

MEASUREMENT OF BANKS' EXPOSURE TO INTEREST RATE RISK

In February 1995, the Hong Kong Monetary Authority (HKMA) introduced the Return of Interest Rate Risk Exposures to monitor the possible impact of interest rate changes on individual institutions' reported earnings. This article explains the common methods for measuring interest rate risk exposure and provides an overview of the approach adopted by the HKMA.

Definition of interest rate risk

Interest rate risk is the risk that changes in market interest rates might adversely affect an institution's financial condition. This risk is an aspect of normal banking operations whenever the interest rate sensitivity of a bank's assets does not match the interest rate sensitivity of its liabilities or off-balance-sheet positions.

For a bank whose liabilities reprice faster than its assets, a rise in interest rates will tend to reduce net interest income by increasing the institution's cost of funds relative to its yield on assets. On the other hand, a bank whose assets reprice faster than its liabilities may experience a decline in net interest income if interest rates fall.

To illustrate how a bank may be exposed to interest rate risk in times of rising interest rates, assume a simple example where the bank has a fixed 1-year loan that bears interest at 6.00% per annum. The loan is funded entirely by customers' deposits with a maturity of three months and throughout bearing interest at an initial 4.25%.

In this example, the bank will obtain an interest margin of 1.75% over the term of the loan as long as the cost of funds remains unchanged.

However, unless the loan is prepaid, there is always the possibility of a rise in the cost of funds during the term of the loan. If the floating rate rises from 4.25% to 4.75% at the next repricing date and remains unchanged thereafter, the interest margin would be reduced to 1.25% over the remaining life of the loan and the bank's income would be correspondingly lower.

The accounting and economic perspectives of interest rate risk

An institution's interest rate exposure can be viewed as the potential for adverse impact of a change in interest rates on its current earnings and/or economic value.

The *Accounting Perspective* (or the current earnings approach) considers interest rate risk from an accounting viewpoint to identify the effects that interest rate changes will have on the profit and loss account in the short term, typically up to one or two years. This perspective is important because reported earnings determine the book value of equity which may affect the investors' perception of the institution.

The *Economic Perspective* (or the economic value approach) of interest rate risk focuses mainly on the economic or market value of an institution and is concerned with how changes in interest rates will affect the present value of all future cash flows or profits. This perspective places greater emphasis on longer-term instruments whose values are more sensitive to interest rate changes.

The accounting and economic perspectives are complementary. The accounting perspective provides a measure of the timing of income effects which can help risk managers to determine the need to change the institution's portfolio's composition while the economic perspective provides an objective measure of an institution's net worth which can indicate potential future problems. In an ideal situation, banks should manage their capital at risk over the long term and maintain robust earnings in the short term. The combination of the accounting and economic approaches should therefore enhance the completeness of exposure measurement.

Measurement framework for interest rate risk

There are many ways for banks to measure their interest rate risk exposures. The two most common generic methods are *gap analysis* and *duration analysis*. In addition, some banks with more sophisticated portfolios may use the simulation approach.

Gap analysis is the most basic measure of interest rate risk, and it is typically used for assessing

impact on current earnings. Under this method, all interest sensitive assets and liabilities including off-balance-sheet items are placed in different time bands according to their time remaining to repricing. For each time band, repricing assets are netted against repricing liabilities to produce the repricing gap. If more assets than liabilities reprice in a given period, there would be a positive gap and earnings will tend to increase as interest rates increase. On the other hand, for a negative gap, earnings will tend to decline as interest rates rise. The overall interest rate risk is usually assessed by taking a weighted average of these repricing gaps, typically using a one-year time horizon.

However, gap analysis normally identifies only the amount of assets and liabilities at risk and does not take account of *basis risk*. Basis risk refers to the risk which arises because of differences in the reference rates that a bank pays on its liabilities and earns on its assets. This risk is present, even when the assets and liabilities are matched in terms of their maturities or repricing periods.

Duration analysis is often used under the economic value approach to measure the sensitivity of the market value of a bank to changes in interest rates. Conceptually, duration is the average time to the receipt of cash flows weighted by the value of each of the cash flows in the series. Duration is a single number that is measured in units of time such as months or years. A larger number indicates higher sensitivity to changes in interest rate. The duration of a bank's capital is derived from the duration of all assets, liabilities and off-balance-sheet positions. It may be positive or negative to indicate whether the market value of the capital of a bank will decline or increase with a change in interest rates.

While gap analysis and duration analysis highlight different facets of interest rate risk, each has its own drawbacks. The interest rate gap assumes that the structure of a bank's asset and liabilities remains constant, which will therefore at best be an approximation in practice. The duration of the bank as a whole is an aggregate number and it does not address the dispersion of cash flows in the portfolio. This means that portfolios with the same duration can have very different cash flow patterns, in respect of which interest rate changes may have different effects on the overall financial position of the portfolios. In addition, the duration measure is only

accurate for small changes in interest rate. As the amount of change increases, the measure becomes less and less accurate. One common drawback suffered by both methods is that these measures indicate the *extent* to which interest rate changes would have an impact on the financial condition of the institution, but fail to predict the *probability* that these changes would occur.

Simulation techniques attempt to overcome some of these limitations by modelling the institution's interest rate sensitivity. Such modelling involves making assumptions about the future course of interest rates and changes in an institution's business activity, and estimating their effect on the institution's net interest income. Since it is a dynamic approach, a sophisticated model can help to evaluate the effect of alternative business strategies on risk exposure. Furthermore, it may be possible to include other effects induced by interest rate changes such as time deposit rollovers and mortgage prepayments. The major problem with this approach is the amount of expertise required to develop such a sophisticated model and the requirements in terms of computational power. In addition, the usefulness of simulation techniques depends critically on the validity of the underlying assumptions.

Many banks use these methods in combination, or use hybrid methods that combine features of each – the duration-weighted gap methodology proposed by the Basle Committee is one example.

Regulatory approach proposed by the Basle Committee

Recognising that interest rate risk is a significant risk which banks and their supervisors need to monitor, the Basle Committee on Banking Supervision has been working to develop ways of measuring the interest rate risk of banks. A consultative paper was issued in April 1993 to set out a framework for measuring a bank's interest rate risk exposure using the economic value approach. Under the framework, a bank's positions would be slotted, according to their maturity or repricing characteristics, into pre-defined time bands. Duration-based risk weights would then be applied to these positions. The resulting difference between the duration-weighted assets and liabilities in each maturity band would provide an estimate of

the change in the economic value of a bank as a result of a pre-specified change in interest rates.

The Basle Committee has broadly identified two stages in determining the appropriate supervisory approach to monitoring banks' exposures to interest rate risk. The first is to decide how to measure the risk. The second is to decide what action, if any, supervisors should take to discourage excessive risk-taking. The measurement framework proposed is designed for use by banking supervisors for observation purposes and as a means of identifying "outliers". However, the Basle Committee has not recommended any benchmarks to help to identify outliers at this stage. It has also left the supervisory response to these outliers to national discretion.

The measurement system in use by the HKMA

While the economic value approach was favoured by the Basle Committee, the HKMA has as a first step opted to use the current earnings approach which focuses on the sensitivity of banks' near-term earnings to changing interest rates. The HKMA's choice of this approach is partly because it is less complicated than the economic value approach; but also because it feels that its short-term focus is more appropriate to the circumstances in Hong Kong. This reflects the fact that the bulk of authorised institutions' interest bearing assets and interest earning liabilities reprice within a short period (three months).

To enable the HKMA to monitor authorised institutions' exposure to interest rate risk on a regular basis, the HKMA introduced in February 1995 a quarterly Return of Interest Rate Risk Exposures. The Return, which is based on the gap analysis approach, measures the impact on the earnings of authorised institutions in different currencies of a 1% rise in interest rates in various time bands over a period of 12 months. Using data obtained from the Return, the HKMA measures an institution's exposure to interest rate risk through the following steps:

- (1) All interest-bearing assets and liabilities, together with those off-balance-sheet items which are sensitive to changes in

interest rates of an institution are slotted into one of the six time-bands, ranging from "up to 1 month" to "more than 1 year", according to their earliest next repricing date.

- (2) The positions within each time-band are netted to produce a net repricing gap for each band.
- (3) The net repricing gaps for the time-bands within 1 year, which is the focus of the HKMA's analysis, are then weighted by the length of time from the mid-point of the time band in question to the end of the year.
- (4) Finally, the sum of these individual weighted gaps will be used to measure the sensitivity of the earnings of authorised institutions. Such sum can be either positive or negative. A positive figure indicates that a rising interest rate in the currency concerned will be favourable to the reporting institution and the reverse is true when the rate is falling.

The reporting system requires the completion of maturity ladders for interest rate risk in HK dollars, US dollars and each of the other currencies in which the reporting institution's business is significant⁽¹⁾.

The HKMA uses the information collected to identify those institutions which may be especially vulnerable to fluctuations in interest rate changes (i.e. outliers).

Observations from the new reporting

In the initial period of the new reporting system, the HKMA observed that the returns submitted to it contained many errors, although the reporting quality has been improving over time. This is partly because some of the transactions covered by the Return are rather complicated; but also because some reporting institutions do not fully understand the interest rate risk associated with some of the more complicated transactions they are conducting. The HKMA therefore believes that the new reporting requirement is useful in terms of both improving the HKMA's knowledge

(1) At present, an institution would be regarded as having a significant position in a currency if the sum of its on-balance-sheet assets or liabilities, whichever is the larger, in that currency and its off-balance-sheet positions, in the same currency is more than 5% of its total balance sheet assets in all currencies.

about the degree of interest rate risk in Hong Kong and increasing the level of awareness about this type of risk among authorised institutions.

According to the returns submitted to the HKMA for positions at end-February 1996, the banking sector as a whole had business in 25 currencies, the positions in which are regarded as "significant" for the purposes of the Return. However, the majority of authorised institutions' business is concentrated in 4 currencies only. The major findings from the returns are:

- Authorised institutions' on-balance-sheet positions in Japanese Yen, US dollar and HK dollar were of predominant importance, thus interest rate changes in these currencies would cause the greatest impact on institutions' earnings (Table 1). Locally incorporated banks' exposure to these currencies amounted to 88% and 84% of total interest bearing assets and liabilities respectively. For the banking sector as a whole, the relevant positions by comparison were more significant (at 94% and 93% respectively). This is due to the fact that foreign bank branches had significantly higher positions in Japanese Yen than locally incorporated banks.
- However, taking the positions in HK dollars and US dollars together, the impact of interest rate changes would not affect significantly the earnings of most institutions. Of the 380 reporting institutions, the majority (84%), including the 31 locally incorporated banks, had an exposure which amounted to less than 10% of their annual income (Table 2)⁽²⁾.
- The interest rate risk of locally incorporated banks is generally small in relation to income: in most cases not more than 5% in respect of the combined HK dollar and US dollar position (see Table 2)⁽²⁾. All but one of the local banks are positioned to benefit in terms of net interest from a rise in interest rates. (This is consistent with the increased margins enjoyed by banks in 1995.)

(2) Based on a 1% change in interest rate.

- A number of branches of foreign banks are much more heavily exposed to interest rate risk in terms of its impact on earnings. However, some of the exposures in Table 2 are exaggerated by the low income base in Hong Kong of some institutions. Moreover, for branches the interest rate risk also needs to be looked at in the context of the bank as a whole, where the Hong Kong positions may be much less significant.
- Most institutions' assets and liabilities repriced within a very short horizon. For the sector as a whole, 75-80% of the sector's interest bearing assets and interest bearing liabilities reprice within 3 months (Annex 1). The positions of local banks were even more concentrated at the short end, with 93% of interest bearing liabilities and 86% of interest bearing assets repricing within 3 months (Annex 2). (Note that the total size of assets in dollar terms is higher than that of liabilities. When off-balance sheet positions are also included, all but one of the local banks show a positive gap as indicated in Table 2.)

The way forward

Introduction of the Return of Interest Rate Risk Exposures represents an important first step for the HKMA to collect industry data and to evaluate the level of interest rate risk exposure of authorised institutions. The second step will be to analyse authorised institutions' reported interest rate risk exposures in detail and to enhance our understanding of authorised institutions' policies and practices in measuring, limiting and controlling interest rate risks. The HKMA will then consider the issuance of a guideline on the management of interest rate risk in the light of such information and best market practices. The HKMA will also closely monitor the regulatory developments in the Basle Committee and other supervisory authorities on this issue. ☺

— Prepared by the Banking Policy Division

Reference: Basle Committee, Consultative Proposal on "Measurement of Banks' Exposures to Interest Rate Risk", April 1993.

Table 1:
Impact on earnings by currencies

Currency	Rising interest rate				Falling interest rate			
	All authorised institutions		Local banks		All authorised institutions		Local banks	
	No. of Affected institutions	Amount suffered (HK\$m)	No. of affected institutions	Amount suffered (HK\$m)	No. of affected institutions	Amount suffered (HK\$m)	No. of affected institutions	Amount suffered (HK\$m)
AUD	30	75	8	26	5	5	-	-
CAD	24	173	8	119	3	3	1	1
CHF	10	32	-	-	1	2	-	-
DEM	32	223	3	74	11	17	-	-
ECU	3	22	-	-	5	12	-	-
FRF	8	45	1	17	3	4	-	-
GBP	20	160	4	75	7	17	-	-
HKD	88	831	2	197	115	1,444	29	869
ITL	3	7	-	-	2	18	-	-
JPY	35	607	4	45	36	678	-	-
MYR	2	10	1	8	3	7	-	-
NZD	8	54	3	45	4	6	-	-
THB	5	15	1	5	2	5	-	-
USD	97	1,450	9	84	149	1,338	14	309

Note: Currencies with less than HK\$10mn impact for both rising and falling interest rates are not shown.

Table 2:
Impact on earnings as % of annual income – positions of HKD+USD combined⁽¹⁾

	All authorised institutions	Local banks
Total no. of institutions	380	31
No. with zero impact ⁽²⁾	86	0
No. with positive ratio ⁽³⁾	184	30
No. with negative ratio ⁽⁴⁾	110	1
Maximum positive ratio	71.94%	8.85%
Maximum negative ratio	74.20%	1.73%
No. of institutions the respective ratios of which are within the range specified:		
0% to +/- 1%	108	3
0% to +/- 3%	192	14
0% to +/- 5%	260	29
0% to +/- 10%	328	31
0% to +/- 20%	358	31
0% to +/- 30%	365	31
0% to +/- 50%	370	31
0% to +/- 100%	380	31

Note: (1) Based on an assumed 1% change in interest rates.

(2) These institutions would not be affected by interest rate changes.

(3) These institutions would be adversely affected by falling interest rates.

(4) These institutions would be adversely affected by rising interest rates.

Annex I

Repricing gaps of all authorised institutions

		Up to 1 month	More than 1M up to 3M	More than 3M up to 6M	More than 6M up to 9M	More than 9M up to 1 Yr	More than 1 year
		(HK\$mnn)	(HK\$mnn)	(HK\$mnn)	(HK\$mnn)	(HK\$mnn)	(HK\$mnn)
JPY	(i)	-6,160	-5,699	7,042	12,758	8,960	13,058
	(ii)	11,802	1,059	9,112	-26,050	-4,590	-5,120
	(iii)	5,642	-4,640	16,154	-13,292	4,370	7,938
	(iv)	37.29%	62.29%	80.76%	85.00%	87.59%	12.41%
	(v)	37.96%	63.47%	81.88%	85.68%	87.95%	12.05%
USD	(i)	-84,675	53,863	142,599	7,396	8,567	21,458
	(ii)	-87,013	-9,472	4,815	49,333	23,481	-5,097
	(iii)	-171,688	44,391	147,414	56,729	32,048	16,361
	(iv)	49.11%	75.83%	92.67%	94.65%	96.00%	4.00%
	(v)	55.52%	81.67%	93.75%	95.55%	96.63%	3.37%
HKD	(i)	49,401	53,739	-3,888	1,090	-2,224	60,684
	(ii)	-30,907	-6,096	6,587	3,351	8,865	6,725
	(iii)	18,494	47,643	2,699	4,441	6,641	67,409
	(iv)	70.05%	90.35%	93.86%	94.62%	95.16%	4.84%
	(v)	73.42%	92.55%	96.57%	97.34%	98.05%	1.95%
CAD	(i)	-42,684	-2,722	16,361	3,285	7,774	1,716
	(ii)	9,234	6,166	-468	-582	1,812	1,522
	(iii)	-33,450	3,444	15,893	2,703	9,586	3,238
	(iv)	45.63%	59.93%	83.46%	88.01%	97.84%	2.16%
	(v)	81.88%	96.58%	99.36%	99.77%	99.97%	0.03%
AUD	(i)	-14,716	4,887	1,172	-90	1,201	968
	(ii)	-3,483	2,003	2,273	6,594	-186	-142
	(iii)	-18,199	6,890	3,445	6,504	1,015	826
	(iv)	69.97%	88.91%	94.40%	94.72%	96.84%	3.16%
	(v)	82.46%	93.82%	97.42%	97.83%	98.30%	1.70%
GBP	(i)	-43,162	955	2,461	1,070	2,372	8,058
	(ii)	15,078	4,841	11,154	-4,736	4,100	-2,189
	(iii)	-28,084	5,796	13,615	-3,666	6,472	5,869
	(iv)	45.79%	72.22%	81.36%	83.97%	87.75%	12.25%
	(v)	75.93%	93.96%	98.07%	98.88%	99.24%	0.76%
DEM	(i)	-35,591	1,241	-3,054	590	2,911	4,362
	(ii)	5,790	4,520	10,100	-8,568	15,372	12,430
	(iii)	-29,801	5,761	7,046	-7,978	18,283	16,792
	(iv)	44.33%	74.24%	84.87%	87.61%	92.71%	7.29%
	(v)	68.57%	87.62%	98.16%	99.39%	99.73%	0.27%
OTHERS	(i)	-26,361	2,312	6,959	1,182	3,130	9,564
	(ii)	-4,696	5,600	6,591	-13	2,680	-7,082
	(iii)	-31,057	7,912	13,550	1,169	5,810	2,482
	(iv)	41.24%	61.01%	76.21%	82.63%	89.99%	10.01%
	(v)	59.66%	77.26%	86.98%	92.38%	97.26%	2.74%
TOTAL	(i)	-203,948	108,576	169,652	27,281	32,691	119,868
	(ii)	-84,195	8,621	50,164	19,329	51,534	1,047
	(iii)	-288,143	117,197	219,816	46,610	84,225	120,915
	(iv)	50.49%	74.64%	88.37%	90.91%	92.73%	7.27%
	(v)	54.99%	78.50%	90.40%	92.66%	94.10%	5.90%

(i) Net on-balance-sheet items.

(ii) Net off-balance-sheet items.

(iii) Net repricing gaps.

(iv) Percentage of interest bearing assets that could be repriced within the upper bound of a time band. Measurements within one year are on a cumulative basis.

(v) Percentage of interest bearing liabilities that could be repriced within the upper bound of a time band. Measurements within one year are on a cumulative basis.

Annex 2

Repricing gaps of locally incorporated banks

		Up to 1 month	More than 1M up to 3M	More than 3M up to 6M	More than 6M up to 9M	More than 9M up to 1 Yr	More than 1 year
		(HK\$m)	(HK\$m)	(HK\$m)	(HK\$m)	(HK\$m)	(HK\$m)
JPY	(i)	-3,602	4,950	3,232	312	95	-1,342
	(ii)	-2,941	-3,062	-2,823	1,902	-6,560	4,840
	(iii)	-6,543	1,888	409	2,214	-6,465	3,498
	(iv)	40.52%	74.14%	93.26%	94.88%	95.34%	4.66%
	(v)	68.23%	81.54%	86.81%	87.05%	87.09%	12.91%
USD	(i)	-16,846	48,259	36,317	466	-4,562	9,436
	(ii)	-27,898	9,415	-10,484	8,682	-11,061	2,379
	(iii)	-44,744	57,674	25,833	9,148	-15,623	11,815
	(iv)	59.84%	83.57%	95.24%	96.90%	97.56%	2.44%
	(v)	74.87%	90.93%	95.70%	97.55%	99.46%	0.54%
HKD	(i)	1,308	77,972	-9,676	1,193	-875	24,844
	(ii)	-316	4,858	4,977	-707	3,965	4,756
	(iii)	992	82,830	-4,699	486	3,090	29,600
	(iv)	71.18%	92.61%	95.28%	96.02%	96.40%	3.60%
	(v)	79.80%	93.71%	97.97%	98.66%	99.19%	0.81%
CAD	(i)	-33,288	-2,059	14,036	3,217	6,374	1,383
	(ii)	8,872	2,943	458	-1,229	226	-151
	(iii)	-24,416	884	14,494	1,988	6,600	1,232
	(iv)	37.08%	49.72%	78.52%	85.00%	97.38%	2.62%
	(v)	83.79%	97.62%	99.44%	99.76%	100.00%	0.00%
AUD	(i)	-8,924	951	317	-47	646	397
	(ii)	1,880	1,717	-24	4,123	-113	1,508
	(iii)	-7,044	2,668	293	4,076	533	1,905
	(iv)	79.83%	93.93%	96.80%	97.05%	98.96%	1.04%
	(v)	87.89%	97.76%	99.50%	99.81%	100.00%	0.00%
GBP	(i)	-20,824	4,221	2,045	1,240	919	7,274
	(ii)	4,028	-787	9,163	-5,014	1,380	-1,502
	(iii)	-16,796	3,434	11,208	-3,774	2,299	5,772
	(iv)	24.94%	53.02%	64.06%	68.81%	72.54%	27.46%
	(v)	82.65%	94.02%	97.35%	97.72%	98.17%	1.83%
DEM	(i)	-5,918	303	307	23	1,351	2,316
	(ii)	-553	-1,873	-440	-712	3,386	-1,384
	(iii)	-6,471	-1,570	-133	-689	4,737	932
	(iv)	22.98%	42.33%	49.42%	49.93%	68.58%	31.42%
	(v)	84.68%	97.17%	99.58%	99.73%	100.00%	0.00%
OTHERS	(i)	-10,252	2,638	3,471	-623	762	6,600
	(ii)	-4,302	3,632	-3,539	3,515	-158	-1,821
	(iii)	-14,554	6,270	-68	2,892	604	4,779
	(iv)	50.59%	71.11%	82.71%	85.95%	88.24%	11.76%
	(v)	71.10%	87.89%	93.86%	98.36%	99.40%	0.60%
TOTAL	(i)	-98,346	137,235	50,049	5,781	4,710	50,908
	(ii)	-21,230	16,843	-2,712	10,560	-8,935	8,625
	(iii)	-119,576	154,078	47,337	16,341	-4,225	59,533
	(iv)	64.43%	86.34%	93.42%	94.82%	95.95%	4.05%
	(v)	78.41%	92.85%	97.11%	98.24%	99.16%	0.84%

(i) Net on-balance-sheet items.

(ii) Net off-balance-sheet items.

(iii) Net repricing gaps.

(iv) Percentage of interest bearing assets that could be repriced within the upper bound of a time band. Measurements within one year are on a cumulative basis.

(v) Percentage of interest bearing liabilities that could be repriced within the upper bound of a time band. Measurements within one year are on a cumulative basis.