655,000	184	60,478,861	2,419,154	1,721,519	4,140,673
20/Jul/00	270,655,000	182	58,059,707	2,419,154	1,637,314	4,056,468
20/Jan/01	270,655,000	184	55,640,552	2,419,154	1,589,094	4,008,249
20/Jul/01	270,655,000	181	53,221,398	2,419,154	1,498,052	3,917,207
20/Jan/02	270,655,000	184	50,802,243	2,419,154	1,456,670	3,875,824
20/Jul/02	270,655,000	181	48,383,089	2,419,154	1,367,787	3,786,941
20/Jan/03	270,655,000	184	45,963,935	2,419,154	1,324,245	3,743,400
20/Jul/03	270,655,000	181	43,544,780	2,419,154	1,237,521	3,656,676
20/Jan/04	270,655,000	184	41,125,626	2,419,154	1,191,821	3,610,975
20/Jul/04	270,655,000	184	38,706,471	2,419,154	1,113,374	3,532,528
20/Jan/05	270,655,000	184	36,287,317	2,419,154	1,059,396	3,478,551
20/Jul/05	270,655,000	181	33,868,162	2,419,154	976,991	3,396,145
20/Jan/06	270,655,000	184	31,449,008	2,419,154	926,972	3,346,126
20/Jul/06	270,655,000	181	29,029,853	2,419,154	846,725	3,265,880
Total	5,413,100,000			48,383,089	29,573,130	77,956,218

2. A breakeven analysis of the SWAP

The currency SWAP mentioned above has more or less the same characteristics as a forward currency future contract between the two contractors. Each party makes a contract to deliver foreign currency according to the price, the quantity and the period as given in advance in the contract. As a result the calculation of the breakeven point of the SWAP contract is the same as the calculation of the future exchange rate to be concluded for the equal benefit of

both. In another sense, it is to determine the exchange rate to make both contractors in the currency SWAP be in equilibrium. The breakeven analysis can be made in two ways:

1. Analysis without consideration of the time value of money. This can be calculated by the following equation:

Breakeven (forward) = $S_o(1 + r_t.T)/(1 + r_e.T)$.....(1)

where

S_o = The immediate exchange rate

r_t = The interest rate of the term currency

r_e = The interest rate of the commodity currency.

As a result, for this case study, we can calculate the breakeven point as follows:

$$\text{Breakeven (forward)} = \frac{S}{\left(1 + r_{UDD/2}\right)^{2n} / \left(1 + r_{YEN/2}\right)^{2n}}$$

$$= \frac{111.8}{(1+0.0268)^{20} / (1+0.015)^{20}}$$

$$= 88.83$$

The breakeven point is 88.83 yen per 1 US$. This means that, at the different interest rates between financial markets in the United states and those in Japan, the exchange rate which enables equilibrium between both sides of the contract, at the time of the contract's ending. should always be 88.83 yen per 1 US$. Otherwise the contract will bring about an opportunity cost to either party making the SWAP. In this context, if the exchange rate of yen to baht can be maintained at the level of 100-110 yen per baht or at a level not lower than 88.83 yen per 1 US$, ERTAT will incur an opportunity cost. However, if the exchange rate of yen per US$ is lower than 88.83 yen per 1 US$, ERTAT will gain benefit from making the SWAP.

2. Calculation of the breakeven point considering the time value of money. This can be calculated by starting with the cashflow of principle as well as interest repayment in yen currency and US$ currency throughout the period of the contract in order to calculate the present value. This is to calculate the exchange rate which makes the present values of the cashflows of both currency families to be equal, according to equation (2) as follows:

$$\frac{NPV_t}{P_b} = NPV_e \quad \text{.....(2)}$$

where NPV_t = The present value of cashflow of the currency family used in determining term currency.

NPV_c = The present value of cashflow of the currency family used in determining commodity currency.

P_B = The exchange rate at the breakeven point.

Table 11 The calculation of present value of the cashflow to be binding on both parties of the contract

Total Yen Payment	Total USD Payment
401,637,190	4,537,947
395,475,154	4,438,268
393,450,803	4,405,522
387,422,241	4,308,003
385,264,416	4,273,098
379,369,328	4,177,738
377,078,029	4,140,673
371,872,555	4,056,468
366,891,642	4,008,249
363,263,501	3,917,207
360,705,255	3,875,824
355,210,588	3,786,941
352,518,868	3,743,400
347,157,675	3,656,676
344,332,482	3,610,975
339,482,937	3,532,528
336,146,095	3,478,551
331,051,489	3,396,145
327,959,708	3,346,126
322,998,935	3,265,880
NPV Yen (3.00%/2, 2n) = 6,250,696,226.55	NPV $(5.355%/22n) – $60,639,796.25

From equation (2) we can calculate the breakeven point of the currency SWAP as follows:

$$\frac{NPV_{YEN}}{P_s} = NPV_{USD}$$

$$\frac{6,250,696,226.55}{P_s} = US\$60,639,796.25$$

The exchange rate at the breakeven point is 103.08 yen per 1 US$. This means that an exchange rate of 103.08 yen per 1 US$ will make the income cashflow and the expense cashflow of both contractors equal. Therefore if this currency SWAP is agreed at the exchange rate of 111.88 yen per 1 US$, ERTAT has smaller income cashflow than expense cashflow. This therefore brings about an opportunity cost. If we want to cut down the opportunity loss incurred the interest rate of US$ currency should be decreased.

3. The value of the SWAP

In making a SWAP it is necessary to calculate the value of the SWAP. In this contract, the value of the cross currency SWAP is equivalent to the value of the income cashflow minus the value of the present value of the expense cashflow at the exchange rate determined. Here the exchange rate determined is 111.88 yen per 1US$. This makes the income cashflow yen 6,250,696,226.55/111.88 – $55,869,648.07, which is smaller than the present value of the expense cashflow in US$, which is $4,770,144.18 (60,639,796.25 - 55,869,648.07). Therefore in making a cross currency SWAP, if the exchange rate of yen currency per US$ does not change throughout the period of the contract, it will be ERTAT that incurs the opportunity loss. However, the main objective of making the currency SWAP is to reduce the debt in yen currency. This is because the Japanese yen has tended to rise. This will bring about an exchange rate risk. On the contrary, if the yen currency is higher in comparison to the US$ over the breakeven point of the contract, ERTAT will receive benefit from making the SWAP.

In summary, considering this case study of a currency SWAP by ERTAT, if another bank were to submit a better proposal than the Union Bank of Switzerland, for example with the determining interest rate lower for US$ currency, or making the exchange rate of the contract higher than 111.08 yen per 1 US$, the currency SWAP would increase in value.

A SWAP is one tool which can be used for financial risk management, and can be compared to two future purchase contracts made by both contractors by exchanging cashflow between the two parties. It is subject to the condition that both contractors get equal benefit. If equilibrium does not occur, either contractor will lose to the other in the currency SWAP. However, making a SWAP is one alternative which a business can use for risk management. In a state of economic

fluctuation as at the present time, changes in interest rates, exchange rate and commodity prices will be financial risks which will affect the operation of a business. As the factors bringing about success in business are changing, these fluctuations make businesspeople aware of the need to maintain operational results and the value of the business at a satisfactory level. To learn and to understand the structure of financial risk and the tools of financial risk management is of benefit to businesspeople and to people in general, who may then understand how, by the use of financial risk management, to create the maximum value for the business.

9. Conclusion and Recommendations

This article has considered two factors which have profoundly affected international financial management: globalization, and the development of IT.

The need to hedge financial risks arises because of the difficulty, or near impossibility, of forecasting changes in credit status, interest and foreign exchange rates and stockmarket prices - though the probability of change, one way or the other, can be estimated. The difficulty becomes greater as the international market moves towards floating exchange rates and currencies, assets, and financial instruments priced by free market and demand forces - forces which central banks find it increasingly difficult to control. It is unlikely that, in the global marketplace, there will ever be a return to artificially stabilized prices, interest or exchange rates.

The international financial manager must undertake careful consideration of the hedging techniques, old and new, that are available to minimize these risks. Foreign exchange risk must be integrated with interest rate risk, commodity and asset price changes, and insurance. Risk managers and financial engineers are still in process of developing hedging policies that will function consistently over different risk situations and over time.

Strategic management of financial risk will focus attention on maximizing the firm's value through appropriate sourcing, financing and pricing policies. Preoccupation with hedging risks should not be allowed to distract attention from the creation of value by sound management of economic exposure, which is the province of global strategic management.

Moreover, modern risk management is not merely defensive. Its objective is to create competitive advantage for the firm by minimizing risk while at the same time maximizing the gains from incurring the risk. It is especially concerned with optimizing the trade-off between risks and returns involved in holding portfolios of assets and financial securities. Modern portfolio management applies mathematical analysis to making this process systematic.

The development of computerized information technology has made possible risk management systems, which support managerial decision making by

applying mathematical financial modeling to complex global market information in real time. The task of the financial manager has become increasingly to understand such systems and to purchase and develop systems appropriate to the firm's needs.

10. Bibliography

Agor, W.H. (1986). "The logic of intuition: How top executives make important decisions." **Organization Dynamics**, Winter, 5.

Agor, W.H. (ed.) 91989). **Intuition in Organizations**. Newbury Park, CA: Sage Publications.

Ahn, M. and Falloon, W.D. (1991). **Strategic Risk Management**. Chicago, IL: Probus Publishing Company.

Amanson, B. (1992). **Interest Rate Risk Management**. London: Graham & Trotman.

Bell, D. (1988). **Risk Management**. New York: Cambridge University Press.

Bilson, J.F.O. (1983). "The evaluation and use of foreign exchange rate forecasting services," in R.H. Herring (ed.), **Management of Foreign Exchange Risk**. Cambridge, UK: Cambridge University Press.

De Rosa, D.F. (1991a). **Managing Foreign Exchange Risk**. Chicago, IL: Probus Publishing Company.

De Rosa, D.F. (1991b). **Options on Foreign Exchange**. Chicago, IL: Probus Publishing Company.

Essinger, J. and Rosen, J. (1991). **Using Technology for Risk Management**. Cambridge, UK: Woodhead-Faulkner.

Fiegenbaum, A. and Thomas, H. (1988). "Attitude towards risk and the risk-return paradox: Prospect theory explanations." **Academy of Management Journal**, 31, 85-106.

Figlewski, S., Silber, W., and Subrahmanyam, M.G. (eds.) (1990). **Financial Options: From Theory to Practice**. New York: Business One, Irwin.

Galitz, L. (1995). **Financial Engineering**. London: Pitman.

Hellriegel, D. and Slocum, J.W., Jr., (1992). **Management**. Reading, MA: Addison-Wesley.

Jacque, L.L. (1996). **Management and Control of Foreign Exchange Risk**. Norwell, MA: Kluwer Academic Publishers.

Kenyon, A. (1990). **Currency Risk and Business Management**. Cambridge, MA: Blackwell.

Levich, R.M. (1980). "Analyzing the accuracy of foreign exchange advisory services: Theory and evidence," in R.M. Levich and C. Wihborg (eds.), **Exchange Risk and Exposure**. Lexington, MA: D.C. Health.

Shapiro, A.C. (1989). **Multinational Financial Management**. 3rd ed. Boston, MA: Alyn & Bacon.

Simon, H.A. (1976). **Administrative Behavior**. 3rd ed. New York: Free Press.

Smith, C.W., Smithson, C.W. and Wilford, D.S. (1990). **Managing Financial Risk**. New York: Harper & Row.

Soelberg, P.O. (1967). "Unprogrammed decision making." **Industrial Management Review**, Spring, 1929.

Stapleton, R.C. and Subrahmanyam, M.G. (1990). "Interest rate caps and floors," in S. Figlewski, W. Silber, and M.G. Subrahmanyam (eds.) **Financial Options: From Theory to Practice**. New York: Business One, Irwin.

Wunnicke, D., Wilson, D., and Wunnicke, B. (1992). **Corporate Financial Risk Management**. New York: Wiley.