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FSAP Stress Testing: Singapore's Experience

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FSAP STRESS TESTING: SINGAPORE'S EXPERIENCE

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*** THE VIEWS IN THIS PAPER ARE SOLELY THOSE OF THE AUTHORS AND SHOULD NOT BE ATTRIBUTED TO THE MONETARY AUTHORITY OF SINGAPORE. THE AUTHORS THANK THE IMF FSAP MISSION TEAM (SHOGO ISHII, PAUL KUPIEC, MARK O'BRIEN, ABDEL SENHADJI, BYUNG KYOON JANG, BURKHARD DREES AND ROBERTO GUIMARAES) FOR ITS CONTRIBUTIONS TO THIS PROJECT. WE WOULD ALSO LIKE TO THANK THE PARTICIPATING BANKS FOR THE TIME AND EFFORT DEVOTED TO THE EXTENSIVE STRESS TEST EXERCISE. SPECIAL THANKS GO TO CHAN CHEE HOE (SPECIALIST RISK SUPERVISION DEPARTMENT) AND OTHER MAS COLLEAGUES FROM THE COMPLEX INSTITUTIONS SUPERVISION, BANKING SUPERVISION AND MACROECONOMICS SURVEILLANCE DEPARTMENTS FOR BOTH THEIR COMMENTS AND ASSISTANCE DURING THE FSAP BANKING STRESS TEST PROCESS. WE ARE GRATEFUL TO PAUL KUPIEC AND SHOGO ISHII FOR COMMENTS PROVIDED ON AN EARLIER DRAFT OF THIS PAPER.**

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ABSTRACT

Singapore participated in the IMF-World Bank Financial Sector Assessment Program (FSAP) in 2002-2004. As part of the FSAP, the MAS coordinated an industry-level stress test involving systemically important banks and insurance companies. The purpose of this paper is to share the many processes needed to execute a broad-based stress test involving institutions with dissimilar risk management practices, with a focus on credit risk stress test for the banking industry. Banks typically use a bottom-up, loan-by-loan approach for stress testing their corporate loans, where model estimates are supplemented by judgment and experiences of bank credit officers. A top-down, portfolio approach is preferred for stress testing consumer loans, given that these loans are usually large in number but small in quantum. On the whole, the FSAP stress test process required intensive coordination and substantial input of resources by both the participating institutions and the MAS. Experience gained from the exercise would be incorporated to improve the MAS' regular stress testing of the financial sector.

TABLE OF CONTENTS

ABSTRACT i

TABLE OF CONTENTS ii

1. INTRODUCTION 1

2. MAS' APPROACH ON STRESS TESTING 3

3. SELECTION CRITERIA FOR PARTICIPATING BANKS 5

4. TEST SCENARIOS 9

5. IMPLEMENTATION PROCESS 13

6. COVERAGE 15

7. METHODOLOGY USED BY THE BANKS 16

8. RESULTS 20

9. CONCLUSION 22

APPENDIX 1 23

1. INTRODUCTION

1.1 As part of its assessment of the stability of the financial sector, the Monetary Authority of Singapore (MAS) regularly conducts coordinated stress tests among systemically important institutions in Singapore's banking and insurance industries. In conjunction with Singapore's participation in the IMF-World Bank Financial Sector Assessment Program (FSAP) in 2002-2004, the MAS conducted a stress test exercise that was more intensive and in-depth than its regular stress tests. The FSAP stress test required intensive coordination and substantial input of time and resources by both the participating institutions and the MAS. In general, the participating institutions found the exercise useful for strengthening internal stress test processes.

1.2 Singapore's financial system has remained robust despite several adverse shocks in recent years, including the terrorist attacks on September 11, 2001 and in Bali, and the outbreak of the SARS (Severe Acute Respiratory Syndrome) disease. While Singapore's financial sector has proven to be resilient to these adverse events, the risks from new potential stresses cannot be ignored. Against the background of volatile domestic and global economic conditions, the MAS has developed stress testing procedures for assessing the financial system's ability to withstand additional shocks. Stress testing of systemically important institutions provides the MAS with a tool that is complementary to the supervisory tools often used to assess the systemic risks faced by the financial sector.

1.3 This paper is, in part, the result of an informal collaboration between the Monetary and Financial Systems Department of the International Monetary Fund (IMF) and the MAS.[1] The purpose of the paper is to share the many processes needed to execute a broad-based stress test involving institutions with dissimilar risk management practices. While Singapore's FSAP stress test included market risk components, the focus of the paper is on credit risk stress testing given the predominance of credit risk in the overall risk profile of the financial sector. Moreover, the methodologies for market risk stress testing are well established. While the FSAP stress test included both banks and insurance companies, this paper will only cover the former, given that banking is the largest industry in the financial sector.

[1] Paul Kupiec led the IMF work on stress testing in the Singapore FSAP and was generous in sharing his knowledge and experiences related to FSAP stress testing in other countries.

1.4 The structure of the paper follows the chronology of the stress test process. Section 2 outlines MAS' approach on stress testing while Section 3 looks at the criteria used for selecting banks to be included in the stress test. Sections 4 to 7 discuss the scenarios, implementation process, coverage and stress test methodologies. Sections 8 and 9 summarise the results of the stress test and main conclusions respectively.

2. MAS' APPROACH ON STRESS TESTING

2.1 While stress test methodologies in the context of an FSAP can take many forms, both the FSAP assessors and the MAS agreed that financial institutions, rather than the regulator, would produce the stress test estimates. This is also MAS' approach on stress testing and arises from several reasons. First, this approach uses the banks' existing and well-tested credit risk models and methodologies on loan classification. The banks are also more inclined to believe and use results that are generated internally. Second, the assessment by the banks can incorporate detailed customer information, especially qualitative factors, that are known to the banks' credit officers. The experience of these credit officers is a valuable input in making a comprehensive assessment. Third, the approach increases the involvement of the banks. The approach focuses the attention of banks' senior management on the estimates generated for their own banks, in particular on areas where the estimates show closer bank scrutiny may be required.

2.2 There are, however, several drawbacks in this approach. When individual banks conduct the stress test, differences are introduced since no two banks employ the exact same measurement approach even if their methodologies are broadly similar. Even within the same bank, there may not be full consistency due to the prevalent use of credit officers' subjective judgment to supplement quantitative measures. These complications make the stress testing process resource-intensive as the MAS has to coordinate and manage several aspects of the stress test process in order to maximise consistency across banks.

2.3 The MAS believes in using both single- and multi-factor stress tests, depending on the focus of the stress test. Multi-factor or broad-based scenarios, involving a wide range of economic shocks, are useful for assessing financial sector resilience as they incorporate inter-relationships between economic variables, which may raise important stability issues, particularly during a crisis. The benefits, however, need to be balanced against the additional burden placed on the banks from having to incorporate fully-specified scenarios into their stress test process. Fully-specified scenarios may not be readily compatible with banks' measurement systems, and human intervention and judgment are often required to produce stress test estimates. Single-factor stress tests are still used by the MAS for

targeting a specific risk criterion and have the advantage of faster computation.

3. SELECTION CRITERIA FOR PARTICIPATING BANKS

3.1 In 2002/2003, when the FSAP stress test was conducted, Singapore's banking sector comprised three locally-incorporated banking groups (Development Bank of Singapore, United Overseas Bank and Overseas-Chinese Banking Corporation), and a host of foreign banks all established in the form of branches.[2] Foreign bank branches operate in Singapore with varying level of privileges. As part of the banking liberalisation that started in 1999, six foreign bank branches were awarded Qualifying Full Bank (QFB) privileges, which allow them to have full access to the retail market subject to a maximum of 25 service locations.[3] Table 1 shows the shares of the local and foreign banks in the domestic banking sector, while Chart 1 provides a broad overview of the sector's balance sheet.

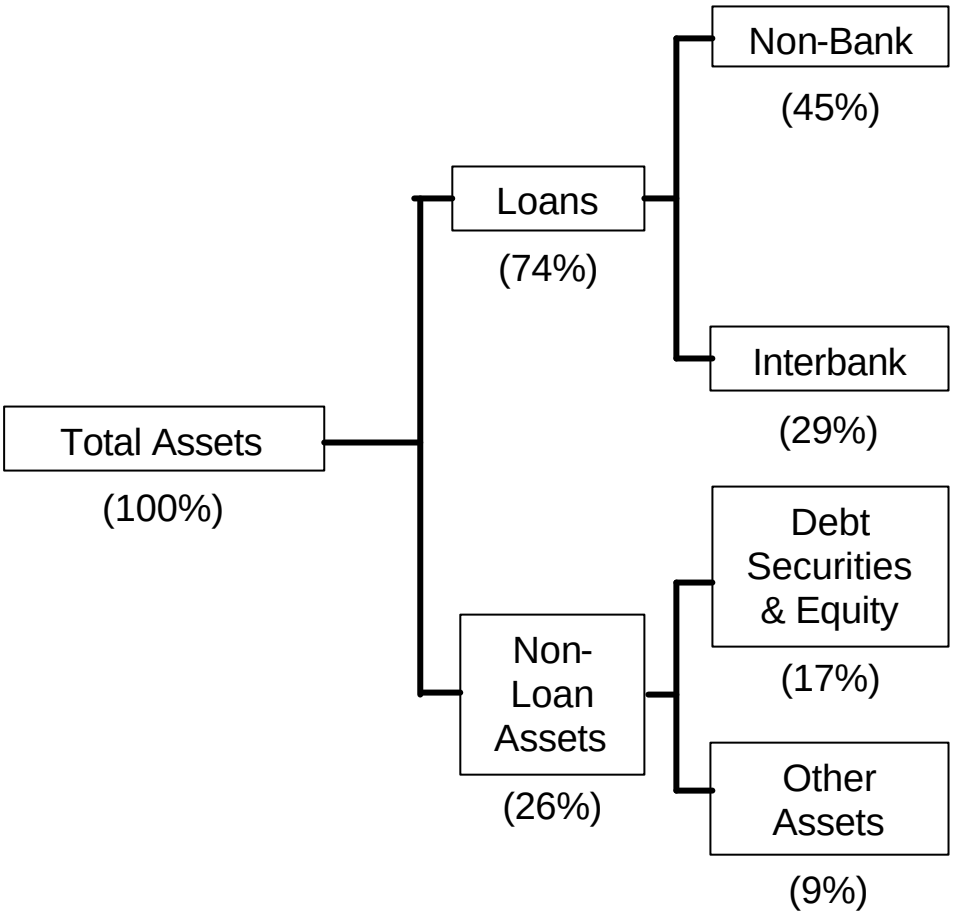
Table 1: Composition of the Domestic Banking Sector (March 2004)

	No. of Banks	Assets (S$Mn)	Deposit (S$Mn)
Local Banking Groups	3	217,153	138,589
QFBs	6	78,553	42,695
Other Foreign Banks	104	90,936	20,246
All Commercial Banks	**113**	**386,642**	**201,530**

[2] More recently, Citibank established a bank subsidiary in Singapore, while retaining its existing branch operations.

[3] See address by Chairman of MAS at the Association of Banks in Singapore's 31st Annual Dinner on 17 June 2004, which can be accessed at www.mas.gov.sg.

Chart 1: Balance Sheet Structure of the Domestic Banking Sector (March 2004)



3.2 While the FSAP in other countries often excluded foreign bank branches, Singapore's FSAP included three foreign bank branches that the MAS identified as systemically important in the stress test exercise.[4] Their inclusion underscores MAS' responsibility as host supervisor, to monitor the foreign bank branches for potential problems that may affect their head offices.

3.3 The inclusion of foreign bank branches provides the MAS with a wider range of outcome and experiences and deeper insights into the

[4] FSAP in other countries excluded branches in part because there were no branch-specific capital against which losses could be compared. Moreover, in many FSAPs, foreign branch activities were not large relative to the activity of the overall banking sector. In Singapore, foreign branches represent a substantial share of the activity of the overall banking sector.

methodologies of credit risk stress test used by international banks. This ultimately helps in promoting best practices in the use of stress testing as a risk management tool in the banking industry, as well as feeding into the design of MAS' own financial surveillance.

3.4 The assessment of systemic significance of a bank draws on the framework that the MAS uses to group banks into different supervisory categories, denoting different levels of supervisory concerns and risks. The framework encompasses the evaluation of key quantitative and qualitative elements of the financial and operating conditions of a bank, and the assessment of the potential systemic impact on Singapore should the bank run into serious problems. The three main measures that determine systemic importance are:

Size of Non-Bank Deposits

3.5 A run on a bank with large non-bank deposits can have a contagion effect on other banks with sizeable retail deposits if it triggers a general loss of confidence in the banking system.

Size of Domestic Inter-Bank Borrowing

3.6 Liquidity problems at a bank that funds its operations substantially from the inter-bank market can have serious repercussions on other banks. Some studies have found that the spill over effects of inter-bank failures can be large.[5]

Importance in the Domestic Payment System

3.7 A settlement failure of a bank with a large payment volume can trigger a gridlock problem and could threaten the stability of Singapore's payment system. The systemic importance of payment systems was demonstrated by the action of the Federal Reserve Bank of New York

[5] See, for example, G. Sheldon and M. Maurer (1998): "Interbank Lending and Systemic Risk: An Empirical Analysis for Switzerland", Swiss Journal of Economics and Statistics, Vol. 134 (4.2), pages 685-704; C. Upper and A. Worms (2002): "Estimating Bilateral Exposures in the German Interbank Market: Is there a Danger of Contagion?", Deutsche Bundesbank Discussion Paper 09/02.

following the September 11 disaster, where a large amount of liquidity support was said to have been injected overnight to enable the settlement of government securities.

3.8 The three foreign banks included in the stress test hold significant market shares in Singapore's non-bank deposits, inter-bank borrowings and payment volume. This is to be expected as these three banks are among the few that engage in a full range of activities in retail and wholesale banking, and treasury markets, similar to those conducted by the local banks.

4. TEST SCENARIOS

4.1 An important element of any stress test is the scenario. Since it is common for both credit and market risks to be affected in the event of a stress situation given the linkages between them, the same scenarios were applied to both the credit and market risk stress testing.

4.2 The first question in the formulation of any scenario is the type of plausible stress events that may cause a significant impact on Singapore. At the discussion in November 2002, the FSAP assessors and the MAS agreed that it would be appropriate to test two scenarios: the first scenario involved a general weakness in the global economy, in particular the electronics sector, which was an important driver of the Singapore economy; the second scenario assumed pressures from global economic weakness compounded by terrorism in the region.

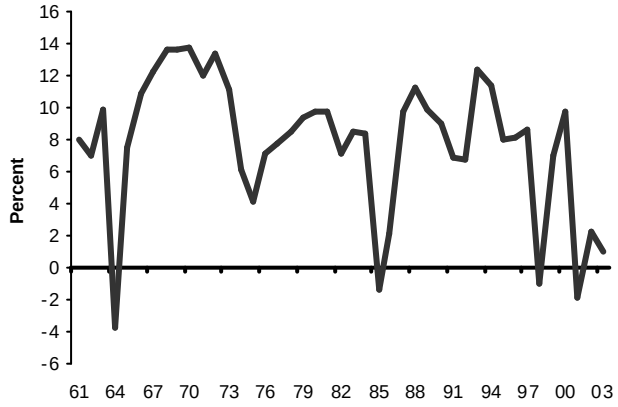
4.3 The stress test scenarios were developed against a backdrop of an economic recovery following the 2001 recession. Singapore grew by 3.7% year-on-year in Q2 2002 after contracting for the preceding four consecutive quarters. At the time of the discussion on the scenarios, however, there were some signs of a possible slowdown re-emerging in the US, one of Singapore's largest export markets, in part due to excess capacity in the high-tech sector. Economic growth in Japan and Europe had remained sluggish. In addition, depressed stock markets had weakened the capital positions of some financial institutions in other countries. Terrorism was a growing risk - as evidenced by the September 11, 2001 attack and the October 2002 bombing in Bali. The threat of a SARS (Severe Acute Respiratory Syndrome) pandemic was not evident at that time.

4.4 To identify shocks sufficiently severe for the purpose of stress testing, the baseline forecast for the year ahead was made based on the World Economic Outlook baseline projections prepared by the IMF for its member countries and the MAS' own forecast for the Singapore economy. To determine the magnitude of the shocks, the historical data of each of the economic variables were analysed to ascertain the worst shock the economy had ever experienced, in terms of both magnitude and volatility, since the year for which data were available.

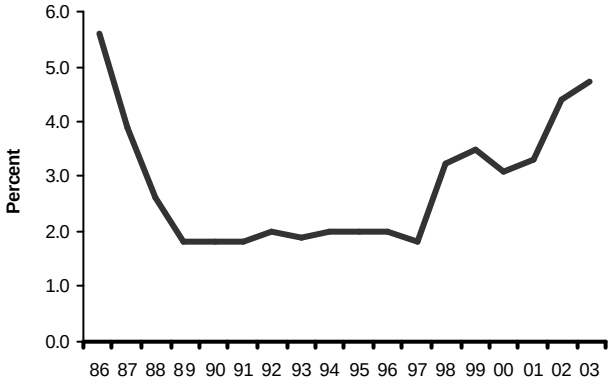
4.5 Since 1960, when the first GDP data was available, Singapore has experienced four recessions. In 1964, Singapore went into its deepest recession where real GDP contracted by 3.8%. The mid-1980s saw a milder slowdown with a 1.4% decline in real GDP. The Asian Financial Crisis led to a 0.9% contraction in real GDP in 1998, with the unemployment rate reaching a high of 4.6% by the fourth quarter and property prices posting double-digit contractions throughout the year. Real GDP contracted by 1.9% in 2001 as a result of the global electronics slowdown. Compared to 1997, when the Asian Financial Crisis hit, the fall in property prices in 2001 was less severe although the unemployment rate was marginally higher (see Charts 2a-c).

Charts 2: Key Economic Variables (Annual)

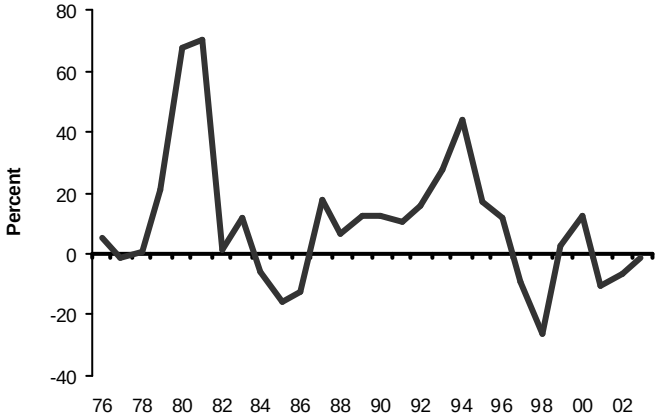
a) GDP Growth



b) Unemployment Rate



c) Changes in Property Prices (Residential)



4.6 At the time of the discussion on the scenarios in November 2002, the official baseline forecast for Singapore's real GDP growth in 2003 ranged 2-5%. The MAS Survey of Professional Forecasters (i.e. private sector forecasters based in Singapore) had an average forecast of 3.9% for GDP growth in 2003. Given that Singapore's GDP growth had been quite volatile historically, however, it was not inconceivable for growth to fall to 0% (as assumed in Scenario 1) or turn negative (as assumed in Scenario 2). See Appendix 1 for details on the scenarios used in the FSAP stress testing.

4.7 To facilitate the banks' implementation of the stress tests, the MAS provided a detailed list of variables and a qualitative description of the economic conditions for the two scenarios. Preliminary discussions with the participating banks had revealed that different banks focused on different variables in implementing their stress testing procedures, so a comprehensive set of economic variables that was internally consistent was provided in order to maximise consistency across the banks.

4.8 The comprehensive set of variables included variables that measure economic conditions in other countries, in order to capture the vulnerability of Singapore to external shocks engendered by trade and financial links. The importance of the trade link was also reflected in the inclusion of the exchange rate, around which Singapore's monetary policy is centered. The financial link with external economies was not only due to the exposure of the Singapore banking system to overseas counterparties but also the exposure of the local banks' subsidiaries and branches located outside Singapore. Performance measures of the various economic sectors in Singapore were included since banks have varying exposures to each sector and the sectors perform differently under the two scenarios. Property prices were included given the concentration of non-bank loans in the property sector and the wide use of property as loan collateral.

4.9 In Scenario 1, the global economy weakens, in particular the electronics industry, leading to a contraction in Singapore's manufacturing sector. The global economic weakness causes stock markets around the world to fall. Singapore's stock market is not spared. The overall deterioration in the economy raises the unemployment rate. Residential property prices drop. The weakness in the manufacturing sector reduces the prices of industrial properties, while the prices of commercial properties suffer from the

general decline in the economy. In the weak economic environment, short-term interest rates fall. No growth is seen in real GDP for the year.

4.10 In Scenario 2, terrorism was included as an additional stress factor specific to Singapore and the region. Under the scenario, Singapore and the regional countries experience negative real GDP growth. All industries in Singapore are more adversely affected than in Scenario 1, in particular, the commerce and financial & business services industries. Stock market and property prices fall further, while unemployment rate rises even higher than in Scenario 1. Interest rates spike up, reflecting a rise in risk premium.

4.11 Ironically, Singapore's economic developments in H1 2003 turned out to be similar to the hypothesised Scenario 1, albeit due to slightly different causes, with GDP growth for 2003 as a whole at 1.1%. However, the impact on the banks' financial position was much milder than the stress test estimates, reflecting the conservative approach taken by the banks in estimating the stress test impact.

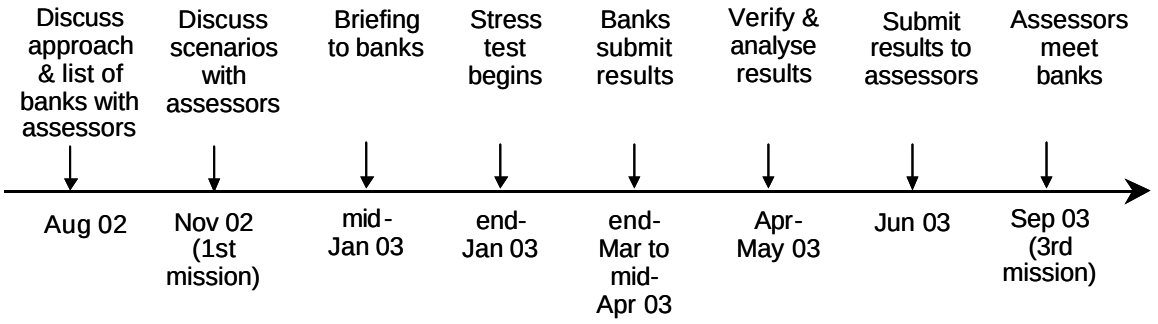
5. IMPLEMENTATION PROCESS

5.1 After the scenarios had been finalised, the MAS sent to the participating banks the scenarios, detailing requirements for implementing the stress test, and a template for the results. The implementation details served as an important guide for ensuring consistency across the banks, which have differing risk measurement methodologies. The results template was designed so as to collect, in a standardised format, all the information required by the MAS for analysing the stress test results and incorporated the requirements of the FSAP assessors. A briefing was also held to explain the materials sent out and to clarify any doubt on the part of the banks. MAS worked closely with the banks on their enquiries and questions throughout the exercise.

5.2 On receiving the banks' stress test results, the MAS checked that each of the stress test requirements set out earlier was adhered to. This was to ensure the FSAP requirements were met and also to facilitate a meaningful comparison of the results across the banks. Where there were deviations from the FSAP requirements, the banks would be asked to re-run the stress test for the relevant areas. In addition, the MAS met up with the banks to get their interpretation of the results, to supplement the MAS' own analysis of the stress test impact. The FSAP assessors visited participating banks to review the assumptions and methodologies used to arrive at the stress test estimates.

5.3 The participating banks took between 2 to 2.5 months to produce stress test estimates. The MAS took about 2 months to complete the verification and analysis of the stress test results, including those for the market risk stress test. Three MAS staff worked intensively on the project, with occasional help from other staff during the period. The relatively long process was in part due to the fact that this was the first time the 3 chosen foreign banks participated in a stress test coordinated by the MAS, with teething issues to be worked out. Moreover, the approach used for estimating much of the banks' loan exposure was bottom-up in nature, as the banks attempted to incorporate credit officers' detailed knowledge of individual borrowers. In addition, the stress test started at a time when the banks were busy with their year-end reporting requirement. The timeline below summarises the stress test process, including that for market risk stress test, which spanned over a year.

Chart 3: Timeline of FSAP Stress Test Process



6. COVERAGE

6.1 Given the local banks' increasing focus overseas and the MAS' consolidated supervision, it was decided that the local banks' major banking subsidiaries located outside Singapore should be included in the assessment, in addition to the Singapore Head Office and subsidiaries. Some of the foreign subsidiaries account for a substantial share of the overall locally-incorporated banking groups. Moreover, the subsidiaries are located in the region that was affected by the Asian Financial Crisis in 1997-98. Conversely for the participating foreign banks, only transactions that were booked and managed in the Singapore branch were included in the stress test exercise.

6.2 The stress test covered all participating banks' positions in the banking book, including credit items such as loans, bills, debt instrument, guarantees, contingent lines with no recourse and credit derivatives. The stress test also required the impact on loan collateral to be assessed. The banks' positions as at 31 Dec 2002 were used for the stress test, with the stress horizon set at 1 year. The banks were to assume no loan growth and no further drawn-down of existing credit lines over the stress horizon. In addition, where loan write-offs were assumed, the banks were asked to add these back to their classified loan numbers. It was also assumed that there would be no resolution of classified loans within the 1-year period.

7. METHODOLOGY USED BY THE BANKS

Corporate Loans

7.1 In general, banks employed a bottom-up approach in stress testing their corporate loan portfolios. This involved the mapping of the economic variables in the test scenarios to the financials of each of the banks' corporate borrowers. This method is a bottom-up approach in the sense that the overall impact on the bank was an aggregation of the estimates provided by each individual bank credit officer for his portfolio of customers.

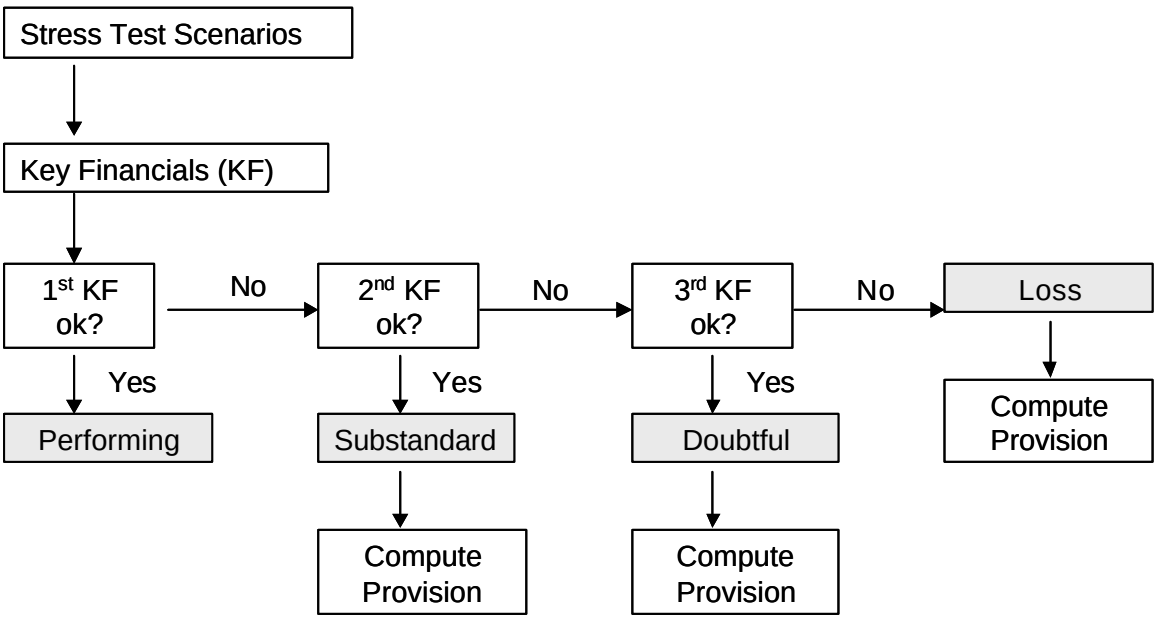
7.2 For some variables such as the interest rate, the mapping was a direct one i.e. a change in the interest rate translated directly to a change in the interest cost of the customers. Notably, interest rates at end-2002 (the base period for the stress test) were already very low, with short-term rates at less than 1%. Hence, under Scenario 1 where interest rates were assumed to fall, the prevailing rates were maintained in cases where these were less than the size of the shocks prescribed, in order to avoid a situation with negative interest rates. For other variables, the banks had to determine the most appropriate financials the variables should be mapped to. For example, a change in the growth of the manufacturing sector was mapped to a change in the revenue or cash flow of the banks' customers who were financially exposed to manufacturers. The mapping usually involved some form of statistically-estimate relationship and additional qualitative assessment by bank credit officers based on their experiences and knowledge of the customers. The effect of a change in the exchange rate on the credit profile of the customers, for example in the case of a customer whose revenue was not in Singapore dollars, was also incorporated. In addition, foreign currency-denominated loans were converted into Singapore dollar using the assumed exchange rate for the stress scenario.

7.3 Changes in customers' cash flows and interest costs were used to compute a Debt Servicing ratio. In the case of secured lending, another common ratio was the Loan-to-Value (LTV) ratio, which was computed based on changes in the values of properties or stocks put up as collateral. Internally, the banks use the national property price indices compiled by the Urban Redevelopment Authority (URA) for quarterly revaluation, with more precise revaluation by professional valuers on an annual basis. The two

ratios on Debt Servicing and Loan-to-Value could be supplemented by other financials that the banks had found to be useful indicators in the past. The financials were then used to determine which performing loans would turn classified or which classified loans would migrate to another category of classified loans e.g. a loan in the "Doubtful" category migrating to the "Loss" category. It is to be noted that Singapore's definition of a classified loan is more encompassing than the international definition of non-performing loans (NPL) in that the former also capture loans, including collateralised loans, which are current in repayment but where the bank may qualitatively consider the borrower to have some credit weaknesses.

7.4 Changes in property and equity prices were also used to estimate the amount of additional specific provisions the banks needed to make as a result of the drop in the value of loan collateral. Some banks were more conservative in the treatment of collateral by applying an additional "haircut" on top of the changes in property and equity prices given in the test scenarios. Chart 4 provides a simple illustration of the stress testing approach used by the banks for corporate accounts.

Chart 4: Illustration of Stress Test Methodology for Corporate Accounts



Consumer Loans

7.5 Unlike the case of corporate loans where the assessment was predominantly done on a bottom-up, loan-by-loan basis, consumer loans were assessed using a top-down, portfolio approach. This was due to the fact that consumer loans are usually larger in number but smaller in quantum as compared to corporate loans. While there is undoubtedly some degree of heterogeneity among consumers, well-designed portfolios would adequately capture the effects of stress scenarios on banks' retail borrowers. To this end, consumer portfolios are usually streamlined by product type, reflecting the different credit risk profile of different products.

7.6 The banks have empirically found the unemployment rate to be a useful determinant of the flow rate of consumer credits through various "aging buckets" that measure the delinquency rate structure of consumer loans. An "aging bucket" contains all accounts that are of a similar number of days past due. For example, the banks would stress the flow rate from the bucket with accounts that are 31-60 days past due to the bucket in which accounts are 61-90 days past due. Under stressed situations, higher flow rates are expected as more borrowers defer or default on payment.

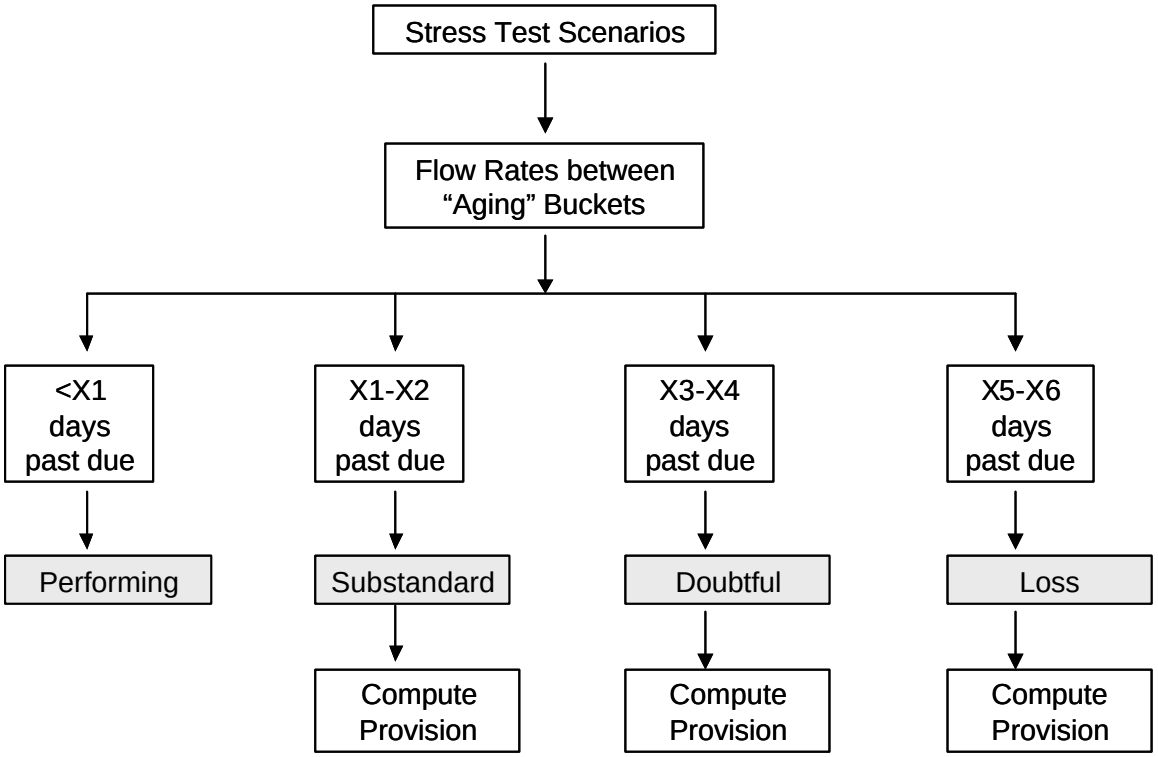
7.7 For secured-lending such as mortgage loans, the LTV ratio was also used by some banks as an additional factor to determine loan delinquency. This followed from the fact that the ability of consumers to service debt is harder to compute in the case of Singapore, given the prevalent use of accumulated Central Provident Fund (CPF)[6] contributions to stay current on loan repayment even if the customer becomes unemployed and other forms of income have ceased. The original LTV ratio together with the loan vintage and time series of changes in the prices of residential properties were collectively used to determine the performance of mortgage loans. Thus, mortgage loans with borderline LTV ratios[7] that were extended for residential properties purchased in 1996, when prices of residential properties were at a peak, faced a high likelihood of turning into classified

[6] The CPF is a government-operated pension fund to which both employers and employees in Singapore are required to make contributions unless the income is below a pre-specified amount. Of the 33% contribution rate for those aged 55 years and below, 18-22% points can be used for financing mortgage loans.

[7] By borderline LTV ratios, we mean ratios that just meet the regulatory requirement for housing loans where these loans can only account for up to 80% of the adjusted purchase price or current market valuation of the residential property, whichever is lower.

loans in the past few years when property prices were weak. The changes in property prices, together with equity prices, were also used in the computation of additional specific provisions for delinquent cases. Chart 5 illustrates the stress test methodology for consumer accounts.

Chart 5: Illustration of Stress Test Methodology for Consumer Accounts



Small and Medium Enterprises (SME) Loans

7.8 The treatment of SME loans varied across banks. Some banks used the corporate loan approach while others used the consumer loan approach. The chosen approach depended on the bank's definition of SME loans. The consumer loan approach was preferred when the product was more standardised in nature and the loan quantum small.

7.9 In reporting the classified loan estimates for the stress test, the banks mapped their more granular credit risk rating, on which the stress test estimates were based, to MAS' rules on loan classification as described in MAS Notice 612 on "Credit Files and Classification of Loans".

8. RESULTS

8.1 From an average ratio of 5.6% for classified loans prior to the stress test, the classified loans ratio of the 6 participating banks rose to an average 9.6% under Scenario 1 (global economic weakness) and 11.8% under Scenario 2 (global economic weakness and terrorism) (see Table 2). For comparison purposes, the 3 local banking groups saw classified loan ratios of 10-13%[8] during the Asian Financial Crisis, while banks in the neighbouring crisis-hit countries experienced even higher NPL ratios.

Table 2: Stress Test Estimates of Classified Loans Ratio

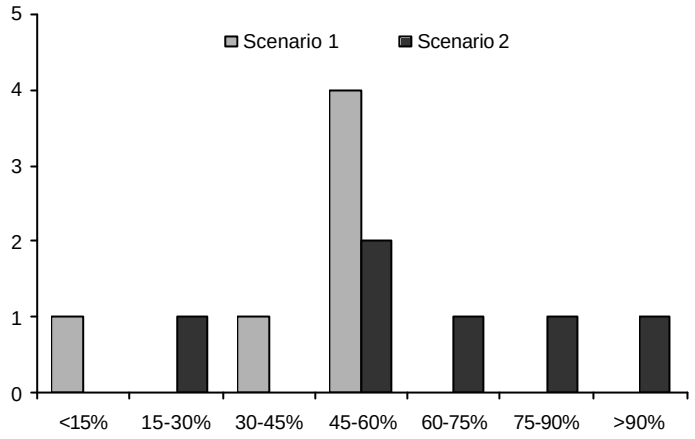
	Classified Loans		Classified Loans Net of Provision	
	Scenario 1	Scenario 2	Scenario 1	Scenario 2
min	2.5%	4.0%	1.9%	3.2%
max	15.2%	19.1%	11.4%	14.3%
average	9.6%	11.8%	6.8%	8.7%

8.2 The bank estimates showed that the loan categories most affected were loans to the General Commerce and Manufacturing sectors under both test scenarios. The impact on property-related loans (i.e. loans to the Building & Construction sector and Housing loans), which accounted for over two-fifth of Singapore's total non-bank loans, was contained.

8.3 The rise in classified loans occurred primarily in the "Substandard" category due to a high degree of loan collateralisation as the banks' books were of relatively high quality following the shakeout from the Asian Financial Crisis and the stress horizon of 1 year was relatively short. As a consequence, the stress test scenarios resulted in a relatively small amount of additional specific provisions. In most cases, the additional specific provisions required were more than covered by profits made by the banks in 2002 (see Chart 6). In the one case where the bank's profit was slightly less than the amount of additional specific provisions (under the more severe Scenario 2), the shortfall was well covered by the bank's excess capital.

[8] Classified loan estimates from the stress test included loans that were written-off as a result of the stress shocks, while the classified loan ratios of 10-13% during the Asian Financial Crisis did not include loan write-offs.

Chart 6: Sample Distribution of Additional Specific Provisions Measured as Percentage of 2002 Pre-tax Profit



8.4 For a meaningful comparison across banks, classified loans net of provision (net classified loans) were also examined given the different write-off and provisioning policies of the banks in the sample. As an example, banks in the North American continent are known for their aggressive write-offs of NPL while banks in some other jurisdictions may prefer to keep NPL on their books for much longer periods. This means North American banks would typically have low NPL by international standards. Indeed, our results showed that the impact on the local and foreign banks were similar when the comparison was done on the basis of net classified loans.

8.5 For the three local banking groups, the impact on their Capital Adequacy Ratio (CAR) was not significant enough to cause a breach of the regulatory requirement then of 8% for tier-1 capital and 12% for total regulatory capital.[9] This was not surprising given the local banks' high CAR of 10-13% for tier-1 capital and 15-19% for total regulatory capital prior to the stress test. The buffer above the regulatory requirement provides the cushion for volatility and growth as the local banks expand their operations outside Singapore.

[9] The capital requirement has been revised in May 2004 to 7% for tier-1 capital and 10% for total regulatory capital.

9. CONCLUSION

9.1 Overall, the stress test results were consistent with both the MAS' understanding of the banks' exposures and the FSAP assessors' independent assessment of the conditions. While this was not the first time the MAS managed an industry-level stress test, the exercise benefited from discussions in which the assessors shared their stress testing experiences from FSAP exercises in other countries. Some of the experiences and suggestions from the participating banks can be incorporated to improve the MAS' regular stress testing of the financial sector.

9.2 Based on the experience gained from Singapore's FSAP stress test, the MAS is planning methodological improvements that may include formulating test scenarios based on financials and other information used in the banks' own credit models or methodologies so that banks can utilise these directly and do not have to go through an additional step of mapping economic variables to financials. This would further increase the degree of consistency across banks, besides minimising the burden on them.

9.3 In recognition of the substantial resources required, the conduct of broad-based scenarios would not be regular unless the situation warrants it. Instead, stress tests that focus on thematic issues and are less resource-intensive will be implemented on a frequent basis. In addition, the MAS is in the process of developing in-house models based on aggregated data to supplement the stress tests conducted by the individual banks.

Appendix 1

Scenarios for Market and Credit Risk Stress Tests
(in percent change per annum, unless otherwise noted)

Variable	Scenario 1 Global Weakness	Scenario 2 Global Weakness & Terrorism
Assumed Real GDP Growth Rate		
Singapore	0.0	-1.7
Regional countries	2.0	-2.5
North Asian countries	2.8	2.8
Advanced countries	1.5	1.5
Singapore's Sectoral Growth Rates		
Manufacturing	-1.0	-2.0
Construction	-2.0	-4.0
Financial & Business	-1.0	-3.0
Commerce	1.0	-2.0
Transportation & Communications	2.0	1.0
Property Prices (Private Residential)		
Singapore	-10.0	-15.0
Malaysia & Indonesia	-5.0	-15.0
Thailand	-5.0	-10.0
Rest of the World	-5.0	-5.0
Singapore Commercial & Industrial	-10.0	-15.0
Unemployment Rate (percent of labour force) 1/		
Singapore	5.5	6.0
Malaysia	4.5	5.5
Indonesia	9.0	9.5
Philippines	11.0	13.0
Thailand	4.0	4.5
Korea	5.0	5.0
Taiwan Province of China	6.0	6.0
Hong Kong, SAR	8.0	8.0
China	6.0	6.0
Equity Prices		
Singapore, Malaysia, Thailand, Indonesia, Philippines	-10.0	-20.0
Rest of the World	-5.0	-5.0
Risk-Free Interest Rates (changes in basis points)		
Singapore and Selected Asian Countries 2/		
Short-term (< or = 3-months) 3/	-60.0	150.0
Medium-term (1 year)	0.0	100.0
Long-term (10 years)	0.0	50.0
Very long-term (>10 years)	0.0	50.0
Rest of the World 4/		
Short-term (< or = 3-months)	-80.0	-80.0
Medium-term (1 year)	-20.0	-20.0
Long-term (10 years)	0.0	0.0
Very long-term (>10 years)	0.0	0.0
Exchange Rate (per S$, percent change) 5/		
vis-a-vis regional, South Asian and Latin American currencies	-1.0	3.0
vis-à-vis North Asian currencies 6/	-1.0	-2.0
vis-à-vis other currencies 7/	1.0	-3.0

Footnotes:

1/ Rest of the World: the growth rate was assumed to be 2% points above average of Q1-Q3 2002 (if quarterly data available) or 2.5% points above 2001.
2/ Selected Asian countries include Indonesia, Malaysia, Philippines and Thailand.
3/ For scenario 1, the drop of 60 bp was subject to a floor of 0.5% for the base rate. If the base rate at end Dec 2002 were already lower than 0.5%, the Dec 2002 rate would be used.
4/ Changes in short- and medium-term rates were subject to a floor of 0.001% in the base rate.
5/ All currency pegs (e.g. HKD to USD) were assumed to continue.
6/ China, Korea and Taiwan Province of China.
7/ Includes advanced economies, Hong Kong SAR and Malaysia.