

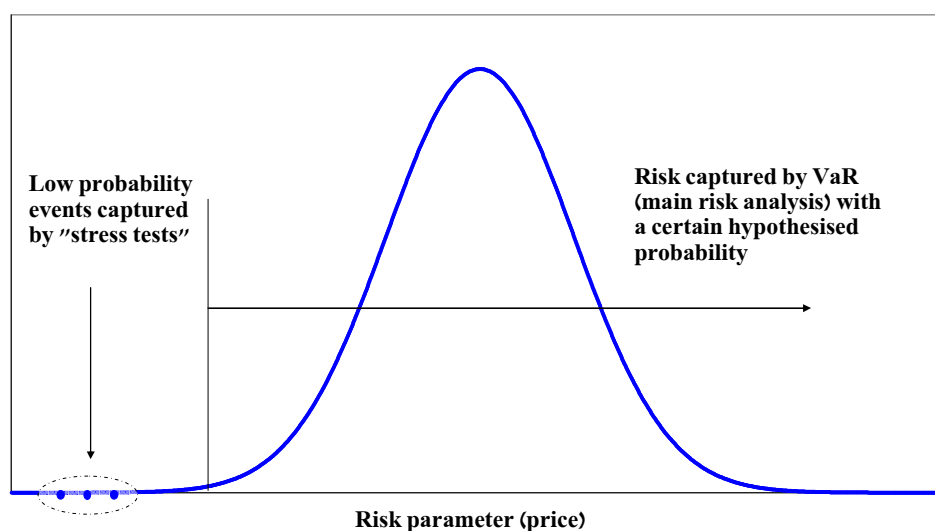
## STRESS TESTS

### a. Introduction

In recent years, stress testing has become one of the most important tools for risk management. It is used by banks as part of their internal risk management process and by regulators to assess the stability of the system and to identify sources of risk. In this context, the Bank Supervision Department carried out stress tests in 2009 and also estimated macroeconomic models for testing the stability of both the banking system and individual banks and their sensitivity to risk factors.

The stress tests can provide a bank's managers with warnings of unexpected negative results related to various types of risk and can give an indication of the capital required in order to absorb losses in the case of large shocks. They are a supplementary tool to models such as VaR (Value at Risk) and focus on exceptional events. Thus, for example, while VaR reflects the day-to-day behavior of the market, stress tests look at the performance of a portfolio over "irregular" periods and therefore provide information on risk outside the range captured by the VaR model (Figure 1).

Figure 1  
Stress test capturing exceptional but plausible events



**SOURCE: Committee on the Global Financial System. (2005), "Stress Testing at Major Financial Institutions: Survey Results and Practice." CGFS Publication No.24 (January).**

The financial crisis that began in 2007 emphasized the importance of stress testing. The depth and perseverance of the crisis raised doubts among regulatory authorities as to the reliability of the stress tests used prior to the crisis and their ability to adjust to rapid change, since the results of the crisis were more serious than those predicted by stress testing. In May 2009, the Basel Committee on Banking Supervision published

“Principles for Sound Stress-Testing Practices and Supervision”<sup>1</sup> (BCBS 2009) following its investigation of the procedures used in carrying out stress tests prior to and during the crisis. Based on this investigation and in an effort to improve the existing procedures, formal guidelines were developed for banks and regulators with regard to the goals and management of stress tests, as well as their implementation in analyzing risk and specific financial products. The document required that, among other things, the stress tests should cover the bank’s various types of risk and areas of activity while taking into account the interrelationships between banks, in order to provide a complete picture of the bank’s risk. Furthermore, the stress tests should include scenarios that reflect a variety of events and levels of severity, including a series of macroeconomic and financial shocks, while taking into consideration systemic interactions and feedback effects.

A study carried out by the Economic Unit of the Bank Supervision Department examined a number of scenarios that reflected a variety of events, including scenarios that examine the effect on the banking system of a collapse of a large group of borrowers, and which analyze the ability of the banks to meet their capital adequacy targets for 2009. In addition, macroeconomic stress tests that link a system of macroeconomic factors to the banking system’s credit risk were also carried out. The scenarios and model presented below reflect only part of that study.

#### **a. Stress scenarios**

##### *(1) Credit risk*

###### *The bank credit portfolio*

Sensitivity tests confirm that of the various risk factors, the effect of the realization of credit risk on the stability of the banks is the largest. We therefore analyzed the effect of a deterioration in the quality of credit on the loss rate of the capital base. In order to do so, we tested a scenario involving an increase in the proportion of balance-sheet credit to problematic borrowers within total credit to the public to a level of 10 percent, where it was in 2002. The assumptions underlying this scenario are as follows: 1) Total non-performing credit,<sup>2</sup> which is the most problematic type of credit, has been recognized as a loss; and 2) the other components of problematic credit have been partially translated into losses at a rate of between 10 and 60 percent according to level of severity.<sup>3</sup> These assumptions are equivalent to a ratio of annual loan-loss provision to total balance-sheet credit that ranges from 2.7 to 5.2 percent for the various banks. The planning of the scenario was based on the assumption that in a slowdown the risky borrowers are those that will experience the most serious difficulties. In the tested scenario, it was found that the loss rate from the banking system’s capital base was estimated at about 20 percent. The results of the scenario

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<sup>1</sup> In January 2010, the Bank Supervision Department distributed a translation of the document as part of its efforts to upgrade the systems for the management of risk, auditing and corporate government.

<sup>2</sup> According to its share of total credit to the public in December 2002.

<sup>3</sup> Rescheduled credit was weighted by 60 percent, credit marked for rescheduling by 40 percent, credit in temporary arrears by 30 percent and credit under special oversight by 10 percent. The result is equivalent to an average loss rate of about 40 percent of total problematic debt.

show that the capital adequacy ratio remained above the required minimum for all the banking groups.<sup>4</sup>

We would emphasize that Israel's past experience with crises is relatively limited and that an examination of financial crises in other countries shows an average increase of about 10 percentage points in the ratio of non-performing loans to total balance-sheet credit about one year following the crisis and an average rate of recovery of about 60 percent.<sup>5</sup>

### *Housing credit*

The dramatic reduction of the Bank of Israel interest rate and the sharp rise in the proportion of variable-interest unindexed loans within total housing credit<sup>6</sup> increased the exposure of the banks to an increase in the rate of interest. Although borrowers who took out variable-interest unindexed loans currently enjoy a small debt burden, they are exposed to an increase in the Bank of Israel rate of interest, which is expected to occur gradually given its current low level. Therefore, we examined the effect on the debt burden<sup>7</sup> of an increase in the rate of interest on variable-interest unindexed loans. The results showed that an increase of about 5 percentage points<sup>8</sup> in the interest rate to 7 percent increased the debt burden by 14 percentage points to 44 percent, similar to the level in 2003. Such an expansion of the debt burden is expected to bring about an increase in the loan-loss provision due to housing credit.

During the last two years, housing prices have increased significantly in Israel following a long decline over a period of 10 years, and some of the purchases and transactions involve apartments for investment purposes. In Israel, the average loan-to-value ratios (LTV) and the average debt burden are low relative to accepted levels in the developed countries. Nonetheless, the realization of a scenario involving a significant drop in housing prices together with a decline in household income will likely lead to the sale of apartments at prices lower than the mortgages taken out for their purchase, and hence to an increase in the loss rates of the banks from their housing credit portfolios. However, we do not foresee a direct threat to the stability of the banking system from the realization of such a scenario.

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<sup>4</sup> It should be mentioned that the scenario does not take into account the directive of the Supervisor of Banks regarding the adoption of a core capital target of not less than 7.5 percent, which will go into effect from December 31, 2010.

<sup>5</sup> IMF Country Report No. 08/63 "Israel Selected Issues", IMF (2008).

<sup>6</sup> The proportion of variable-interest shekel loans reached a record level of 77 percent in February 2009.

<sup>7</sup> The debt burden is defined in this context as the average proportion of repayments on housing loans within average income, which was calculated on the basis of the average original period to maturity, an average rate of interest, an average-sized housing loan, and taking inflation expectations into account. Average income was calculated on the basis of the average real wage per salaried post.

<sup>8</sup> According to Bank of Israel Research Department estimates (based on the DSGE model) of the Bank of Israel rate of interest for the end of 2011, a level of 6 percent is located in an area that covers 66 percent of the distribution of the expected rate of interest, or in other words, an increase of about 5 percentage points relative to its current level (Inflation Report, Fourth Quarter 2009).

## *(2) Interest rate risk*

Testing was carried out for the effect of a 300 basis point shift upward in the yield curve of the unindexed segment and a 200 basis point shift upward in the indexed and foreign currency segments. The scenarios included only the direct effect on the banking system and did not include any indirect effects, which may be significant.<sup>9</sup> The results of the scenario indicate a loss of up to about 2 percent of the capital base for some banks.<sup>10</sup>

## *(3) Exchange rate risk*

The effect of a 20 percent depreciation in the NIS/\$ exchange rate was examined.<sup>11</sup> The direct effect of a change in the exchange rate on the banking system's losses was found to be negligible (about 1 percent of the banking system's capital base). The reason for this is the policy of the banking system to maintain only small positions in the foreign currency segment. In contrast, the indirect effect on the risk components and on capital adequacy was found to be non-negligible.

### **Box 3.2**

#### **Macroeconomic stress testing for credit risk**

Macroeconomic credit risk models link a system of macroeconomic factors to the probability of default and are used to carry out stress testing. However, these models use historical statistical relationships to forecast the development of risk in the future and therefore their ability to capture exceptional responses is limited, particularly when they are based on a long period of stability. Thus, notwithstanding the importance of using macroeconomic models, they should not be relied on exclusively but rather should be used alongside stress testing that reflects a variety of events and levels of intensity, as described above.

Macroeconomic stress testing is a multi-stage process (Figure 2). The first stage involves choosing an external shock (Stage 1). A macroeconomic model<sup>12</sup> is then used to estimate the effect on macroeconomic variables (Stage 2). An example would be a test for the effect of a sharp drop in GDP on the interest rate and the exchange rate. Since macroeconomic models do not usually include financial variables, it is necessary to add a satellite model to the process, which will link the macroeconomic variables to the financial variables, particularly those that describe the quality of the credit portfolio (Stage 3). The two models combined can be used to estimate the effect

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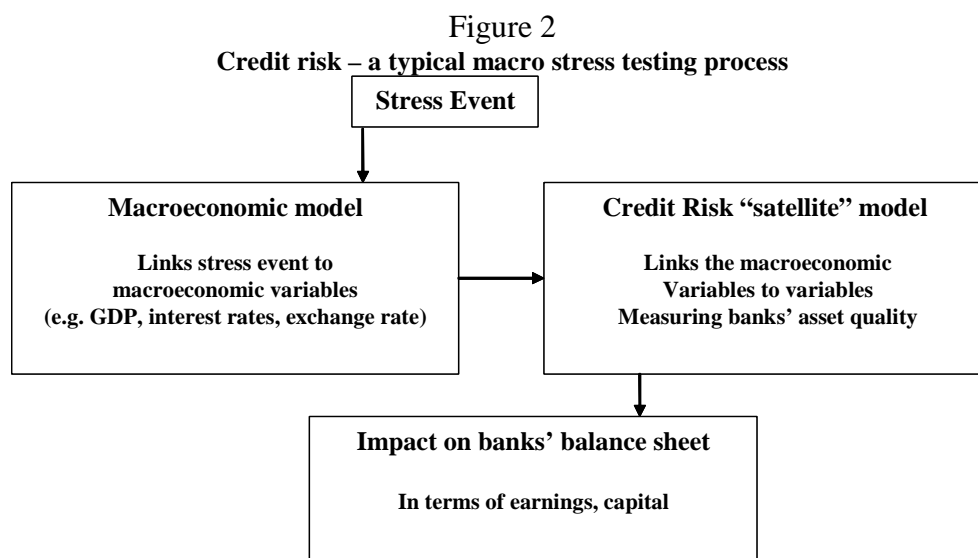
<sup>9</sup> An increase in the nominal rate of interest raises the real rate of interest and makes it more difficult for borrowers to pay back their debts and to obtain new credit. In general, there is a positive relationship between a high rate of interest and credit losses.

<sup>10</sup> The scenario that was tested involved an increase in the rate of interest and therefore the threat was to banks with a positive adjusted duration.

<sup>11</sup> A depreciation scenario was chosen since the position of most of the banks in the foreign currency segments was negative as of December 31, 2009 and therefore they were exposed to a depreciation.

<sup>12</sup> Such as models used by central banks to carry out macroeconomic forecasts or models such as vector autoregression (VAR) or VEC (vector error correction).

of an external shock on the credit portfolio, on the bank's losses and on its capital (Stage 4).



**SOURCE:**

Cihak, Martin, 2007 a, "Systemic Loss: A Measure of Financial Stability," *Czech Journal of Economics and Finance (Finance and Credit)*, Vol. 57 (1-2).

Antonella Foglia, 2008. "Stress testing credit risk: a survey of authorities' approaches," *Questioni di Economia e Finanza (Occasional Papers)* 37, Bank of Italy, Economic Research Department.

As part of the Bank Supervision Department's work on stress testing, we estimated a macroeconomic credit risk model based on Wilson's model,<sup>13</sup> which links the system of macroeconomic variables to the probability of default<sup>14</sup> and is used for stress testing. The model was tested for the business sector and for the construction and real estate industry and included the following variables:

- In the business sector: changes in the Composite State-of-the-Economy Index,<sup>15</sup> changes in the Bank of Israel real rate of interest and changes in the Tel Aviv 100 Index.<sup>16</sup>

<sup>13</sup> The model was initially developed for McKinsey & Co. and is known as the Credit Portfolio View. See:

Wilson, T.C. (1997a). "Portfolio Credit Risk (I)," *Risk*, vol. 10, issue 9, pp. 111–17.

Wilson, T.C. (1997b). "Portfolio Credit Risk (II)," *Risk*, vol. 10, issue 10, pp. 56–61.

<sup>14</sup> A company was defined as being in default if a bank has created a provision for doubtful debts for it. The probability of default (*PD*) for each quarter was obtained by dividing the number of companies defined as being in default by the number of companies active during that period.

<sup>15</sup> The Composite Index is a synthetic cyclical indicator for determining the direction of real economic activity in real time and is calculated on the basis of the monthly change in seven components that represent various aspects of real economic activity: the Index of Manufacturing Production, the import of consumption goods, the import of production inputs, the revenues from commerce and services, the number of salaried posts in the business sector, the export of goods (without agriculture, fuel, diamonds and planes and ships) and the export of services (tourism, computers and information, communications, insurance and other business services).

<sup>16</sup> The macroeconomic variables chosen are similar to those commonly used by many other regulatory authorities. For a survey of the macroeconomic credit risk models used by regulatory authorities world wide, see: Foglia Antonella (2008). "Stress testing credit risk: A survey of authorities' approaches," Banca d'Italia, Banking and Financial Supervision.

- In the construction and real estate industry, two models were estimated: an “output” model which included total output in the construction industry and the rate of change in the rate of interest and the “housing prices” model which is used to analyze the effect of changes in housing prices in Israel on the probability of default in the industry.<sup>17</sup>

In addition, we considered a number of widely-used models from the literature in order to estimate the relationship between a bank’s losses due to credit provided to the household sector and the economic environment, using aggregate data on the sector’s credit risk.<sup>18</sup> Also tested was the effect of changes in the rate of unemployment and changes in the public’s portfolio of financial assets on the ratio of loan-loss provision to total non-housing credit to private individuals for the five large banking groups.

The results obtained from all the estimated models show that the average capital adequacy ratio for the banking system remained above the required minimum.<sup>19</sup>

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<sup>17</sup> Since housing prices in the model that includes the construction industry’s total output and the rate of change in the real rate of interest were not found to be significant, the effect of housing prices was estimated separately.

<sup>18</sup> This was in order to differentiate it from another widely-used approach for estimating credit risk in the household sector which makes use of models based on specific information on borrowers.

<sup>19</sup> It should be mentioned that this scenario does not take into account the directive of the Supervisor of Banks regarding the adoption of a core capital target of no less than 7.5 percent, which will go into effect on December 31, 2010.