

Portugal: Financial Sector Assessment Program—Technical Note—Stress Testing

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TECHNICAL NOTE

STRESS TESTING

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GLOSSARY

BdP	Banco de Portugal
BU	Bottom up stress test
CAR	Capital adequacy ratio
CAT	Catastrophic risk
CEIOPS	Committee of European Insurance and Occupational Pensions Supervisors
EAD	Exposure at default
FSAP	Financial Sector Assessment Program
ISP	Instituto de Seguros de Portugal
LGD	Loss given default
PD	Probability of default
PFS	Preparatory Field Study
QIS	Quantitative Impact Study
RBC	Risk-based capital
TD	Top down stress test
VaR	Value at risk
VAR	Vector auto regression

EXECUTIVE SUMMARY

To better quantify the extent of banks and insurers' vulnerability to major types of risks, a comprehensive set of stress tests was undertaken. These covered a wide diversity of institutions, risk factors and shocks, and used a range of methodologies.

Stress tests to the banking system analyzed a set of internally consistent macroeconomic scenarios both in the bottom-up and in the top-down exercises. A baseline macroeconomic scenario, broadly in line with the regular Banco de Portugal macroeconomic projections, was built together with two stress scenarios, the so-called "disruptive adjustment" and "cyclical asynchrony" scenarios. The trigger event for the "disruptive adjustment" scenario is a sharp correction of global imbalances, with a decline in global economic growth, a significant depreciation of the U.S. dollar and an abrupt decline in equity prices. The euro-wide monetary policy response to these events implies a reduction in short-term interest rates in this scenario. The "cyclical asynchrony scenario" is one in which the Portuguese economy fails to follow a strong recovery of economic activity in the euro area, which is accompanied by a steep rise in short-term interest rates. Fiscal consolidation consistent with the Stability and Growth Pact is imposed in both scenarios. In both scenarios, the Portuguese economy experiences a prolonged recession throughout the whole projection horizon.

The *banking sector* stress testing exercise points to the generally high level of resilience of the system to severe, yet plausible, shocks. A consistent picture arises from the different scenarios and sets of methodologies: the solvency of the system is such that quite severe shocks can be absorbed. This message comes through most strikingly with the bottom-up and top-down scenario-based exercises, where neither the "disruptive adjustment" scenario nor the "cyclical asynchrony" scenario seem to cause a substantial impact for the system as a whole. Depending on the approach used (bottom-up or top-down), the disruptive adjustment scenario (which produces the strongest impact) causes a reduction in the average capital adequacy ratio of the system of about 1.3 to 1.8 percentage points, when compared with the values forecasted under the baseline scenario.

Beneath the aggregate picture, there is a degree of heterogeneity in the impact of each shock on the capital adequacy ratio of different banks. This applies in particular to the disruptive adjustment scenario (especially due to the equity price decline), and is related to the different exposures of banks to this source of risk. However, even in this case, the solvency ratio remains above 9 percent for all banks.

According to the results of the top-down exercise and notwithstanding the relatively muted impact on capitalization, profits take a significant hit, as a result of the severity of the stress scenarios imposed. The system's return on assets (after tax and before minority interests) could fall from 0.9 percent in 2005 to 0.2 and 0.5 percent by the first year of the global adjustment and cyclical asynchrony scenarios, and 0.6 and 0.8 percent by the third year. Likewise, the system's return on equity would fall substantially, from 16.3 percent initially to 3.8 and 8.9 percent by the first year, and 11.3 and 12.0 percent by the third year of the

respective scenarios. In interpreting these figures, it is recognized that the scenario shocks are calibrated to a low probability measure.

One of the main risk factors underlying these results for banks is equity risk. However, this is not with respect to bank portfolios as such, but rather the portfolios of the banks' employee pension schemes. Large equity price shocks, such as those imposed with the disruptive adjustment scenario, cause actuarial losses beyond what can be smoothed out within the 10 percent "regulatory corridor." As the sensitivity tests show, a 30 percent equity decline could wipe out about 10 percentage points of pension scheme's net assets relative to liabilities. Actuarial losses in excess of the corridor are deducted directly from the bank's Tier 1 own funds, even though the impact on profits can be amortized over several years. Credit risk matters for the banks, as it does traditionally, but they are sufficiently capitalized to withstand credit risk shocks relatively comfortably. The cyclical asynchrony scenario is the more severe in terms of expected credit losses, as not only output slumps domestically but also euro interest rates are hiked up. Under this scenario, expected losses roughly double for retail credit, corporate credit and mortgage loans. Even though the shocks cause a substantial dip in profits, the system can withstand the shock well. Overdue loans rise 73 percent over the projection horizon, causing annual net impairment charges as a percentage of total assets to rise about 50 percent.

Indeed, the same general conclusion holds, even in the event that the estimated default probabilities and loss-given-default rates turned out even worse than assumed in the main scenarios. The main scenarios embodied a substantial deterioration in credit quality, developed on the basis of conservative (prudent) assumptions, within an explicit and internally consistent modeling framework, for low probability events. An additional, ad hoc robustness check was undertaken, which assumed expected credit loss projections under the stress scenarios would be hiked up by up to a further 50 percent, allowing both for normal model uncertainty and the possibility of even more extreme—and correspondingly even more unlikely—scenarios.

The bank stress tests suggest that other risk factors matter to a lesser extent. Movements of the yield curve have only limited effects, except in cases where the actuarial discount rate falls which produces a large impact on account of duration mismatches in the pension funds. Foreign exchange rate shocks have small effects, and shocks to implied volatilities in financial market prices produce negligible effects.

As part of the stress testing exercise, a survey-based assessment of liquidity risk was undertaken, which suggests that the larger banks' liquidity positions would remain comfortable under the scenarios described. Banks tap a diversified set of markets for different instruments and investor profiles, and are relatively small participants in these typically Europe-wide (if not broader still) markets. In particular, they all have in place contingency procedures to address market liquidity constraints. Even in the case of a sovereign ratings downgrade by one or two notches, banks did not foresee any difficulties, even though in the two-notches case not only funding costs but possibly also the availability of credit lines could be affected. This latter impact would be relevant only in the event of a

downgrade of banks' rating to a level below investment grade, which was reported by banks as highly unlikely.

For the *insurance sector*, bottom-up stress tests suggest that the Portuguese life and nonlife insurance sector is able to withstand a number of severe shocks, both singly and simultaneously. The risk factors considered span a variety of financial risks (interest rate, exchange rate, credit, equity price and real estate risks) and underwriting risks (biometric, lapse, catastrophic and nonlife premium and reserve risks). A maximum probability of insolvency of 0.5 percent within one year has led to several scenarios which have been tested for participating companies. Even though the free surplus (assets minus liabilities) drops significantly following these shocks, it remains sufficient to absorb the impact of any individual shock. The free surplus is also able to withstand, for all except one insurance company, the materialization of all risk factors under conservative correlation assumptions.

The test indicates that life and nonlife insurers respond differently to the shocks, which is in part due to the diversity in products and business lines. In aggregate terms, the nonlife sector appears more vulnerable than the life-sector, even though part of this difference can be explained by the fact that the nonlife sector was subjected to a more severe combination of shocks. There appears to be a wide diversity in resilience across institutions. While for the system as a whole the free surplus would fall by 57.5 percent, one life company would experience a fall of 101.1 percent, whereas two other companies (one life and one nonlife) would experience a fall of 95.2 and 89.9 percent, respectively. Thus, one company would fall marginally below the solvency requirements. However, this is expected to be offset by future embedded profits that were not recognized.

The most important risk drivers for the sector as a whole are equity price risk, interest rate risk, nonlife premium and reserve risk, and credit risk (listed in decreasing importance). The life sector is most exposed to equity price risk, followed by interest rate. Credit risk and lapse risk are important in individual cases. Biometric risk is not very important. The nonlife sector appears most exposed to premium and reserves risks (nonlife solvency risk) and equity price risk. Other risks, such as foreign exchange and real estate risk, are of limited importance.

Complementing the bottom-up stress tests a top-down exercise was carried out by the ISP to assess the significance of catastrophic risk. Specifically, a stress test was developed to assess the potential impact of an earthquake above 8.5 on the Richter scale. The stress tests were based on a probable maximum loss estimate of 1.1 percent of sums insured. The results show that the free surplus of insurance companies is sufficient to absorb this extreme shock.

I. INTRODUCTION

1. This note describes the assumptions, procedures and outcomes of the stress testing exercise of the Portugal FSAP. The stress tests provide a macroprudential assessment of the resilience of the Portuguese financial system to various exceptional but plausible shocks.
2. The stress testing exercise conducted for Portugal was comprehensive in several dimensions (Table 1). The institutions covered included a financial conglomerate, the largest banking groups, their pension schemes, and the largest life and nonlife insurance companies. Depending on the type of stress test, systemic coverage was at 80-87 percent for banking and 48-78 percent for insurance.¹ A host of risk factors was considered: credit and market (for banking and insurance), liquidity (for banking), actuarial (for pension schemes), and biometric, lapse and catastrophic risks (for insurance). The impact of shocks was studied on the basis of sensitivity and scenario analyses. Shocks were calibrated on the basis of historical extremes and macroeconomic simulations, where necessary adjusted with an element of judgment. Various methodologies were used: bottom-up, top-down, Monte Carlo, econometric estimation, and survey methods.
3. The exercise was designed by the Banco de Portugal (BdP) and the Instituto de Seguros de Portugal (ISP), in collaboration with the FSAP team. The “banking stress tests” coordinated and conducted by the BdP consisted of: a bottom-up exercise for a financial conglomerate, five banking institutions as well as the pension schemes of five institutions;² a top-down exercise for the banking sector as a whole; and two additional studies complementing the top-down analysis. The “insurance stress tests” by the ISP consisted of a bottom-up exercise (with a top-down component for catastrophic risk), focusing on individual insurance companies and the financial and underwriting risks they face. The BdP and ISP had frequent contact among themselves and with individual institutions regarding the design and implementation of the exercise and the validation of its results.
4. For both banking and insurance institutions, the starting point of the analysis was end-2005. The sensitivity shocks introduced were supposed to take place instantaneously with the beginning of the new year. The scenarios were assumed to play out over a period of three years. In terms of sectoral cross issues, it should be noted that the shocks applied to the banking and insurance institutions are not the same, in view of the different nature and horizon of risks.

¹ Table 1 provides more information on these percentages according to the type of stress test conducted.

² The financial conglomerate was stress tested by the BdP at the conglomerate level for financial risks. Additional analysis was conducted by the ISP, which also included underwriting risks.

Table 1. Overview of Banking and Insurance Stress Tests

	Banking		Insurance	
	Bottom-up	Top-down	Bottom-up	Top-down
Coverage	1 conglomerate 5 banking groups 5 pension schemes	13 banking groups	4 life 2 nonlife 3 composite	4 nonlife 1/
Relevance 2/	80 percent	87 percent	78 percent life 64 percent nonlife	48 percent
Financial risks	Credit risk * Equity price risk * Interest rate risk Fx risk Volatility risk	Credit risk * Equity price risk *	Credit risk * Equity price risk * Interest rate risk * Fx risk Real estate risk	
Other risks	Actuarial risks		Life biometric risk Life lapse risk Nonlife premium and reserve risk *	Nonlife catastrophic
Scenario analysis	Disruptive adjustment Cyclical asynchrony	Disruptive adjustment Cyclical asynchrony	Historical correlation structure	Probable max loss estimation
Sensitivity analysis	yes	No	yes	No
	<i>(in percentage points of CAR)</i>		<i>(in percent of free surplus)</i>	
Maximum impact on solvency 3/				
versus 2005	-1.4	-1.1	-101.1	-16.6
versus 2008 baseline	-2.7	-1.8	..	..

Source: Fund staff estimates.

Note: Main risks identified are starred.

1/ Including nonlife companies and nonlife undertakings of composite companies.

2/ For banking: relative to system assets. For insurance: relative to premiums (bottom-up) and insured capital (top-down).

3/ Note that the top-down banking stress test was conducted only to the system's aggregate.

5. The mission's work in general was facilitated by the excellent preparation of the BdP and ISP for the stress testing exercise and the quality of background papers that were prepared.

II. BANKING STRESS TESTS

6. In what follows, the banking stress tests are discussed. To begin with, a description is provided of the process that preceded the stress tests, namely the development of consistent macroeconomic stress scenarios and the calibration of the impact of these macroeconomic scenarios on credit risk parameters. This is followed by a discussion of the procedures, assumptions and outcomes of the core banking stress tests, namely the bottom-up and top-down approaches. Finally, two additional exercises are discussed, consisting of a Monte Carlo study of the distribution of credit losses arising from corporate credit defaults and a VAR study of the interactions between the financial sector and macroeconomy in Portugal.

A. Development of Scenarios

Macroeconomic aggregates

7. Underlying the banking stress tests was the development by the Research Department of the BdP of macroeconomic scenarios for the period 2005-2008. The baseline scenario was based on the macroprojections in the context of the Eurosystem Broad Macroeconomic Projection Exercise, as of December 2005, and thus takes into account the information available at that time. Inherent in the projections are endogenous monetary policy reactions following a Taylor-type rule, and fiscal policy reactions in compliance with the Stability and Growth Pact criteria. The assumptions, procedures and outcomes of the macroeconomic projections were provided in a background paper on the annual macroeconometric model of the BdP.³

8. Two stress scenarios were developed. The first is a “disruptive adjustment” scenario, featuring an abrupt adjustment of global imbalances which is hypothesized to occur early 2006. The second is a “cyclical asynchrony” scenario, featuring an unexpected euro-area productivity rise that does not spill over into Portugal. The two scenarios were detailed in a separate report that was circulated to banks participating in the stress test exercise. A brief description of the two scenarios is provided in Box 1. Table 2 provides the actual projections.

³ Gabriela Lopes de Castro (2006), “The annual macroeconometric model of the Banco de Portugal”. *Mimeo*, Banco de Portugal, Research Department.

Box 1. Description of Scenarios

Baseline Scenario

The baseline scenario comprises:

- A very moderate economic recovery over 2006-2008.
- A stabilization of the unemployment rate half a percentage point above the initial level.
- A temporary hike in inflation in 2006, followed by a leveling off;
- A stabilization of net external borrowing requirements.

Scenario 1: Disruptive adjustment scenario

This scenario unfolds in response to an abrupt adjustment of global imbalances in early 2006, featuring:

- A sudden decline in the demand for US assets and an abandonment of existing pegs with the US dollar;
- A shift in portfolio preferences causing a sharp depreciation of the dollar;
- A sharp rise of US long-term interest rates, due to asset substitution and rising risk premia;
- A sharp deceleration in US domestic demand and activity impacting on imports and worldwide activity;
- A sharp decline in global equity prices, due to a downward revision in companies' profit outlook.

The impact on the Portuguese economy is projected as follows:

- The effective exchange rate appreciates by about 1.5 percent;
- Short-term rates fall by about 100 basis points;
- Long-term rates broadly stabilize, with offsetting higher euro asset demand and increased global uncertainty;
- Export demand falls over the horizon, due to direct and indirect effects;
- Exports drop by an additional amount each year due to increased international competition.
- Fiscal policy is tightened to fulfill Stability targets in 2006 and 2007, and reach 3-percent deficit in 2008.

Scenario 2: Cyclical asynchrony scenario

This scenario unfolds in response to a major positive productivity shock in the euro area that does not spill over into the Portuguese economy, causing substantial export market share losses. The scenario features:

- An unexpected rise in euro area productivity, boosting consumption and investment;
- A continued rise in oil prices due to increased global demand and prevailing oil refining capacity constraints;
- A monetary policy tightening in response to higher GDP growth and consumer price inflation rates;
- A rise in long-term neutral interest rates, reflecting the increase in productivity embedded in this scenario.

The impact on the Portuguese economy can be characterized as follows:

- Oil prices rise from a baseline of 60 dollars per barrel to 70, 75 and 80 dollars over the horizon;
- Short rates rise by 1.4, 0.5 and 0.6 percentage points relative to the baseline over the horizon;
- Export market shares fall by 3 percentage points each year;
- Nominal house prices decrease by 0.5 percent each year.

Table 2. Projection of Macroeconomic Aggregates

	Stress scenario 1			Stress scenario 2		
	Disruptive adjustment			Cyclical asynchrony		
	2006	2007	2008	2006	2007	2008
<i>(percentage point deviations from baseline projections)</i>						
Real GDP growth	-1.7	-1.7	-1.4	-1.0	-1.6	-1.5
Inflation	0.0	0.2	-0.8	0.5	1.4	0.5
Unemployment rate	0.4	0.9	1.2	0.3	0.6	1.0
3-month interest rate	-1.2	-1.5	-1.5	1.4	1.9	2.5
10-year interest rate 1/	-0.3	-0.5	-0.5	0.5	0.7	1.0
Dollar/euro exchange rate /2	23.7	0.0	0.0	0.0	0.0	0.0
Stock prices	-30.0	0.0	0.0	0.0	0.0	0.0
Real Estate Prices	0.0	0.0	0.0	-0.5	-0.5	-0.5
Total credit 3/	1.4	1.1	0.2	-2.6	-5.1	-5.9
Credit to households 3/	3.3	3.5	1.8	-3.6	-6.0	-6.8
Credit to corporations 3/	-1.1	-2.1	-2.2	-1.4	-3.9	-4.8

Sources: Banco de Portugal; and staff estimates.

1/ Regarding pension schemes, the actuarial rate is assumed constant for the baseline and disruptive adjustment scenarios. For the cyclical asynchrony scenario, the actuarial rate rises by a cumulative 25 basis points, distributed annually in proportion to changes in the 10-year interest rate.

2/ A positive number represents an appreciation of the euro.

3/ End-of-year figures.

Probabilities of default

9. The impact of the macroeconomic projections on the evolution of default probabilities was calibrated on the basis of two background studies.

- The first study draws on detailed credit registry data and provides estimates on the response of corporate default frequencies for credits to fifteen different economic sectors to the baseline and stress scenarios.⁴ This study was methodologically implemented through a Probit pooled regression between default indicators and loan-level, firm-level and macroeconomic variables over the period 1995-2004.

⁴ António Antunes (2006), "FSAP Portugal: Modeling corporate default rates with micro data. Methodological notes," *Mimeo*, Banco de Portugal, Research Department.

- The second study examined the evolution of default probabilities for other types of credit.⁵ This study examined the sensitivity of loan spreads to macro factors. The estimates were based on data that spanned the period 1992-2005.

10. Table 3 presents the projected evolution of probabilities of default (PDs) relative to the baseline for the following four types of credit: (i) corporations; (ii) households—housing purposes; (iii) households—other purposes; and (iv) other credits. The PD projections for corporate credits were further disaggregated into fifteen economic activity sectors and four credit classes which controlled for the size of a firm’s average total credit.⁶ Loss given defaults (LGDs) were assumed constant at 10 percent for credit to households for housing purposes and 45 percent for all other credit.

11. In addition, for illustrative purposes, a robustness test was conducted with respect to expected loss rates (PD times LGD). The purpose of this exercise was to provide an additional measure of comfort about the PD and LGD estimates, which may be subject to model uncertainty and sample bias. The robustness test consisted of multiplying expected loss rates with a factor of 1.20 and 1.50.

B. Bottom-Up Approach

Process

12. A core part of the banking stress tests was the bottom-up exercise implemented by individual institutions. The bottom-up approach examines the impact of stress on the individual balance sheets of financial institutions, thereby taking into account as fully as possible how the various risk factors affect the value of all instruments of a portfolio. Once the impact across individual institutions is assessed, individual results are compared and aggregated to arrive at a picture of the resilience of the system.

13. The bottom-up stress tests benefited from the experience of Banking Supervision Department of the BdP, which coordinated stress tests implemented by banks in early 2005. For the purpose of the FSAP stress test exercise, the Economics and Research Department of the BdP developed two sets of questionnaires with templates: one for financial conglomerates and one for banks not belonging to a financial conglomerate. The questionnaires were sent to banks early February. Various meetings were held with banks to exchange views on the questionnaires and to provide follow-up guidance. Beginning of April, the results were processed and validated by the BdP. The results were reported during the second FSAP mission in May.

⁵ Nuno Ribeiro (2006), “Estimating macro factors parameters for unobserved probabilities of default,” *Mimeo*, Banco de Portugal, Research Department.

⁶ These probabilities of default were included in the questionnaire sent to banks.

Table 3. Probabilities of Default Projections and Loss Given Default Assumptions

	Stress scenario 1			Stress scenario 2		
	Disruptive adjustment			Cyclical asynchrony		
	2006	2007	2008	2006	2007	2008
<i>(percent increase relative to baseline)</i>						
Corporations	30	51	101	20	71	139
Households - housing purposes	2	5	15	45	80	119
Households - other purposes	4	10	25	57	106	158
Other credits	13	24	51	38	82	136
Loss given default						
Corporations	45	45	45	45	45	45
Households - housing purposes	10	10	10	10	10	10
Households - other purposes	45	45	45	45	45	45
Other credits	45	45	45	45	45	45

Source: Banco de Portugal.

14. Some explanation is warranted regarding the information used in conducting the bottom-up stress tests. As agreed with the authorities, the bottom-up stress test exercise was designed to take into account end-2005 data only. Thus, the vulnerabilities of the system would be assessed with reference to the information available at that time. On this basis, a full set of results was provided to the mission team during the mission in May. End of May, however, one of the banks participating in the bottom-up stress tests implemented a major capital issue, boosting its Tier-1 capital ratio by 3.5 percentage points. In view of the significance of this event, the authorities asked this bank to repeat the scenario-based stress tests as well as the sensitivity analysis as if the capital increase had occurred end-2005. Updated results were provided in July. This report will only reflect the updated stress test results.

15. Among the instructions given to banks, the following items are important. First, the accounting standards currently in use are applicable, which meant that all institutions applied the new accounting standards. Second, credit evolves in response to the scenarios but no transactions take place in the securities portfolio during the simulation horizon. Third, the stress tests apply to the whole portfolio of the banking group on a consolidated basis. The consolidation perimeter includes banks and financial companies but excludes insurance companies, special purpose vehicles and non-financial affiliates. Notwithstanding this, indirect risks stemming from shocks to assets and liabilities of the banks employees' defined-benefit pension funds were also taken into account in the exercise. Credit may be treated on a non-consolidated basis in that the analysis may be restricted to resident affiliates. Financial conglomerate groups also need to implement additional stress test exercises for affiliated insurance companies (separately) and the conglomerate level (banking and insurance arms together).

16. The limitations of stress testing are well recognized. The bottom-up stress tests focus only on the impact of expected losses on indicators of profitability and capitalization and, like almost all other FSAP stress tests to date, do not reflect “unexpected losses.” These are tackled in a separate study on corporate credit risk. As is common, secondary feedback effects in the financial system are hard to model. On this basis, the assessment of liquidity risk was made on a qualitative basis.

Coverage of institutions and risk factors

17. The exercise covered one financial conglomerate and five of the largest banking institutions, representing 80 percent of total banking system assets (as of end 2004). The following institutions participated in the exercise: Montepio Geral, Grupo Espírito Santo, Banco Comercial Português, Banco Santander Totta, Banco Português de Investimento, and Caixa Geral de Depósitos. Two institutions were asked to perform the exercise as conglomerates (including both the banking and insurance arms of the group). However, ultimately only one of the two institutions conducted the exercise as a conglomerate, as the other institution had applied for a change in the structure of the group.

18. As mentioned above, the stress tests considered the impact of shocks on the pension schemes of banks and how this generates extraordinary contributions from banks to compensate for actuarial losses in excess of regulatory levels. Five of the institutions mentioned above participated in the pensions aspect of the stress tests. One institution did not report the impact of the shocks on its pension scheme. In terms of the relevance of this omission, it was mentioned that this institution’s pension scheme is relatively small with a relatively low equity exposure in terms of the fund’s total assets.

19. The bottom-up stress tests consist of two distinct approaches: a scenario analysis and a sensitivity analysis. The scenario analysis adopts a “general equilibrium” point of view, taking into account the correlations between risk factors. Institutions were asked to project their financial condition (balance sheets, operating profits and regulatory capital) under the baseline and two stress scenarios over a three-year period. In addition, institutions were asked to qualitatively report on the impact of the different stress scenarios on their liquidity positions, taking into consideration the possibility of a Portuguese sovereign rating downgrade. The qualitative assessment of liquidity risk takes into account banks’ initial liquidity profiles as well as any contingency plans that are in place.

20. The sensitivity analysis aims to assess the impact of large and instantaneous shocks in risk factors, holding other risk factors constant. Four risk factors were examined: interest rate risk (a nonparallel shift in the yield curve and a pivoting of the yield curve), equity price risk, foreign exchange rate risk (euro/U.S. dollar), and changes in the implied volatility of all financial market prices.

Calibration of shocks

21. The scenario-based stress tests were calibrated on the macroeconomic projections outlined before. Banks were provided with these projections under the baseline and two stress scenarios over the period 2005-2008. PD and LGD projections were also provided.

Banks were allowed to provide their own PD and LGD projections conditional on the macro scenarios, as long as the methodology underlying the projections is made explicit. Only one bank chose to use its own PDs and LGD projections. BdP reported that expected losses derived from these projections were not dissimilar from the projections provided to banks.

22. The sensitivity-based stress tests were calibrated on historical monthly changes in equity prices, short- and long-term yields of government debt from countries currently members of the euro area, and the US\$/EUR exchange rate (dollars per euro). The proposed shocks are improbable yet justifiable considering past data, standard industry practices and/or other FSAPs. The size and nature of the shocks is described in Table 4.

Results

Scenario analysis

23. The results of the scenario-based stress tests are presented in five steps. First, the results are presented in terms of the magnitude of the change in the capital adequacy ratio (CAR) that is caused by the aggregate effect of all risk factors. Excluded from this analysis, however, is the impact on capitalization arising from the accrual of income due to factors not affected by the shocks. Second, the overall impact is decomposed into different risk drivers: expected losses, credit growth, equity prices, interest rates, exchange rates and pension funds. Third, the results are presented in terms of the actual solvency levels before and after the shock, allowing for an assessment of the capacity of banks to withstand the shocks. Here, not only the impact of shocks is considered but also other elements which affect the accrual of income that is not affected by the shocks and was not captured in the first presentation of results. Fourth, the impact on profitability is presented. Fifth, banks' qualitative assessment of liquidity risk is discussed.

Results 1: Impact on capital adequacy ratio of all risk drivers

24. Table 5 shows the cumulative impact of all risk factors embedded in the scenarios on the risk-weighted capital ratio of banks, excluding as already mentioned the impact on the accrual of income through items not affected by the stress tests. Thus, the results show the cumulative impact of the various credit and market risks factors on the capital levels of banks, including through the effects of shocks on the pension schemes of banks. For each year and each scenario (baseline and two stress scenarios), the table presents the difference between the CAR in the year and the end-2005 level. Note that, for each year, the results are presented in terms of the average, best and worst performer, where it is important to point out that the best and worst performer may differ from year to year. Thus, the time paths of best or worst results are not necessarily associated with a single bank. Note also that the average performance was weighted using the share of risk-weighted assets of each bank in the total risk-weighted assets.

Table 4. Overview of Sensitivity Shocks

Risk Factor	Nature of Shock	Size of Shock
Interest rate risk	Joint change of 3-month and 10-year interest rates 1/ 2/	<ul style="list-style-type: none"> ▪ 100 bps and 50 bps up ▪ 100 bps and 50 bps down ▪ 200 bps and 100 bps up ▪ 200 bps and 100 bps down
	Pivotal change of 10-year interest rate 2/	<ul style="list-style-type: none"> ▪ 50 bps up ▪ 50 bps down
Foreign currency risk	Change of euro exchange rates 3/	<ul style="list-style-type: none"> ▪ 15 percent up ▪ 15 percent down
Equity price risk	Change of equity prices 4/	<ul style="list-style-type: none"> ▪ 30 percent up ▪ 30 percent down
Volatility risk	Change of implied volatility of financial market prices 5/	<ul style="list-style-type: none"> ▪ 30 percent up ▪ 30 percent down

Notes:

1/ Shocks to interest rates with other maturities obtained by linear interpolation. Stress tests for pension schemes incorporate changes in the actuarial discount rate of 25 bps up, 25 bps down, 50 bps up and 50 bps down for shocks 1, 2, 3 and 4, respectively.

2/ Interest rate changes are equal in all currencies.

3/ Change in euro exchange rate is applicable to all currencies. An upward shock of 15 percent thus represents a 15-percent depreciation of the euro with respect to all other currencies.

4/ Equity price shock is applied simultaneously to all equity markets.

5/ Volatility shock is applied simultaneously to all financial market prices (equity prices, exchange rates and interest rates). If the volatility level is 10 percent initially, a 30-percent increase implies that the volatility level rises from 10 to 13 percent.

25. The results suggest that the two scenarios produce very different impacts even though, in each case, the magnitude of the impact appears contained. First of all, the CAR does not move much in the baseline scenario. Second, the disruptive adjustment scenario appears to be more than twice as stressful as the cyclical asynchrony scenario in its overall average impact (-1.3 versus -0.6 percentage points). The impact of the first scenario is also more front-loaded with 50 percent of the capital reduction occurring in the first year as opposed to 31 percent for the second scenario, which corresponds to the timing of the equity price crash one year into the first scenario. Third, the overall magnitude of the impact appears limited, even for the worst performers which suffer capital losses of 1.9 and 1.2 percentage points for the respective scenarios.

Table 5. Impact on Capital Adequacy Ratio According to Year

	2006	2007	2008	Total
(In percentage points of capital adequacy ratio)				
Baseline Scenario				
Average	0.00	-0.02	-0.04	-0.05
Best	0.05	0.04	-0.01	0.03
Worst	-0.03	-0.05	-0.09	-0.17
Stress Scenario 1: Disruptive Adjustment				
Average	-0.65	-0.31	-0.33	-1.30
Best	-0.21	-0.04	-0.15	-0.61
Worst	-1.38	-0.73	-0.69	-1.92
Stress Scenario 2: Cyclical Asynchrony				
Average	-0.18	-0.16	-0.24	-0.58
Best	0.06	-0.01	-0.06	-0.01
Worst	-0.41	-0.34	-0.46	-1.19

Source: Banco de Portugal.

Note: Considers the impact of credit risk and market risk on the bank portfolio plus the impact of market risk factors on the bank employees' pension funds.

Results 2: Impact on capital adequacy ratio by risk driver

26. Table 6 decomposes the impact of the different risk drivers on the aggregate 2008 impact of the shocks under the three scenarios. The risk drivers identified are: expected losses, credit growth, share prices, interest rates, exchange rates, and finally the impact through pension schemes of market risk factors and actuarial discount rate assumptions (see footnote 2 in Table 2). In reading these results, note that the actuarial discount rates change only in the second scenario and, again, the best and worst performers may differ for each risk factor.

27. The stress tests identify equity price risk and credit risk as the most relevant risk factors, with interest rate risk and exchange rate risk playing only a minor role:

- Equity price risk is the most important risk in the first scenario, which features a 30-percent crash in equity markets. The equity price shock affects banks in two ways: first, through bank portfolios directly (-0.2 percentage points) and second, through the impact on banks' pension schemes and thus the extraordinary contributions banks need to make to address any underfunding as a result of the shock (-0.8 percentage points). For the worst performer, these figures are -0.4 and -1.6 percentage points.

- Credit risk is the most important risk factor in the second scenario, causing through expected losses a reduction in the CAR of -0.4 and -1.0 percentage points for the average and worst performer respectively. Credit risk is also a significant risk factor in the first scenario, where the figures are -0.2 and -0.7 percentage points for the average and worst performer respectively.
- Other risk factors produce much smaller effects for the average performer. This is also true for the worst performer, except, as could be argued, in the second scenario where the interest rate shocks cause a -0.3 percentage points reduction in the CAR.

Table 6. Impact on Capital Adequacy Ratio According to Risk Factor

	Expected Loss	Credit Growth	Share Prices	Interest Rates	Exchange Rates	Pension Funds	Total
In percentage points of capital adequacy ratio							
Baseline Scenario							
Average	0.04	-0.05	0.00	-0.02	0.02	-0.04	-0.05
Best	0.12	-0.02	0.00	0.01	0.05	0.00	0.03
Worst	0.02	-0.12	0.00	-0.07	0.00	-0.20	-0.17
Stress Scenario 1: Disruptive Adjustment							
Average	-0.25	-0.05	-0.22	0.03	-0.04	-0.77	-1.30
Best	-0.14	-0.02	0.00	0.28	0.00	0.00	-0.61
Worst	-0.66	-0.13	-0.43	-0.14	-0.09	-1.56	-1.92
Stress Scenario 2: Cyclical Asynchrony							
Average	-0.43	0.00	0.00	-0.10	0.02	-0.06	-0.58
Best	-0.23	0.00	0.00	0.23	0.05	0.00	-0.01
Worst	-1.06	-0.02	0.00	-0.33	0.00	-0.15	-1.19

Source: Banco de Portugal.

28. Box 2 discusses a number of accounting issues which are relevant in interpreting the response to shocks through banks' pension schemes. First, it should be noted that several banks already had excess losses in relation to the corridor limit, meaning that any further adverse development as a result of the shocks would have to be fully offset by extraordinary contributions from the bank proper. Second, while any losses outside of the corridor would be fully reflected into Tier 1 capital, the recognition in the profit and loss statement may be smoothed out over several years.

Box 2. Accounting Issues with Respect to Pension Stress Tests

Initial position within the corridor

Since January 1, 2005, the largest Portuguese banking groups prepare their consolidated financial statements in accordance with International Financial Reporting Standards/International Accounting Standards (IFRS/IAS). IFRS 1 regulates the first-time adoption of IFRS/IAS by institutions. Specifically on the issue related to employees benefits (pension funds), IFRS 1 provides for two options:

Restatement: Under IAS 19 an entity may elect to use a “corridor approach” that leaves some actuarial gains and losses unrecognized. IFRS 1 allows for the retrospective application of this approach requiring an institution to split the cumulative actuarial gains and losses from the inception of the plan until the date of transition to IFRS into a recognized portion and an unrecognized portion. This means that the entities which select the restatement option are required to determine actuarial gains or losses for each year since the inception of the plan in order to determine the net cumulative unrecognized gains or losses at the date of transition to IFRS.

Reset: Under this option an entity which is a first-time adopter of IFRS may elect to recognize all cumulative actuarial gains and losses at the date of transition to IFRS (determined under the previous GAAP), even if it uses the “corridor approach” for future actuarial gains and losses arising from the full application of IAS 19. These institutions start the application of IAS 19 with a “full available corridor”.

At the transition date to IFRS/IAS, the five banking groups which performed the pension fund stress test made use of the two options evenly (3 reset; 2 restatement). At the end of 2005, 3 institutions already had excess of losses in relation to the corridor limit.

Amortization of actuarial gains and losses

IAS 19 permits credit institutions to apply the “corridor approach” to actuarial gains and losses arising from its defined benefit pension plans, allowing them to recognize only a portion of those gains and losses as income or expense if the net cumulative unrecognized actuarial gains and losses at the end of the previous reporting period exceeds the greater of 10 percent of the present value of the defined benefit obligation at that date (before deducting plan assets); and 10 percent of the fair value of any plan assets at that date.

The period of recognition of such excesses is the expected average remaining working life of the employees covered by the pension plan (under the previous GAAP the amortization generally corresponded to a period of 10 years).

Portuguese credit institutions generally apply the corridor approach as their accounting policy for the recognition of actuarial gains and losses and this is the case for all 5 groups included in the stress test.

For those which already have excesses above the corridor limit, the length of the amortization period ranges from 15 to 20 years.

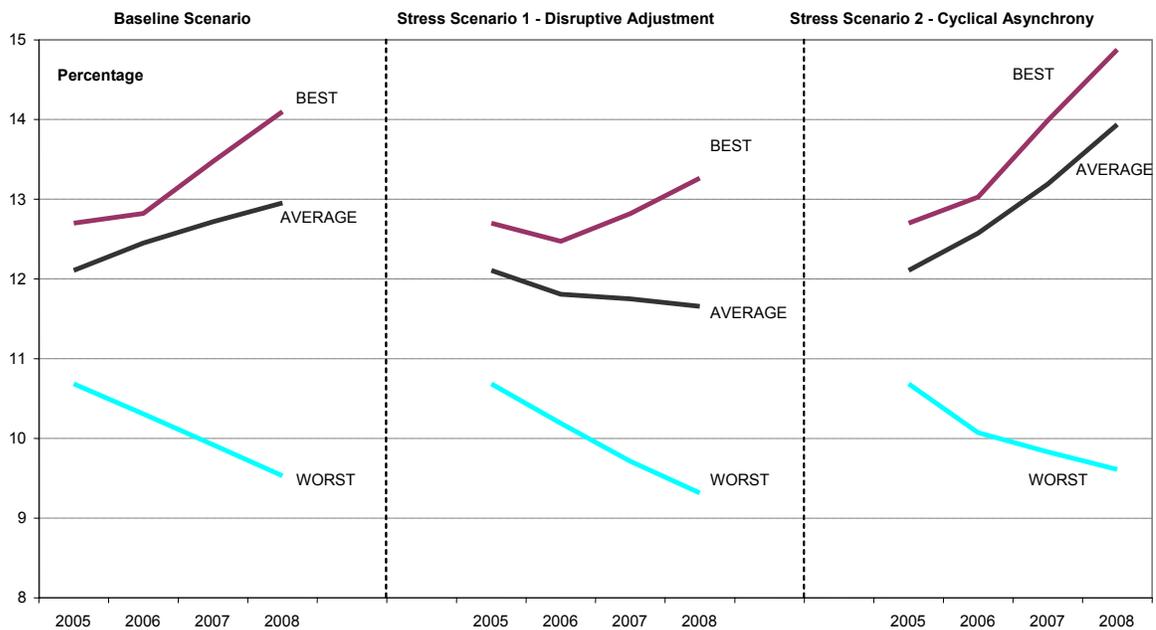
Results 3: Impact on overall solvency ratio

29. The overall impact of the scenarios on solvency levels presented in Figure 1 points to the general resilience of the system. Following the scenario shocks, the solvency ratio remains above 9 percent for all banks. The projection of banks’ solvency levels is based on the best estimates of banks’ balance sheets and profit and loss items, thus also taking into

account the accrual of income not impacted directly by shocks. The figure suggests the following interpretations:

- Baseline capitalization is relatively high, on average, and continues to grow over the projection horizon.
- The disruptive adjustment scenario reduces average capitalization but there is a wide divergence in performance across banks. The best performer still manages to improve its solvency position relative to 2005. The worst performer suffers a decline in the capital ratio of approximately 1.4 percentage points relative to the pre-shock level.
- The cyclical asynchrony scenario causes the average capital ratio to improve not only relative to 2005 but also relative to the projected baseline levels. The best performer manages to improve its solvency position well beyond the baseline projection. The worst performer suffers a decline in the capital ratio of about a percentage point.

Figure 1. Solvency Ratio



Source: Banco de Portugal.

Results 4: Impact on profitability

30. The impact of the different scenarios on profitability is shown in Table 7. It is clear that operating profits take a large hit following the shocks, which attests to the severity of the shocks imposed. The first scenario appears to be the most stressful, causing profits to fall to less than half the 2005 level. For the worst performer, profits are wiped out almost entirely even though this is partly a result of the bank's assumptions on interest accrual.⁷ The second scenario is milder: profits stay at their 2005-level for the average performer, and fall by half for the worst performer.

Table 7. Impact of Scenarios on Profitability

	2006	2007	2008
(in percent of 2005 operating profits)			
Baseline scenario			
Average	95.4	99.2	104.1
Best	105.0	122.0	133.5
Worst	55.0	73.6	75.0
Stress scenario 1: disruptive adjustment			
Average	49.4	48.9	39.7
Best	65.5	79.7	70.0
Worst	15.1	12.9	1.3
Stress scenario 2: cyclical asynchrony			
Average	102.8	102.5	100.0
Best	116.8	131.4	137.9
Worst	70.5	72.3	54.3

Source: Banco de Portugal.

⁷ The BdP cautioned about a likely underestimation of the operating income due to the reporting bank's assumptions underlying the interest accrual, even though regardless of this the solvency ratio remains above the average of the sample.

Results 5: Impact on liquidity

31. A qualitative survey of banks' liquidity positions, policies and reactions to shocks resulted in several findings. All banks are reported to have in place contingency procedures to deal with market liquidity constraints. Banks highlighted the need to be prepared for extreme market liquidity squeezes, including through securing interbank credit lines, maintaining adequate liquidity buffers, having in place procedures to liquidify less liquid securities as well as diversifying instruments across markets and investor profiles. Banks recognized that the most stressful situation would occur if international capital markets were to dry up—country-specific issues related to Portugal were deemed to have a smaller impact on liquidity conditions.

32. Banks suggested that a sovereign downgrade would primarily impact the price at which they are able to issue debt in the international money and debt securities markets. One bank with a large structural pool of liquid assets suggested that a 1-notch downgrade of Portuguese sovereign paper would have minor effects on its funding costs (4-5 basis points for the medium- to long-term segment, 1-2 basis points for the short-term debt securities segment, and nil in the money market segment). A 2-notch downgrade would triple the increase in the funding cost of debt securities (12-15 basis points in the medium- to long-term segment and 3-6 basis points in the short-term debt securities segment) as well as trigger potential quantitative reductions in available credit lines.

Sensitivity analysis

33. Table 8 presents the impact of sensitivity shocks on the CAR. The sensitivity shocks consist of various interest rate shocks: first, to short- and long-term rates jointly, implying a non-parallel shift in the yield curve; second, to long-term rates only, implying a pivoting of the yield curve. In addition, the sensitivity shocks include foreign exchange shocks, equity price shocks and shocks to the implied volatilities of financial market prices.

34. The overall results suggest that banks can withstand these individual shocks well. As expected, the equity price risk produces the strongest effects in relative terms (-0.48 percentage points for the worst performer) even though in absolute terms the impact on bank portfolios is quite limited. Interest rate risk yields the second largest effect especially in the case of a large interest rate hike affecting both short and long rates (-0.32 percent for the worst performer). The impact of foreign exchange risk is minor and that of volatility risk is negligible.

35. Table 9 shows the results of the sensitivity shocks for the defined-benefit pension schemes of banks' employees. The metric used is that of net assets (assets minus liabilities) over total liabilities. The impact of the shocks is measured in terms of the changes caused in this variable. The difference with the previous table is that shocks to the actuarial discount rate are incorporated in the first four shocks that cause a joint movement in rates.

Table 8. Bank Portfolios: Impact of Sensitivity Shocks on Capital Adequacy Ratio

	Short and Long Rates Jointly 1/				Long Rates Only		Euro		Equity		Volatilities	
	100 bps 50 bps up	100 bps 50 bps down	200 bps 100 bps up	200 bps 100 bps down	50 bps up	50 bps down	15% up	15% down	30% up	30% down	30% up	30% down
Impact on CAR	(In percentage points)											
Average	-0.04	0.03	-0.08	0.06	-0.01	0.02	0.02	-0.03	0.24	-0.25	0.00	0.00
Best	0.06	0.17	0.13	0.36	0.03	0.07	0.11	0.05	0.44	-0.11	0.01	0.00
Worst	-0.17	-0.06	-0.32	-0.11	-0.06	-0.04	-0.07	-0.11	0.11	-0.48	0.00	-0.01

Source: Banco de Portugal

Note:

1/ The upper and lower items are the shocks to the 3-month and 10-year interest rates, respectively.

Table 9. Pension Schemes: Impact of Sensitivity Shocks on Net Assets to Liabilities

	Short, Long, and Actuarial Rates Jointly 1/				Long Rates Only		Euro		Equity		Volatilities	
	100 bps 50 bps 25 bps up	100 bps 50 bps 25 bps down	200 bps 100 bps 50 bps up	200 bps 100 bps 50 bps down	50 bps up	50 bps down	15% up	15% down	30% up	30% down	30% up	30% down
Impact on net assets to liabilities 2/	(In percentage points)											
Average	3.16	-3.41	6.33	-6.94	-0.45	0.40	0.55	-0.55	9.34	-9.34	-0.08	0.09
Best	4.00	-2.21	7.83	-4.02	-0.12	0.94	1.41	-0.06	14.88	-5.26	0.63	2.44
Worst	2.69	-4.46	6.18	-9.17	-1.08	0.09	0.06	-1.41	5.26	-14.88	-2.76	-0.50

Source: Banco de Portugal.

Note:

1/ The upper, middle and lower values are the shocks to the 3-month interest rate, the 10-year interest rate and the actuarial discount rate, respectively.

2/ Asset minus liabilities as a percentage of total liabilities.

36. The results suggest a strong sensitivity to equity price and yield curve shocks. The impact of the equity price shock is large due to the magnitude of the shock and also the substantial exposure of pension funds to equity (for the two banks with the highest exposures, the share of equity to total assets is slightly below 40). The impact of downward changes in the yield curve is due to a large duration mismatch between pension scheme assets and liabilities. Falling rates cause net asset values to fall as well, primarily because of the large impact of a lower actuarial discount rate. The results further suggest minor effects arising from the changes in the euro exchange rate or in implied volatilities.

Robustness test

37. For illustrative purposes, a robustness test was conducted, which consisted of raising expected loss rates with a factor of 1.20 and 1.50. Table 10 shows the overall impact of the robustness test on the CAR for the best, worst, and average performers over the horizon of the three scenarios. It is clear that the incremental stress does not alter the bottom line

assessment that the system is in general well placed to absorb the shocks imposed by the scenarios. The worst performer's impact on capital worsens but not dramatically so.

Table 10. Robustness Tests: Capital Adequacy Ratio

	Robustness Test 1 Factor 1.2				Robustness Test 2 Factor 1.5		
	2005	2006	2007	2008	2006	2007	2008
	(percentages)						
Baseline Scenario							
Average	12.1	12.4	12.7	12.9	12.3	12.6	12.8
Best	12.7	12.8	13.4	14.1	12.7	13.4	14.0
Worst	10.7	10.1	9.8	9.4	9.9	9.5	9.2
Stress scenario 1: disruptive adjustment							
Average	12.1	11.7	11.7	11.5	11.6	11.5	11.3
Best	12.7	12.3	12.8	13.1	12.3	12.5	12.8
Worst	10.7	10.0	9.5	9.0	9.7	9.1	8.6
Stress scenario 2: cyclical asynchrony							
Average	12.1	12.5	13.1	13.8	12.4	13.0	13.7
Best	12.7	13.0	13.9	14.8	12.9	13.8	14.7
Worst	10.7	9.9	9.6	9.3	9.6	9.2	8.8

Source: Banco de Portugal.

38. Table 11 shows the isolated cumulative impact of the increase in expected loss. Thus, if the expected loss rate were to increase by half, the table suggests that the CAR of the worst performer would be expected to fall by 1.6 percentage points.

Table 11. Cumulative Impact of Expected Loss Factor

	Scenario 1 Disruptive Adjustment	Scenario 2 Cyclical Asynchrony
	(In percentage points)	
Expected loss		
Average	-0.3	-0.4
Best	-0.1	-0.2
Worst	-0.7	-1.1
1.2 times expected loss		
Average	-0.3	-0.5
Best	-0.2	-0.3
Worst	-0.8	-1.3
1.5 times expected loss		
Average	-0.4	-0.7
Best	-0.2	-0.4
Worst	-1.0	-1.6

Source: Banco de Portugal.

C. Top-Down Approach

Process

39. A second core part of the banking stress tests was a top-down exercise also implemented by the BdP. In contrast to the bottom-up approach, the primary focus here was to evaluate the impact of macroeconomic stress scenarios on the financial statements of the system (balance sheet, and profit and loss). As with the bottom-up exercise, the evaluation period under consideration is 2006-2008.

40. The exercise benefited from similar studies carried out over the last four years by the Research Department of the BdP. To map the macroeconomic scenarios into aggregate financial statements, various time-series equations were estimated. Explicit modeling was carried out for credit and deposit aggregates. Deposits were taken to correspond to those deposits held by the private nonfinancial resident sector in resident banks. Separate modeling was undertaken for deposits of households and nonfinancial corporations. The same distinction was made for credit. Tables 12 and 13 present key assumptions underlying the approach.⁸ A full description of the econometric methodology underlying these comprehensive tests is beyond the scope of this document.

⁸ “Top-down stress test exercise for the Portuguese banking sector,” mimeo, Banco de Portugal.

Table 12. Assumptions Underlying Balance Sheet Items

Assets		Liability and Capital Accounts	
Item	Assumptions	Item	Assumptions
Interbank assets	Set at the last known value (Dec. 2005).	Interbank liabilities	
Credit to customers	Gross loans to households and non-financial corporations were projected according to models. Deduction of impairment is performed in line with specific provisions projections according to model results.	Securities issued	These three items correspond to bank's market financing when taken in conjunction. This is the balance sheet's slack variable. In the event market financing decreases, the reduction is imputed to interbank liabilities. Otherwise, additional funding needs are accommodated in securities' issuance. Subordinated debt is kept constant.
Securities (includes investment in subsidiaries and associates book by the equity method)	Net acquisitions consistent with nominal GDP growth. Deduction of value changes: in 2006 a 30 per cent decline in stock prices was considered in the Disruptive adjustment scenario; estimations of fixed-income value changes considered according to each scenario.	Subordinated debt	
Non-financial assets	No transactions after Dec. 2005. Depreciations at a constant rate.	Funding from customers	Projected according to model for deposits of the non-financial private sector. An additional model projects the share of demand deposits for the purpose of simulating net interest income.
Other assets	Evolve according to nominal GDP growth.	Other liabilities	Projected according to nominal GDP growth.
		Capital and reserves	Accumulate with retained earnings (50% pay-out if positive). Available for sale and investment in associates' value changes are reflected in changes in reserves.

Source: Banco de Portugal.

Table 13. Assumptions Underlying the Profit and Loss Account

Net interest income	Reflects the joint dynamics of balance-sheet positions and implicit interest rates of major interest bearing assets and liabilities. Non-performing loans do not accrue interest.
Income from securities (dividends and other income from securities representing capital)	Baseline: fixed at the 2005 level (as a percentage of average total assets - ATA). Disruptive adjustment: in 2006, percentile 5 of a normal distribution with mean and standard deviation equal to the 1999-2005 historical series. Afterwards, linear trajectory towards baseline level. Cyclical asynchrony: simple average of the other two scenarios.
Net commission income	Baseline: fixed at the 1999-2005 sample average (as a percentage of ATA). Disruptive adjustment: in 2006, equal to the 2002 level, the minimum of the 1999-2005 historical series. Afterwards, linear trajectory towards baseline level. Cyclical asynchrony: simple average of the other two scenarios. In both disruptive adjustment and cyclical adjustment scenarios, value changes reported by banks in their portfolio of shares and bonds in the bottom up exercise were also taken into account.
Trading and foreign exchange gains	Baseline: fixed at the 2005 level in all scenarios (0.15 percent of ATA). <i>Summation item</i>
Other current income (net)	Average wage growth in line with macro-scenarios. Staff number reduction of 1 percent per year in all scenarios.
<i>Gross income</i>	Fixed at the 2005 level in all scenarios (0.15 percent of ATA).
Staff costs	Fixed at the 2005 level in all scenarios (0.15 percent of ATA).
Other administrative costs	Model-based projection.
Depreciation	Baseline: fixed at the 1999-2005 sample average (as a percentage of ATA). Disruptive adjustment: in 2006, percentile 5 of a normal distribution with mean and standard deviation equal to the 1999-2005 historical series. Afterwards, linear trajectory towards baseline level. Cyclical asynchrony: simple average of the other two scenarios.
Impairment and provisioning charges	Baseline: fixed at the 2005 level in all scenarios (0.15 percent of ATA). <i>Summation item</i>
Income from associates excluded from consolidation	13.5 percent of before-tax result.
<i>Net before tax income</i>	<i>Summation item</i>
Taxes on income	15.1 of net after-tax income.
<i>Net after-tax income (before minority interests)</i>	<i>Summation item</i>
Minority interests	<i>Summation item</i>
<i>Net income</i>	

Source: Banco de Portugal

Coverage of institutions and risk factors

41. Top-down stress tests were carried out only for banks. A total of thirteen banks were included, representing approximately 87 percent of system assets (as of end 2004). While all thirteen banks have adopted International Accounting Standards (IAS) in 2005, given data limitations in terms of detail and time series length of the consolidation accounts, most modeling work was carried out with solo basis data. The shift to IAS presented some challenges, in that certain individual balance sheet and profit and loss items had to be adjusted and made a bit broader so as to ensure comparability over time.

42. The main analytical focus of the top-down stress tests is on the quantification of future default intensity on the loan portfolio and the resulting impact on the profitability and capital adequacy of banks. Special attention is also given to equity market risk in the securities portfolio.

Calibration of shocks

43. The top-down stress tests are entirely scenario-based. The baseline scenario and two stress scenarios that were adopted are the same as those in the bottom-up stress tests.

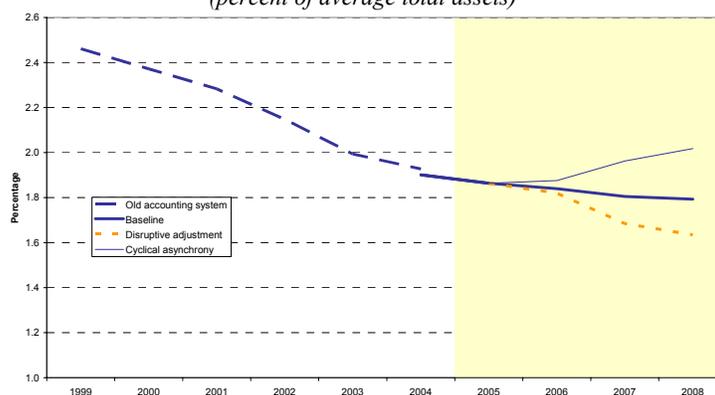
Results

44. Tables 14 and 15 show the projected balance sheet and profit and loss accounts for the banking groups included in the top-down stress tests. The projected items are based on the econometric relationships estimated between key variables, the assumptions outlined before, and the macroeconomic projections under the baseline scenario and two stress scenarios.

45. Table 16 outlines the key results of the top-down stress tests, expressed in percentage of total average assets.

- The fall in interest rates projected in the disruptive adjustment scenario causes a corresponding fall in net interest income over the horizon of the stress test. By 2008, net interest income stands at 1.6 percent of total assets under this scenario, which compares to 1.8 percent relative to the baseline. The opposite effect holds for the cyclical adjustment scenario, where net interest income rises to 2.0 percent as a result of the rate hike.

Figure 2. Net Interest Income
(percent of average total assets)

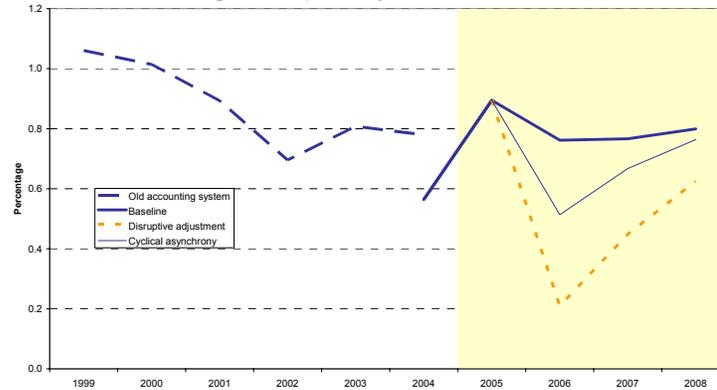


Source: Banco de Portugal.

- The before-tax return on average assets falls sharply in 2006 but recovers afterwards. Relative to baseline (0.9 percent), the return on assets (ROA) falls in 2006 to 0.2 and 0.6 percent, under the disruptive adjustment and cyclical asynchrony scenarios, recovering by 2008 to 0.7 and 0.9 percent, respectively.

- The solvency ratio remains flat under the baseline, but experiences a significant drop under the disruptive adjustment scenario (from 11.1 to 9.3 percent in 2008). In part due to the positive impact on net interest income, the solvency ratio under the cyclical asynchrony scenario improves from 11.1 to 12.3 percent).

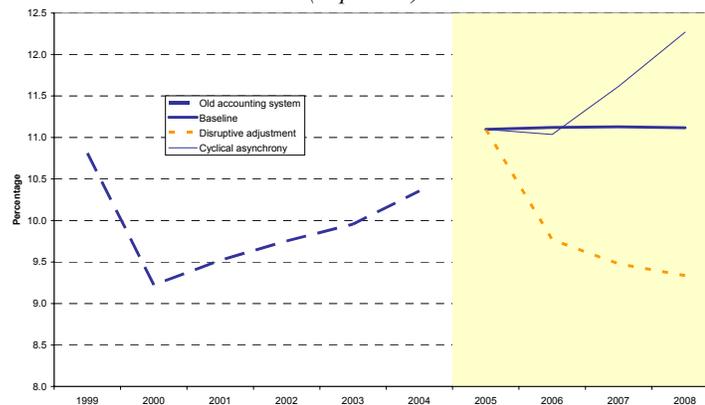
Figure 3. Return on Assets
(percent of average total assets)



Source: Banco de Portugal.

- Overdue loans rise under both scenarios relative to total assets. The rise in the disruptive adjustment scenario is however much smaller (from 2.2 to 2.5, in 2008) than in the cyclical asynchrony scenario (from 2.2 to 3.8 percent). Heightened credit risk under the latter scenario is the direct result of higher interest rates in a recessionary environment. As a consequence, impairment and provisioning charges also rise by more under this scenario.

Figure 4. Solvency Ratio
(in percent)



Source: Banco de Portugal.

Table 14. Balance Sheet Developments and Projections

	Levels					Growth			
	04	05	06	07	08	05	06	07	08
Baseline	(In millions of euro)					(percent yoy)			
Interbank assets	32,596	37,109	37,109	37,109	37,109	13.8	0.0	0.0	0.0
Credit to customers	194,873	213,945	222,092	231,253	241,558	9.8	3.8	4.1	4.5
Securities	30,688	37,346	38,246	39,535	41,004	21.7	2.4	3.4	3.7
Non-financial assets	3,611	3,895	3,895	3,895	3,895	7.9	0.0	0.0	0.0
Other assets	10,643	13,068	13,382	13,833	14,347	22.8	2.4	3.4	3.7
Total assets	272,411	305,363	314,725	325,626	337,914	12.1	3.1	3.5	3.8
Market financing 1/	105,588	123,293	129,139	137,128	144,625	16.8	4.7	6.2	5.5
Funding from customers	142,784	149,142	151,386	152,691	155,672	4.5	1.5	0.9	2.0
Other liabilities	10,013	15,239	15,606	16,132	16,731	52.2	2.4	3.4	3.7
Capital and reserves	14,025	17,689	18,594	19,675	20,885	26.1	5.1	5.8	6.2
Net income (before minority interests)	1,520	2,202	2,363	2,455	2,653	44.9	7.3	3.9	8.1
Disruptive adjustment									
Interbank assets	32,596	37,109	37,109	37,109	37,109	13.8	0.0	0.0	0.0
Credit to customers	194,873	213,945	224,846	236,818	247,812	9.8	5.1	5.3	4.6
Securities	30,688	37,346	36,316	36,742	37,216	21.7	-2.8	1.2	1.3
Non-financial assets	3,611	3,895	3,895	3,895	3,895	7.9	0.0	0.0	0.0
Other assets	10,643	13,068	13,290	13,446	13,619	22.8	1.7	1.2	1.3
Total assets	272,411	305,363	315,456	328,011	339,652	12.1	3.3	4.0	3.5
Market financing 1/	105,588	123,293	133,666	146,157	156,622	16.8	8.4	9.3	7.2
Funding from customers	142,784	149,142	149,439	148,371	148,187	4.5	0.2	-0.7	-0.1
Other liabilities	10,013	15,239	15,498	15,680	15,882	52.2	1.7	1.2	1.3
Capital and reserves	14,025	17,689	16,948	17,896	19,055	26.1	-4.2	5.6	6.5
Net income (before minority interests)	1,520	2,202	752	1,667	2,411	44.9	-65.9	121.8	44.6
Cyclical asynchrony									
Interbank assets	32,596	37,109	37,109	37,109	37,109	13.8	0.0	0.0	0.0
Credit to customers	194,873	213,945	216,098	212,993	209,185	9.8	1.0	-1.4	-1.8
Securities	30,688	37,346	37,583	38,118	38,711	21.7	0.6	1.4	1.6
Non-financial assets	3,611	3,895	3,895	3,895	3,895	7.9	0.0	0.0	0.0
Other assets	10,643	13,068	13,202	13,413	13,636	22.8	1.0	1.6	1.7
Total assets	272,411	305,363	307,887	305,528	302,537	12.1	0.8	-0.8	-1.0
Market financing 1/	105,588	123,293	125,326	123,770	120,577	16.8	1.6	-1.2	-2.6
Funding from customers	142,784	149,142	149,386	147,334	146,214	4.5	0.2	-1.4	-0.8
Other liabilities	10,013	15,239	15,395	15,641	15,902	52.2	1.0	1.6	1.7
Capital and reserves	14,025	17,689	17,780	18,783	19,844	26.1	0.5	5.6	5.6
Net income (before minority interests)	1,520	2,202	1,576	2,048	2,323	44.9	-28.4	29.9	13.5

Source: Banco de Portugal.

1/ Market financing includes interbank liabilities, securities issued and subordinated debt.

Table 15. Profit and Loss Developments and Projections

	Levels					Growth			
	04	05	06	07	08	05	06	07	08
Baseline	(In millions of euro)					(percent yoy)			
Net interest income	5,119	5,384	5,704	5,781	5,948	5.2	5.9	1.4	2.9
Income from securities	161	217	212	219	227	34.4	-2.1	3.3	3.6
Net comission income	1,923	2,213	2,375	2,453	2,542	15.1	7.3	3.3	3.6
Gains and losses on financial operations	730	1,397	1,073	1,108	1,148	91.3	-23.2	3.3	3.6
Other current income (net)	602	429	472	487	505	-28.7	10.0	3.3	3.6
<i>Gross income</i>	8,535	9,640	9,836	10,048	10,370	12.9	2.0	2.2	3.2
Staff costs	3,667	3,301	3,364	3,424	3,486	-10.0	1.9	1.8	1.8
Other administrative costs	1,891	1,978	2,123	2,193	2,272	4.6	7.3	3.3	3.6
Depreciations	562	466	499	515	534	-17.2	7.2	3.3	3.6
Impairment and provisioning charges	1,291	1,272	1,579	1,554	1,505	-1.5	24.1	-1.6	-3.2
Income from associates excluded from consolidation (net)	625	363	460	475	493	-41.8	26.8	3.3	3.6
<i>Net before tax income</i>	1,749	2,987	2,731	2,837	3,066	70.8	-8.6	3.9	8.1
Taxes on income	228	402	368	382	413	76.3	-8.6	3.9	8.1
<i>Net after tax income (before minority interests)</i>	1,521	2,585	2,363	2,455	2,653	70.0	-8.6	3.9	8.1
Minority interests	236	383	357	371	401	62.2	-6.9	3.9	8.1
<i>Net income</i>	1,284	2,202	2,006	2,084	2,252	71.4	-8.9	3.9	8.1
Disruptive adjustment									
Net interest income	5,119	5,384	5,649	5,420	5,458	5.2	4.9	-4.1	0.7
Income from securities	161	217	150	188	229	34.4	-31.0	25.4	21.8
Net comission income	1,923	2,213	1,706	2,117	2,558	15.1	-22.9	24.1	20.8
Gains and losses on financial operations	730	1,397	490	1,001	1,148	91.3	-64.9	104.1	14.7
Other current income (net)	602	429	472	490	508	-28.7	10.1	3.6	3.8
<i>Gross income</i>	8,535	9,640	8,468	9,214	9,900	12.9	-12.2	8.8	7.4
Staff costs	3,667	3,301	3,349	3,386	3,425	-10.0	1.5	1.1	1.2
Other administrative costs	1,891	1,978	2,126	2,203	2,286	4.6	7.5	3.6	3.8
Depreciations	562	466	590	611	634	-17.2	26.7	3.6	3.8
Impairment and provisioning charges	1,291	1,272	1,819	1,673	1,640	-1.5	43.1	-8.1	-2.0
Income from associates excluded from consolidation (net)	625	363	168	326	496	-41.8	-53.7	93.7	52.0
<i>Net before tax income</i>	1,749	2,987	752	1,667	2,411	70.8	-74.8	121.8	44.6
Taxes on income	228	402	101	225	325	76.3	-74.8	121.8	44.6
<i>Net after tax income (before minority interests)</i>	1,521	2,585	650	1,442	2,086	70.0	-74.8	121.8	44.6
Minority interests	236	383	98	218	315	62.2	-74.4	121.8	44.6
<i>Net income</i>	1,284	2,202	552	1,225	1,771	71.4	-74.9	121.8	44.6
Cyclical asynchrony									
Net interest income	5,119	5,384	5,751	6,019	6,134	5.2	6.8	4.7	1.9
Income from securities	161	217	179	195	208	34.4	-17.5	8.7	7.0
Net comission income	1,923	2,213	2,017	2,184	2,329	15.1	-8.9	8.3	6.7
Gains and losses on financial operations	730	1,397	965	1,085	1,057	91.3	-30.9	12.4	-2.6
Other current income (net)	602	429	467	467	463	-28.7	8.8	0.0	-0.9
<i>Gross income</i>	8,535	9,640	9,378	9,949	10,191	12.9	-2.7	6.1	2.4
Staff costs	3,667	3,301	3,364	3,424	3,489	-10.0	1.9	1.8	1.9
Other administrative costs	1,891	1,978	2,100	2,100	2,082	4.6	6.1	0.0	-0.9
Depreciations	562	466	583	583	578	-17.2	25.1	0.0	-0.9
Impairment and provisioning charges	1,291	1,272	1,821	1,858	1,809	-1.5	43.2	2.0	-2.6
Income from associates excluded from consolidation (net)	625	363	311	383	451	-41.8	-14.4	23.3	17.8
<i>Net before tax income</i>	1,749	2,987	1,822	2,367	2,685	70.8	-39.0	29.9	13.5
Taxes on income	228	402	245	319	362	76.3	-39.0	29.9	13.5
<i>Net after tax income (before minority interests)</i>	1,521	2,585	1,576	2,048	2,323	70.0	-39.0	29.9	13.5
Minority interests	236	383	238	309	351	62.2	-37.9	29.9	13.5
<i>Net income</i>	1,284	2,202	1,338	1,739	1,973	71.4	-39.2	29.9	13.5

Source: Banco de Portugal.

Table 16. Projected Profit and Loss Items Relative to Total Average Assets

	Baseline				Disruptive Adjustment				Cyclical Asynchrony			
	04	05	06	07	08	06	07	08	06	07	08	
	(In percent unless otherwise noted)											
Net interest income	1.9	1.9	1.8	1.8	1.8	1.8	1.7	1.6	1.9	2.0	2.0	
Income from securities	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	
Net commission income	0.7	0.8	0.8	0.8	0.8	0.5	0.7	0.8	0.7	0.7	0.8	
Gains and losses on financial operations	0.3	0.5	0.3	0.3	0.3	0.2	0.3	0.3	0.3	0.4	0.3	
Other current income (net)	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	
Gross income	3.2	3.3	3.2	3.1	3.1	2.7	2.9	3.0	3.1	3.2	3.4	
Staff costs	1.4	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.1	1.1	1.1	
Other administrative costs	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	
Depreciations	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	
Impairment and provisioning charges	0.5	0.4	0.5	0.5	0.5	0.6	0.5	0.5	0.6	0.6	0.6	
Income from associates excluded from consolidation (net)	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
Net before tax income	0.6	1.0	0.9	0.9	0.9	0.2	0.5	0.7	0.6	0.8	0.9	
Taxes on income	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	
Net after tax income (before minority interests)	0.6	0.9	0.8	0.8	0.8	0.2	0.4	0.6	0.5	0.7	0.8	
Minority interests	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	
Net income	0.5	0.8	0.6	0.7	0.7	0.2	0.4	0.5	0.4	0.6	0.6	
Total assets (billions of euros, average)	269.2	288.9	310.0	320.2	331.8	310.4	321.7	333.8	306.6	306.7	304.0	
Capital and reserves (billions of euros, average)	15.6	15.9	18.1	19.1	20.3	17.3	17.4	18.5	17.7	18.3	19.3	
ROE (before minority interests)	9.8	16.3	13.0	12.8	13.1	3.8	8.3	11.3	8.9	11.2	12.0	
Solvency ratio	10.4	11.1	11.1	11.1	11.1	9.8	9.5	9.3	11.0	11.6	12.3	
Tier 1 solvency ratio	7.3	8.3	8.4	8.6	8.7	7.2	7.0	7.0	8.3	8.8	9.4	
Cost-to-income	65.1	54.8	55.8	55.9	55.5	64.7	60.7	57.7	58.3	55.5	54.7	
Overdue loans (& total loans)	1.9	2.2	2.5	2.6	2.5	2.6	2.6	2.5	2.8	3.5	3.8	
Overdue loans (& total assets)	1.3	1.6	1.9	1.9	1.8	1.9	1.9	1.8	2.0	2.4	2.6	

Source: Banco de Portugal

46. Table 17 provides further background to the results by examining the resilience of key counterparts to the stress scenarios. With regard to households, the results suggest that, under the disruptive adjustment scenario, households' indebtedness is projected to rise relative to disposable income, from 119 percent in 2005 to 138 percent in 2008. This is primarily the result of the lower interest rates projected under this scenario, which is also reflected in the fact that households' debt burden (interest only) actually falls in this scenario. However, under the cyclical asynchrony scenario, households' indebtedness falls from 119 percent to 109 percent, while the debt burden rises from 5.1 percent to 8 percent.

47. With regard to non-financial corporations, the table suggests that indebtedness falls from 96.9 percent to 96.3 and 91.9 percent, under the disruptive adjustment and cyclical asynchrony scenarios. The debt burden, however, falls from 3.8 percent to 2.6 percent and rises to 5.7 percent, under the respective scenarios.

Table 17. Development of Counterparty Indebtedness

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Households' indebtedness (%Disposable income)									
Baseline	87	92	99	106	112	119	122	123	123
Disruptive adjustment	87	92	99	106	112	119	125	132	138
Cyclical asynchrony	87	92	99	106	112	119	119	115	109
Households' debt burden - interest only (%Disposable income)									
Baseline	5.3	6.3	5.6	5.1	5.0	5.1	5.4	5.6	5.7
Disruptive adjustment	5.3	6.3	5.6	5.1	5.0	5.1	4.1	4.0	4.3
Cyclical asynchrony	5.3	6.3	5.6	5.1	5.0	5.1	6.9	7.6	8.0
Nonfinancial corporations indebtedness (%GDP)									
Baseline	81.0	91.5	93.4	95.9	94.1	96.9	96.7	96.4	96.3
Disruptive adjustment	81.0	91.5	93.4	95.9	94.1	96.9	96.4	96.2	96.3
Cyclical asynchrony	81.0	91.5	93.4	95.9	94.1	96.9	96.7	94.5	91.9
Nonfinancial corporations' debt burden - interest only (%GDP)									
Baseline	4.2	5.0	4.5	4.0	3.8	3.8	3.9	3.9	3.9
Disruptive adjustment	4.2	5.0	4.5	4.0	3.8	3.8	3.6	2.7	2.6
Cyclical asynchrony	4.2	5.0	4.5	4.0	3.8	3.8	4.2	5.2	5.7
Household debt y-o-y growth rate(a)									
Baseline	19.8	12.2	11.8	9.9	10.4	9.0	5.6	4.5	4.2
Disruptive adjustment	19.8	12.2	11.8	9.9	10.4	9.0	8.9	8.0	6.0
Cyclical asynchrony	19.8	12.2	11.8	9.9	10.4	9.0	2.0	-1.5	-2.6
Non-financial corporations debt y-o-y growth rate (a)									
Baseline	18.8	19.7	7.0	4.4	1.6	4.0	0.7	2.7	3.5
Disruptive adjustment	18.8	19.7	7.0	4.4	1.6	4.0	-0.4	0.5	1.4
Cyclical asynchrony	18.8	19.7	7.0	4.4	1.6	4.0	-0.7	-1.3	-1.3

Source: Banco de Portugal

Note: (a) Total interest bearing debt

D. Additional Approaches

Corporate credit risk study

48. This study looks further into the impact of corporate credit defaults on the banking sector.⁹ While the top-down approach only provides a central projection of losses, this exercise attempts to estimate loss distributions across banks for the corporate loan portfolio. Quarterly measures of sectoral credit default rates are constructed using data from the Portuguese credit registry database, drawing from a sample of almost 2 million observations ranging from 1995: Q1 to 2004:Q4. A binary response model with a probit specification is estimated, with the default rates of each sector being explained in terms of macroeconomic variables, sector-specific data and other factors. The estimated model is used to Monte Carlo simulate the loss distribution of banks stemming from credit defaults. Thus, simulated loss distributions are obtained for the baseline scenario and the two stress scenarios.

49. The results of this exercise suggest that the expected loss in 2008 increases 101 and 139 percent relative to the baseline in stress scenarios 1 and 2, respectively. The median loss more than doubles relative to the baseline in both scenarios. For the 95th percentile of losses, the increase is 66 and 89 percent relative to the baseline, respectively.

50. Thus, the cyclical asynchrony scenario is more adverse than the disruptive adjustment scenario. This result is also true once we look at the entire distribution of losses in both stress scenarios.

51. The implications of the scenarios for the capital adequacy ratio are shown in Table 18. The probability that the CAR in 2008 lies below 10.8 percent is 0.5 percent in the baseline. The 0.5-percent probability CAR level under the two shock scenarios are respectively: 10.1 percent and 9.9 percent. This suggests that the impact of risk on the CAR is well within internationally accepted norms, such as in the Basel II Capital Accord.

⁹ António Antunes, “Assessing the distribution of loan losses in the corporate sector” and “The variability of losses and their impact on the capital adequacy ratio”, Mimeo, Research Department, Banco de Portugal.

Table 18. Implications of Simulations for Capital Adequacy Ratio

		2006	2007	2008
Disruptive adjustment	p0.5	-0.1	-0.4	-0.7
	p1	0	-0.2	-0.6
	average	0.6	0.4	0.1
	p50	0.6	0.4	0.2
Cyclical asynchrony	p0.5	-0.1	-0.5	-0.9
	p1	0	-0.3	-0.8
	average	0.6	0.4	0
	p50	0.7	0.4	0.1

Source: Banco de Portugal

Macro-financial interactions study

52. The second complementary study analyzes the two-way interaction between the banking sector and the wider macroeconomic environment, thus incorporating the feedback effect of financial variables onto the macroeconomy.¹⁰ The sample period over which this study will be performed is restricted to 1990Q1-2004Q4, in view of constraints on data availability and structural breaks.

53. This study examines the response of macroeconomic variables to monetary policy and technology shocks by means of a vector autoregressive (VAR) approach. The VAR is then augmented to include several financial variables, including the non-performing loan ratio, the term structure, the change in the stock of credit to households and non-financial corporations, the change in stock prices and the change in housing prices. The results of this study suggest that the response of the Portuguese economy to technology and monetary policy shocks is in line with what is found for the main advanced economies: financial variables respond significantly to the shocks.

54. The study assesses the significance of the feedback from financial variables to the macroeconomy. This is achieved by examining to what extent financial variables can be considered as exogenous variables in the regressions and by calculating the response paths for consumption, investment and inflation when shocks to financial variables are introduced. The study finds that real macroeconomic variables respond sizeably and significantly to the identified financial shocks, thus attesting to the existence of an empirical feedback relationship from the financial to the real side of the economy. However, the impact of

¹⁰ Nuno Alves. "Dynamic Interactions between Real and Financial Variables in Portugal," mimeo, Banco de Portugal.

financial shocks in explaining the dynamics of the data was found to be small within the sample period.

III. INSURANCE STRESS TESTS

55. In what follows, the insurance stress tests are discussed. Two approaches were implemented: bottom-up and top-down. Whereas a range of risk factors will be considered in the bottom-up stress tests, the top-down stress test examines only one risk factor, namely that of catastrophic risk (related to the possibility of a large earthquake). The first two sections will discuss the process, coverage of institutions and risks, and calibration of shocks for the bottom-up and top-down approaches, respectively. The third section will discuss the individual results under both approaches as well as the combined results taking into account a plausible correlation structure between risk factors.

A. Bottom-Up Approach

Process

56. The Instituto de Seguros de Portugal, the Portuguese insurance supervisor coordinated a bottom-up exercise implemented by individual insurance companies. The exercise built upon experience with the analysis already developed within CEIOPS for the Preparatory Field Study (PFS) and the Quantitative Impact Studies (QIS). The ISP contacted insurance companies, oversaw the implementation of the exercise and validated the results. The ISP summarized its findings in a report provided the FSAP team, which in large part is reflected in this write-up.

57. The validation process consisted of a detailed comparison of balance sheet items reported for the purpose of this exercise with those reported as part of the regular supervisory process and an in-depth analysis of individual shock results. Final validation of results was obtained following discussions with participating companies.

Coverage of institutions and risk factors

58. The stress tests were performed on a representative sample of life, nonlife and composite insurance companies. The largest companies for each line of business were represented. Specifically, the sample included four life, two nonlife and three composite companies, where for the composite companies the analysis was performed separately for their nonlife and life businesses. Thus, the sample could be considered to reflect seven life and five nonlife undertakings. No reinsurance companies were included in the sample, given that there is only one such institution in Portugal and the operations of this institution are of modest size.

59. The participating companies represent 78 and 64 percent of the life and nonlife insurance sector, as measured by direct insurance premiums written in 2005. In terms of technical provisions, the sample represents 76 and 59 percent of the life and nonlife business.

60. The sample is representative in terms of market coverage, market structure and product coverage. The Portuguese market is highly concentrated for the life and nonlife segments, with the top 5 companies representing 82 percent of the life market in terms of insurance premiums written and 67 percent of the nonlife market in terms of technical provisions. This sample includes the four largest companies for the life business as well as three small- and medium-sized enterprises. For the nonlife business, all participating companies belong to the top 10. The products and lines of businesses considered by participating companies are highly representative. Product coverage was consistently above 94 percent of the current value of technical provisions. Products excluded were old insurance contracts of minor importance.

61. The following life insurance undertakings were represented with the market share measured by direct insurance premiums written in 2005 between brackets: Allianz (0.9 percent market share), BPI Vida (21.9 percent), Fidelidade Mundial (15.9 percent), Império Bonança (1.0 percent), Ocidental Vida (22.2 percent), Tranquilidade Vida (13.2 percent) and Zurich Vida (0.6 percent). The sample of nonlife insurance undertakings was as follows with the market share measured by technical provisions as of end 2005 between brackets: Allianz (7.4 percent), Fidelidade Mundial (22.2 percent), Império Bonança (17.1 percent), Tranquilidade (10.2 percent) and Zurich (7.4 percent).

62. Participating institutions reported on a legal entity basis, which corresponds to how insurance companies report to the ISP. Thus, in cases where several insurance companies belong to the same group, these companies reported to the ISP independently. Companies with international operations only included their domestic operations, which is not a significant omission given the low importance of international activities.

63. The exercise consisted of two parts. First, a market-consistent value was calculated for both assets and liabilities. Second, sensitivity tests were carried out on the market-consistent balance sheets and the impact on insurer's capital requirements was derived. The reported values are based on the situation as of end 2005.

64. The valuation exercise required a recalculation of assets and liabilities in order to ensure the proper reflection of their market values. On the asset side, it must be noted that most assets are already accounted for at market value, the exceptions being: bonds which can be accounted for at amortized cost, and unquoted assets which are accounted for at prudent value. The valuation adjustments thus only concerned a recalculation of the values of bonds and unquoted assets. On the liability side, a market-consistent value was calculated. The valuation of liabilities, including contractual and discretionary liabilities to policyholders, was valued on the basis of a best estimate and a risk margin on the 75th percentile.

65. The risk factors included both financial risks and insurance-specific risks. The financial risks considered in the exercise were market risks (interest rate, equity, real estate and foreign exchange) and credit risk. The insurance-specific risks consisted of life underwriting risks (biometric and lapse). In addition, for the purpose of the risk-based capital

adequacy formula, it was assumed that the nonlife underwriting risk for premium and reserve risk corresponded to Solvency I capital requirements.

Calibration of shocks

66. The proposed shocks were calibrated with reference to earlier studies carried out within CEIOPS (Table 19). In particular, the shocks were chosen to reflect an insolvency probability of maximum 0.5 percent within one year, consistent with the level supported by CEIOPS and other international bodies. Following consultation with the BdP, the ISP recalibrated the real estate price shock applied within CEIOPS from -30 to -5 percent, so as to make it more realistic given the absence of a real estate bubble in the Portuguese market. The shocks applied are sensitivity shocks and thus occur in isolation. No management response is considered. In calculations, only the investments and liabilities for which the insurer bears the risk are taken into account. Unit-linked liabilities for which the policyholder bears the investment risk were excluded.

Table 19. Overview of Shocks Under the Bottom-Up Approach

Risk factor	Nature of shock	Size of shock
<i>Financial risks</i>		
Interest rate risk	Shift in yield curve 1/	94 bps up 94 bps down
Foreign currency risk	Change of euro exchange rates	15 percent up 15 percent down
Equity price risk	Change of equity prices	35 percent up 35 percent down
Real estate risk	Change in real estate values	5 percent up 5 percent down
Credit risk	Implementation of simplified method based on standardized approach under Basel II	0 percent for AAA to AA- 20 percent for A+ to A- 50 percent for BBB+ to BBB- 100 percent for BB+ to B- 150 percent for below B- 100 percent for unrated
<i>Life underwriting risks</i>		
Biometric risk	Change in mortality table	15 percent up 15 percent down
Lapse risk	Change in lapse rate	50 percent up 50 percent down
<i>Non-Life underwriting risks</i>		
Premium and reserve risk	Adoption of Solvency 1 capital requirement 2/	

Notes:

1/ This corresponds to a 30 percent movement in the five-year rate.

2/ More advanced methodologies for estimating these risks are being tested under QIS2.

Results

Revaluation of assets and liabilities

67. Table 20 shows the valuation effects that arise from the current basis to a market-consistent/best-estimate approach for assets and liabilities. On aggregate the results suggest that the value of assets is increased by 0.6 percent, whereas the value of liabilities is reduced by 0.7 percent. As a result, the free surplus rises by 17.5 percent, thus improving the average initial financial position of insurance companies.

68. The decrease in liabilities can be attributed to the discounting of nonlife liabilities, even though the overall effect is small since a high proportion of nonlife provisions relate to short-tailed business (e.g. motor and property insurance).

Table 20. Impact of Revaluation

	Current Basis	Following Revaluation
(In millions of euro)		
Liabilities	30,720	30,499
Assets	33,010	33,190
Free surplus	2,288	2,690

Source: Instituto de Seguros de Portugal.

Impact of risk factors

69. Table 21 shows the overall impact of each risk factor on the free surplus. The results suggest that the equity price shock produces the largest negative impact on the free surplus. This is followed in importance by the adoption of nonlife Solvency I, interest rate risk and credit risk. The small real estate shock, the foreign exchange shock, and the life underwriting risks all have small effects.

Table 21. Impact of Risk Factors

Risk factor	(in millions of euros)
Interest rate risk	
Total effect (b-a)	268.1
Effect on assets (a)	569.6
Effect on liabilities (b)	837.7
Equity risk	775.4
Real estate risk	50.5
Foreign exchange risk	7.7
Credit risk	219.7
Life biometric risk	94.2
Life lapse risk	97.1
Nonlife Solvency I	403.2

Source: Instituto de Seguros de Portugal.

70. Note that in the table above, the reported value for the impact of interest rate risk corresponds to a fall in the term structure of interest rates as applied to all companies alike.

While this corresponds to the worst-case scenario for the market as a whole, for some companies the worst-case shock would be an increase in the term structure of interest rates. Note that for the market as a whole, an increase in the term structure of interest rates would have a positive aggregate impact of 153.4 million euros.

71. Table 22 decomposes the impact of shocks for individual insurance companies. Specifically, the table presents for each insurance company the statutory solvency requirement according to Solvency I, the free surplus resulting from the revaluation of assets and liabilities, as well as the importance of individual risk factors measured as the ratio of the impact of the recalculated free surplus. In calculating individual solvency effects, the worst-case scenario is considered on an individual basis. Thus, the hypothetical situation may arise in which a simultaneous increase in the term structure of interest rates for one company would be compatible with a simultaneous decrease in the term structure for another company.

Table 22. Solvency Impact

Company	Life				Nonlife		Composite		
	A	B	C	D	E	F	G	H	I
(In millions of euros)									
Revaluation									
Statutory requirement	203	134	208	18	54	46	402	150	71
Free surplus	420	148	395	127	165	122	981	177	182
(In percent)									
Shocks									
Interest rate	22.9	17.1	13.8	9.4	6.5	7.7	12.1	30.6	3.4
Equity	12.6	46.5	72.8	13.7	26.5	6.3	26.2	14.7	9.2
Real estate	0.8	0.0	1.0	0.0	4.7	2.0	2.1	4.5	2.5
Foreign exchange	0.1	1.3	0.0	0.0	0.0	0.0	0.4	0.8	0.0
Credit	3.4	47.0	25.0	3.6	6.0	2.7	0.9	4.7	1.8
Life biometric	0.8	0.1	5.6	7.5			5.7	3.0	0.1
Life lapse	0.9	0.9	17.6	12.4			0.9	0.8	0.0
Nonlife Solvency I					33.1	38.0	15.3	58.6	26.3

Source: Instituto de Seguros de Portugal.

72. Table 23 identifies, for cases where the direction of the shock may produce opposite results for different companies, in which direction the shock produces the worst-case effect.

Table 23. Direction of Impact

	Interest rate risk	Underwriting risk	Lapse risk
Life companies			
Company A	▼	▲	▲
Company B	▲	▲	▼
Company C	▼	▲	▲
Company D	▲	▲	▲
Non-life companies			
Company E	▲		
Company F	▲		
Composite companies			
Company G	▼	▲	▼
Company H	▼	▼	▲
Company I	▲	▲	▼

Source: Instituto de Seguros de Portugal

Note: ▲ denotes an increase in the risk factor and ▼ denotes a decrease in the risk factor

73. While the results point to a fair amount of differentiation across insurance companies, it is clear that all companies can withstand individual shocks. The interest rate shock could reduce up to 30.6 percent of the free surplus for one mixed company and 22.9 percent of one life company. One life company holding a significant share of equity investments (approximately 25 percent) would suffer particularly from a stock market crash, causing a reduction in the free surplus of 72.8 percent. Credit risk appears important for only two life companies (47 and 25 percent reduction). Life lapse risk is important for one life company (17.6 percent reduction). Adoption of Solvency I to cover nonlife underwriting risks would absorb a major part of the free surplus (up to 58.6 percent reduction). As in the aggregate, the impact of real estate risk and foreign exchange risk and, where relevant, life biometric risk is small for all companies.

B. Top-Down Approach

Process

74. In addition to the previous exercise, a top-down exercise was conducted by ISP to measure the sensitivity of the nonlife sector to catastrophic risk ('CAT risk'). The ISP conducted the exercise on the basis of the techniques adopted in the QIS2 exercise within CEIOPS for measuring nonlife CAT risk. Loss estimates were provided by an international reinsurance broker.

Coverage of institutions and risk factors

75. The sample of institutions consisted of four selected nonlife insurance companies operating in the Portuguese insurance market.

76. The selection of a CAT event took into account the likelihood of natural disasters in the Portuguese territory. Due its geographical position, on the western portion of the Iberian peninsula, where a complicated pattern of micro-plates, in relative motion with each other and with the other major tectonic plates, Portugal is exposed to a non-negligible risk of severe seismic activity. Almost all of the country's territory is susceptible to earthquakes.

77. The occurrence of a severe earthquake was the selected scenario for the stress testing of the Portuguese insurance market's financial capacity and responsiveness. The occurrence of an earthquake with severity was considered to correspond to a frequency probability of 1/250 years. The last severe earthquake dates back to 1755, exactly 251 years ago.

78. For simplicity, only property insurance was considered, namely policies on buildings and contents covering the specific peril of seismic hazard.

Calibration of shocks

79. The earthquake scenario was applied using the "Market Loss" technique, which is also being used by CEIOPS for measuring nonlife CAT risk on the QIS 2 exercise, currently in force. The technique relies on an estimate of the expected probable maximum loss (PML) due to the catastrophic event and allocates a proportion of that overall loss to each insurance company operating in the market, based on a selected exposure measure. For property insurance, the sum insured was used as the volume measure. Thus, the amount of loss for each insurer would be given by the multiplication of the PML with the total sum insured by the company over the total sum insured by the market. These last two values were considered net of reinsurance so as to allow the study of the catastrophe on the true financial position of insurance companies.

80. The probable maximum loss over the sum insured by the market was set at 1.11 percent. This figure corresponds to the estimate provided by an international reinsurance broker for an earthquake with a severity level higher than 8.5 points on the Richter's scale.

Results

81. Table 24 presents the results calculated for the four selected companies. The table lists the sum insured both in gross and net terms (net of reinsurance) and likewise the loss both in gross and net terms. Note that, assuming no default of reinsurers, the amounts calculated in the table truly represent a worst-case scenario as the impact of any CAT XL reinsurance treaty was not taken into account. This type of treaty would allow the transfer of a portion of the calculated net loss resulting from the catastrophe.

82. The results show that the free surplus of insurance companies is sufficient to absorb this type of shock, even though the results differ across institutions. The reason why the negative impact is limited is twofold: first, the sums insured are relatively small given the cost of CAT risk insurance; and second, insurers have reinsured a significant part of their risks. Nevertheless, the impact does differ quite markedly across institutions with the worst affected experiencing a loss of 16.6 percent in the free surplus and the least affecting experiencing a virtually zero loss.

Table 24. Impact of Catastrophic Event

	Sum insured		Loss		Loss to Free Surplus	
	Gross	Net	Gross	Net	Gross	Net
Company	(in millions of euros)				(In percent)	
G	7,084	3,986	79	44	8.0	4.5
H	17,266	2,652	192	29	107.9	16.6
E	10,571	1,389	117	15	70.9	9.3
F	16,310	3	181	0	148.4	0.0
Total	51,231	8,030	569	89	39.2	6.1
Market	107,244	29,423	1,190	327	...	...

Source: Instituto de Seguros de Portugal.

C. Combining Both Approaches

Methodology

83. In what follows, the impact on the free surplus is considered when all shocks, under both the bottom-up and top-down approaches, happen simultaneously. This exercise requires the aggregation of results based on plausible correlation assumptions between individual risk factors. Risk-based capital (RBC) requirements were derived following the modular correlation approach used in QIS 2.

84. The correlation structure assumed is shown in Table 25. Note the perfect correlations between real estate and equity price risk, the high correlations between interest rate risk and equity and real estate risk, and the relatively low correlations of exchange rate risk with other risks. Also, note the high correlation between credit and market risk, the relatively high correlation between nonlife underwriting and credit risk, the low correlations of life underwriting risk with market and credit risk, the low correlation between nonlife underwriting risk and market risk. In addition, it is assumed that there are no correlations between life and nonlife underwriting risks. Also, but not displayed in the table, it is assumed

that there is no correlation between the catastrophic risks and other nonlife underwriting risks.

Table 25. Correlation Assumptions

	Interest	Equity	Real estate	FX
Interest rate risk	1	...	...	...
Equity risk	0.75	1	...	...
Real estate risk	0.75	1	1	...
Exchange rate risk	0.25	0.25	0.25	1
	Market	Credit	Life	Nonlife
Market risk	1	...	...	...
Credit risk	0.75	1	...	...
Life risk	0.25	0.25	1	...
Nonlife risk	0.25	0.5	0	1

Source: Instituto de Seguros de Portugal.

85. Furthermore, the estimated Total RBC is adjusted to take into account the risk absorption properties of future profit sharing liabilities. This refers to liabilities that are discretionary, i.e. not guaranteed, and thus can be used by the company to smooth the impact of adverse circumstances.

86. In practice, the RBC after this deduction will be given by RBC before the deduction minus “k” times profit sharing items. The calibration of the factor k should reflect the extent to which the management is expected to put in practice the reduction on future discretionary bonuses in adverse circumstances.

Results

87. RBC calculations shown in Table 26 suggest that, for the system as a whole, the fall in the free surplus would amount to 57.5 percent of the initial position. Only one company (B) would marginally fall below the solvency requirement used under this approach. The authorities pointed out that this particular company has a considerable amount of embedded future profits that, if accounted for, would produce a value far below 100 percent.

Table 26. Combined Impact of Shocks

Company	Life				Non-Life		Composite		
	A	B	C	D	E	F	G	H	I
Estimated RBC 1/	37.2	101.1	95.2	31.5	60.8	46.1	47.3	89.9	33.2

Source: Instituto de Seguros de Portugal

1/ Risk-based capital represented as the ratio of the impact to the free surplus after the revaluation.

2/ This value takes into account the adjustment for future profit sharing assuming $k = 1/3$.