

Stress Tests for the Austrian FSAP Update 2007: Methodology, Scenarios and Results

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This paper presents the methodology, scenarios and results of the stress tests conducted for the update of Austria's Financial Sector Assessment Program (FSAP) in 2007. The focus of the paper lies in particular on the following two macroeconomic stress scenarios: (a) a regional shock in Central, Eastern and Southeastern Europe hitting Austrian banks through their large exposure in the region, and (b) a global downturn in economic activity causing a deterioration of Austrian banks' domestic loan portfolios, whereby in the second scenario, contagion risk within the Austrian interbank market was also taken into account. Stress test calculations were performed by the OeNB for all Austrian banks (top-down approach) as well as by the six largest Austrian banking groups for their respective exposure (bottom-up approach). The paper describes the methodologies for scenario construction and the stress tests themselves and then discusses the scenarios as well as the stress test results in detail, including a comparison of the two approaches. Finally, the paper presents the results of additional sensitivity stress tests for credit risk emanating from foreign currency lending, for the most important categories of market risk and for liquidity risk. Overall, the update of Austria's FSAP 2007 confirmed the results of previous stress testing exercises, in particular for the large Austrian banking groups that show considerable shock resistance mainly as a result of their generally sound capital buffers and high profitability.

JEL classification: G10, G21, F23

Keywords: Financial stability, stress testing, FSAP

Introduction

The recent turmoil triggered by tensions in the U.S. subprime mortgage market is only the latest instance of financial markets disruptions of the past decades that revealed vulnerabilities of the global financial system and the threat financial crises can pose to the real economy. In 1999, the International Monetary Fund (IMF) initiated the Financial Sector Assessment Program (FSAP) in response to another crisis, the Asian crisis, seeking i.a. “to identify the strengths and vulnerabilities of a country's financial system.”² Stress testing is a key instrument in achieving this goal and therefore forms an integral part of each FSAP.³ Austria

underwent an assessment under the program in November 2003 (FSAP 2003), followed by an update in November 2007 (FSAP 2007). This paper describes the methodologies, scenarios and aggregate results of the stress tests conducted for the Austrian banking system in the course of the FSAP 2007.⁴

The FSAP 2007 represents the most recent effort of the OeNB in advancing its stress testing capabilities, which have been under development since the late 1990s. The first projects were developed in the context of market risk⁵ and were followed by credit risk models allowing for simple macroeconomic stress tests.⁶ The FSAP 2003 not only

¹ The authors would like to thank the two referees and the Austrian Financial Market Authority, in particular Jürgen Bauer, for their valuable input. Special thanks go to Alexander Tieman and the other IMF mission team members for the professional support before, during and after the FSAP mission.

² For further details on FSAPs see: www.imf.org/external/np/fsap/fsap.asp.

³ See Blaschke et al. (2001) for an early and Čihák (2007) for a recent overview of FSAP stress tests.

⁴ See Boss et al. (2004) for a description of the stress tests developed for the FSAP 2003.

⁵ See OeNB (1999) and Krenn (2001) for early examples.

⁶ See Kalirai and Scheicher (2002) and Boss (2002).

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gave a fresh impetus to the OeNB's stress testing operations, but also helped institutionally integrate such tests, which led i.a. to the semiannual publication of stress testing results in the OeNB's Financial Stability Report. In 2006, the project "Systemic Risk Monitor" (SRM), a software tool to quantitatively assess the main components of systemic risk in the Austrian banking system,⁷ was successfully rolled out and has since been used for quarterly reassessments of financial stability. Given the significant exposure of Austrian banks to Central, Eastern and Southeastern Europe (CESEE), a separate stress testing tool was implemented to assess associated credit risk.⁸

For the FSAP 2007, most of the OeNB's stress testing tools were further refined. As in the case of the FSAP 2003, macroeconomic forecast models were used to develop macroeconomic stress scenarios over a three-year horizon. Substantial progress could be achieved with model integration. This refers in particular to the stress testing tool for the CESEE credit exposure of Austrian banks, to the model linking macroeconomic variables to domestic probabilities of default (PDs), and to the adaption of existing stress testing tools to simulate the impact of the stress scenario over a three-year horizon. In contrast to the FSAP 2003, when all stress tests were calculated in a top-down (TD) manner, i.e. centrally by the OeNB on the basis of reported data, the 2007 stress tests also actively incorporated the six largest Austrian banks. In this bottom-up (BU) approach, banks ran calculations for given stress scenarios based on their internal risk management sys-

tems, and the results were in turn collected and evaluated by the OeNB.

The remainder of this paper is structured as follows: section 1 gives a brief overview of the scope of the FSAP 2007 stress tests including risk categories, the part of the banking system covered, and the database used. Sections 2 to 4 cover the macro stress tests, i.e. their methodology, the two scenarios and the results for the BU and the TD approaches. Section 5 describes sensitivity analyses for foreign currency lending for the most important categories of market risk and for liquidity risk. Finally, section 6 provides the main conclusions of the FSAP 2007, including directions and challenges for future stress test research at the OeNB.

1 Scope

1.1 Risk Categories

The following risk categories were taken into account in the FSAP 2007 stress tests: (a) credit risk, including its main components, namely domestic credit risk, credit risk stemming from Austrian banks' CESEE exposure and the credit risk of foreign currency loans triggered by foreign exchange rate fluctuations; (b) market risk, covering interest rate risk, foreign exchange rate risk, equity price risk and volatility risk; (c) contagion risk within the Austrian interbank market, and (d) liquidity risk.

Two different methodological approaches were applied: (a) macro stress tests that take into account various risk factors simultaneously and base the scenario construction on macroeconomic modeling, and (b) sensitivity analyses, which look at the effects of changes in one single risk factor or a limited set of

⁷ A detailed description of the SRM including some results can be found in Boss et al. (2006a). For an overview see Boss et al. (2006b). The scientific foundation is given in Elsinger et al. (2006).

⁸ See Boss et al. (2007).

risk factors while all other risk factors are assumed to be constant. As credit risk constitutes the main source of risk in the Austrian banking sector, with credit risk in the CESEE region and domestic credit risk being its most important components, these risk categories were specially addressed through macro stress tests. By contrast, the credit risk of foreign currency loans, the most important categories of market risks and liquidity risk were incorporated in sensitivity analyses.

1.2 Banking System

1.2.1 Bottom-Up Exercise

In line with common practice of FSAP reviews in other developed countries, the IMF proposed to apply the TD as well as the BU approach for the FSAP 2007 in Austria. Accordingly, the OeNB asked the six largest – in terms of total assets – Austrian banking groups to run stress tests as well. The sample consisted of: Bank Austria, BAWAG P.S.K., Erste Bank, Raiffeisen Zentralbank Österreich, Österreichische Volksbank, and Hypo Group Alpe Adria. These groups were chosen as they represent not only the systemically most important Austrian banking groups but also the ones most active in CESEE.

1.2.2 Top-Down Exercise

All stress tests calculated by individual banks under the BU approach were also performed under the TD approach. Furthermore, the OeNB performed a number of complementary TD stress tests. All of these tests were calculated for all individual banks at the group level, i.e. the whole FSAP 2007 stress testing exercise was based on consoli-

dated data. Additionally, results were accumulated for the entire banking system (702 banking groups and/or banks) and aggregates by size and by banking sectors: The subgroups by size were: (a) big banks: the six largest banks as specified above; (b) large banks: 22 banks with total assets above EUR 2 billion, excluding the big six; (c) medium-sized banks: 39 banks with total assets above EUR 500 million but below EUR 2 billion; and (d) small banks: 635 banks with total assets below EUR 500 million. The subgroups by sectors were: (a) 34 joint stock banks, (b) 8 savings banks, (c) 5 state mortgage banks, (d) 561 Raiffeisen credit cooperatives, (e) 64 Volksbank credit cooperatives, and (f) 30 special purpose banks.⁹

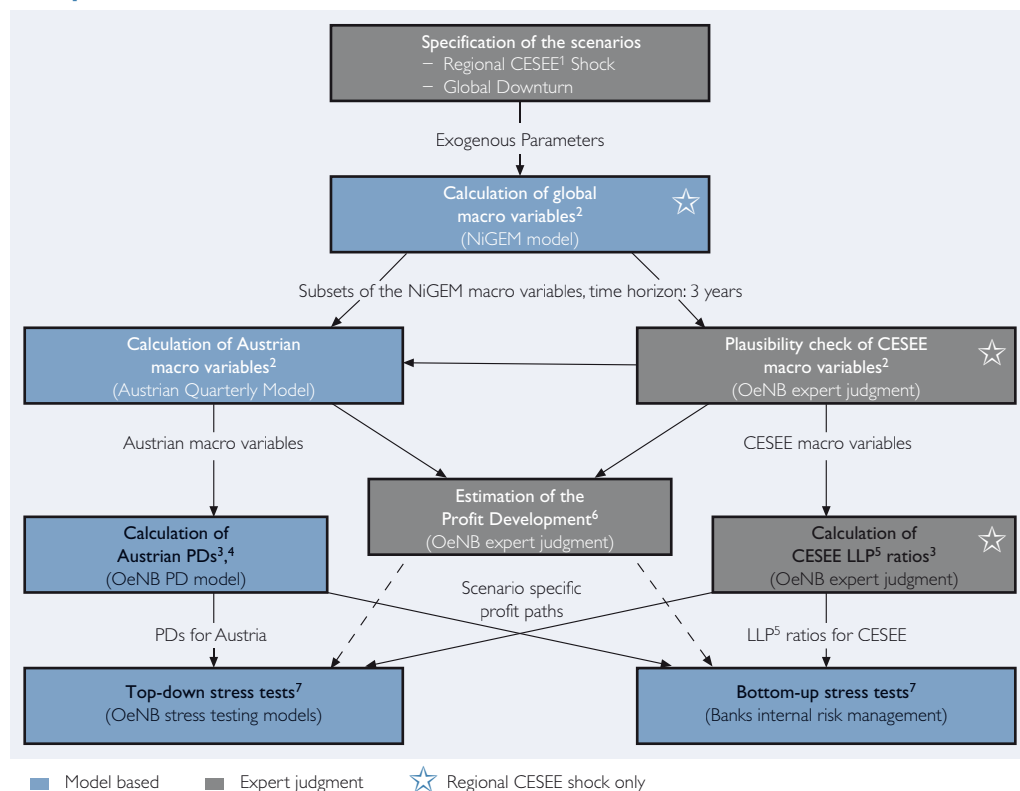
1.3 Data Set

In order to ensure comparability and timeliness of results, the latest reporting data available to the OeNB served as a reference for the FSAP 2007. Hence, data of June 30, 2007 were used under the BU as well as the TD approaches for both the macro stress tests and the sensitivity analyses. TD stress tests were based on banks' regular reports to the OeNB, including the Austrian Central Credit Register. In addition, the OeNB used quarterly default frequencies obtained from the Austrian creditor association Kredit-schutzverband von 1870. Data on macroeconomic, market and credit risk factors were taken from the OeNB's macroeconomic database or provided by Bloomberg's financial data services and national central banks. The individual banks were asked to base their stress test calculations on internal

⁹ The definition of these sectors follows the formal sectoral breakdown of the Austrian banking system, with the exception of construction savings and loans banks, which were included in the sector of special purpose banks for the stress testing exercise.

Chart 1

Components of the FSAP 2007 Macro Stress Tests



Source: OeNB.

¹ CESEE: Central, Eastern and South-Eastern Europe.

² Models for the economic environment, see section 2.1.

³ Methods that link the economic environment to credit risk, see section 2.2.

⁴ PD: Probability of Default.

⁵ LLP: Loan Loss Provision.

⁶ Treatment of profits, see section 2.4.

⁷ Stress testing models, see section 2.3.

credit risk measures and portfolio positions as at the reference date.

2 Macro Stress Test Methodology

Two forward-looking macroeconomic scenarios were constructed according to the guidelines provided by the IMF corresponding to the main sources of risk in the Austrian banking system: (a) a shock in CESEE that assessed the credit risk exposure of Austrian banks to the region and (b) a shock to the Austrian economy that assessed their domestic credit risk. In order to come up with these scenarios a suite of internal

and external models had to be aligned at OeNB. Chart 1 shows the individual steps and corresponding models that were necessary to construct the FSAP-2007 macro stress tests, which are discussed individually throughout the remainder of this chapter.

2.1 Models for the Economic Environment

After the specification of the scenarios, the next step was the construction of the global economic environment. For the first scenario, the “Regional CESEE Shock” scenario, this was implemented

with the global economic model NiGEM.¹⁰ In order to reduce macroeconomic modeling complexity, only Austria and four country aggregates were considered: New EU Member States 2004 (NMS-04), New EU Member States 2007 (NMS-07), Southeastern Europe (SEE), and the Commonwealth of Independent States (CIS).¹¹ For the second scenario, the “Global Downturn” scenario, the benign global economic environment of the last few years led to scenarios that would not have qualified as a severe shock, hence undermining the purpose of a stress testing exercise. Consequently, OeNB agreed with the IMF to reject NiGEM output and opted for ad-hoc assumptions regarding the global economic environment of the Global Downturn scenario. This is well justified from a risk assessment perspective, but limits the scenario’s economic interpretability. In both scenarios, variables and/or assumptions entered the Austrian Quarterly Model, a small to medium-sized macroeconomic model in the tradition of the neoclassical synthesis in line with most models used by Eurosystem central banks.¹² Macroeconomic shocks were assumed to occur at the beginning of the third quarter of 2007. Foreign as well as domestic macroeconomic variables were simulated over a three-year horizon until the second quarter of 2010 on a quarter-by-quarter basis.

2.2 Methods that Link the Economic Environment to Credit Risk

Some measure of credit risk had to be linked to macroeconomic variables to assess the impact of the scenarios on the banking system. This was a straightforward task for the Austrian exposures in both scenarios, as the OeNB has developed a credit risk model that links changes of domestic PDs in different corporate sectors to changes in macroeconomic variables. For CESEE, however, reliable data on PDs is generally not available. Therefore, some expert judgment had to be applied.

2.2.1 Estimation of CESEE Credit Risk

In general, reliable PD time series were not available for the CESEE region. In the limited cases where at least some data exist, time series either encompass several structural breaks in the local economy or are too short to estimate sound econometric models. Therefore, measuring the impact of the Regional CESEE Shock scenario on banks’ credit risk was based on loan loss provision (LLP) ratios¹³ instead of PDs. Although there are certainly limitations to the use of LLP ratios (e.g. income smoothing), the same applies to potential alternatives, like the nonperforming loan (NPL) ratio (e.g. different legal definitions across countries). Another reason for the use of LLP ratios was the fact that when the FSAP 2007 was conducted, they were the only credit risk

¹⁰ NiGEM (version v3.07d) is an estimated, theoretically coherent forward-looking model from the National Institute of Economic and Social Research, U.K. For a description of NiGEM, see www.niesr.ac.uk. For an application to simulate a financial crisis, see e.g. Barrell and Holland (2007).

¹¹ NMS-04: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia.
NMS-07: Bulgaria and Romania.

SEE: Albania, Bosnia and Herzegovina, Croatia, Macedonia, Montenegro and Serbia.

CIS: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine and Uzbekistan.

It should be noted that not all regions could be fully reflected in NiGEM.

¹² For a model description, see Schneider and Leibracht (2006).

¹³ In the entire paper, LLP and NPL ratios refer to total loans to corporates and households.

measure for Austrian banks' foreign subsidiaries reported to the OeNB.¹⁴

But even using LLP ratios as a credit risk measure, the translation of the Regional CESEE Shock scenario had to draw upon expert judgment instead of econometric modeling. Based on the argument by Barisitz (2006) about the asynchronous, but comparable development stages of CESEE banking systems during their post-communist transformation, first estimates of the credit quality under the scenario were based on a single cross-country data set, starting in the mid- to late 1990s. The set contained NPL ratios and LLP ratios as well as GDP growth rates; various univariate regression models were estimated for each of these aggregates. To account for the weak economic foundation of this linear relationship between credit risk and GDP growth across countries for different development stages of economies and banking systems in the region and for diverse LLP levels at the reference date, further expert judgment had to be applied to come up with estimates of the regional credit quality deterioration.

2.2.2 Calculation of Domestic Credit Risk

By contrast to the procedure applied to calculate foreign credit risk econometric modeling was used throughout to assess the impact of both macro stress scenarios on credit risk of Austrian banks with respect to domestic customers. Using an update of the estimation method and model selection procedure presented in Boss (2002),¹⁵

models for 11 sectors of the Austrian economy¹⁶ were developed to assess the dependencies of average sectoral PDs on the macroeconomic environment. Historically observed default frequencies – interpreted as PDs – for each corporate sector were calculated by dividing the number of insolvencies by the number of total firms¹⁷ per quarter in each sector. The resulting quarterly time series of sectoral PDs start in 1969 and cover several business cycles. To account for seasonality, moving averages over four quarters were used for the dependent as well as the independent variables. Starting with a set of 27 macroeconomic variables, the model selection procedure was applied in order to find an optimal model for each sector, optimal meaning that the models had high explanatory power, reasonable overall statistical properties and that all estimates were statistically significant as well as economically meaningful. However, for five sectors¹⁸ no reasonable model could be found and hence a model based on the aggregated PD of the Austrian economy was applied. The remaining seven models contained two to four macrovariables from the following set: GDP, industrial production, the unemployment rate, gross fixed capital formation equipment, the oil price, and the three-month real interest rate. Adjusted R squares of the models varied between 10% and 27%, which is rather low compared to other empirical evidence. This, however, can mainly be explained by the high variance in the quarterly time series, as similar models based on

¹⁴ This will change with the new reporting regulation, which had not been introduced until January 2008.

¹⁵ A publication of the update is planned for 2008.

¹⁶ The sectors were defined as: basic industries (including agriculture), construction, energy, financial services, households, production, services, tourism, trading, transport, and others.

¹⁷ The underlying data were provided by the *Kreditschutzverband von 1870*.

¹⁸ These sectors were: basic industries, energy, financial services, private households, and others.

annual data typically show adjusted R squares above 50%.

2.3 Stress Testing Models

For the sake of consistency and comparability, all participating banks, including the OeNB, used the OeNB's estimates of credit risk measures for both scenarios. Under the BU approach, banks were provided with time series of percentage increases of credit quality deterioration over the three-year horizon relative to the reference date June 2007¹⁹ and were asked to use their internal stress testing models to assess the impact of the scenarios. Under the TD approach, the absolute levels entered the respective OeNB stress testing tools. The aim of both approaches was mainly the calculation of additional expected losses under stress based on exposures at the reference date. Losses were calculated for every single credit institution, and aggregation was carried out by simply adding losses, regulatory capital and risk-weighted assets across banking groups and subsequently calculating the stressed capital adequacy ratio (CAR). As all balance sheet positions were assumed to remain constant over the entire time horizon (with the exception of capital), some additional assumptions – in particular regarding profits²⁰ – had to be made. It should be noted that under the TD approach in the case of uncertainty, worst

case assumptions for an estimate of the upper bound of losses were made.

2.3.1 Methodology for the Regional CESEE Shock

Additional expected losses were calculated for all domestic nonbank loans as well as for all nonbank exposures to CESEE countries, given the credit quality deterioration of the Regional CESEE Shock scenario on a quarter-by-quarter basis. Under the TD approach, these exposures included unsecured as well as securitized domestic lending based on the OeNB's Central Credit Register.²¹ CESEE exposures accounted for unsecured as well as securitized lending that was either granted as a cross-border loan by an Austrian bank to a debtor domiciled in the CESEE region²² or by an Austrian parent institution's CESEE subsidiary.^{23,24} Under the BU approach, banks were asked to do the same; however, due to resource constraints, they could not comply in all cases. Consequently, a bank's loss implied by the Regional CESEE Shock scenario consisted of three components: the losses from domestic exposure and the losses from direct and indirect CESEE exposures. Under the TD approach, quarterly additional domestic credit risk losses were calculated by sector based on the PDs estimated with the Austrian credit risk model. To calculate the additional

¹⁹ Banks were actually provided with percentage increases for annual PDs in such a way that they resulted in additional quarterly PDs to facilitate the calculation of additional expected losses per quarter. The same was done with LLP ratios, assuming that LLPs are made for one year. By providing relative measures, the OeNB assured consistent scenarios across participating banks while at the same time accommodating for their diverse portfolio composition and/or asset quality.

²⁰ See section 2.4.

²¹ The Central Credit Register contains information on all exposures above a reporting threshold per bank and borrower of EUR 350,000. OeNB monthly balance sheet reports were used as a complementary data source to account for loans falling below this threshold.

²² These exposures are referred to as "direct exposures" in this study.

²³ Referred to as "indirect exposures".

²⁴ For a detailed description of the data sources for direct and indirect CESEE exposures, see Boss et al. (2007).

losses stemming from direct CESEE exposures, these exposures and the associated LLPs reported in the Central Credit Register were aggregated by country. The resulting LLP ratios were increased on a country-by-country and quarter-by-quarter basis in accordance with the Regional CESEE Shock scenario. The implied additional LLPs were summed across all CESEE countries, yielding the scenario's quarterly loss. For additional losses due to indirect CESEE exposures, LLP ratios from Austrian banks' regional subsidiaries' supervisory reports were increased. The resulting additional LLPs were weighted by the respective parent institution's share in the subsidiary. The sum of weighted additional LLPs across all CESEE subsidiaries gave the quarterly loss for the parent institution. For all three components, this procedure implies a loss given default (LGD) ratio of 100%.²⁵ As participating banks used their internal risk management systems under the BU approach, most were able to calculate additional losses for domestic and foreign exposure based on PDs, some even on a creditor-by-creditor basis, not all though, again because of resource constraints. Banks, however, were free to choose their preferred credit risk measure as well as their LGD assumptions.

2.3.2 Methodology for the Global Downturn

Under the BU approach, banks were provided with percentage increases of domestic PDs sector by sector on a quarterly basis over the entire three-

year horizon relative to June 2007. Banks used this input to calculate additional expected losses under the Global Downturn scenario based on their internal risk management systems in line with the methodology described above. Under the TD approach, the methodology was based on the SRM model, an integrated model to assess credit, market, and interbank contagion risk of the Austrian banking system. The SRM uses a Monte Carlo simulation to estimate the loss distributions of these three risk categories for each individual Austrian bank over a horizon of one quarter.²⁶ In each step of the Monte Carlo simulation, quarterly changes in market and macroeconomic risk factors are drawn from their joint distribution²⁷ to calculate banks' losses – or gains in the case of market risk – assuming that the portfolio is not changed over this horizon. For credit risk, CreditRisk+²⁸ is modified to employ PDs based on individual customer ratings reported to the Central Credit Register adjusted according to the relative increase of the sectoral PDs defined by the scenario as described in section 2.2.2. The outstanding volume is calculated as all credit risk-sensitive instruments including credit lines reported to the Central Credit Register minus collateral at the individual customer level. This corresponds to the assumption that LGDs equal one minus collateral over outstanding volume. For loans below the reporting threshold of the Central Credit Register, the PD of the aggregate economy was used.

²⁵ As shown in subsection 4.1.2, this was the single most severe assumption separating TD from BU results for the Regional CESEE Shock scenario.

²⁶ The horizon was chosen in order to integrate credit and market risk without making additional assumptions about banks' reactions to changes in market risk. See Boss et al. (2006a).

²⁷ The SRM uses a grouped *t*-copula. See Boss et al. (2006a).

²⁸ See Credit Suisse (1997).

As the Global Downturn scenario was constructed for a three-year time horizon, some changes to the original approach were necessary so that the SRM could be used for multiperiod stress testing. First, market risk was not considered in the calculations, as this would have necessitated additional assumptions regarding banks' reactions to changes in the economic environment, in particular market risk factors. Second, to reduce simulation time, macroeconomic risk factors were not simulated; instead, PDs were shocked directly according to the impact of the scenario on the domestic PDs described above. Third, to assess contagion risk within the Austrian interbank market²⁹ in a multiperiod environment, the interbank market was cleared after each period. If a bank defaulted in some period, its interbank exposure was ignored in subsequent quarters to avoid double counting of contagion effects. As a default criterion, a CAR below a 4% threshold was assumed.³⁰ However, to ensure comparability, contagion risk was not taken into account in the comparison of the TD and BU results.

2.4 Treatment of Profits

Profits are banks' first line of defense against unforeseen losses. Therefore, they had to be considered in the multiperiod stress testing exercise. A path of declining profits before additional credit risk losses relative to the reference date was constructed for each scenario. These two paths were based on an analysis of the regional components of earnings and expenses of the six par-

ticipating banks at the reference date and the changes in macroeconomic variables implied by the scenarios, again under the assumption of constant balance sheets. Historical crises (e.g. the Asian crisis of the late 1990s) and experiences from other FSAPs were used as references. As in the case of credit quality, the six participating banks were provided with an identical path of relative quarterly profit declines for each scenario under the BU approach. The same profit paths were applied under the TD approach. As the scenario covered 12 observation periods, another assumption about banks' behavior had to be made: Whenever a bank remained profitable in a certain quarter, it had to distribute its gains to its shareholders immediately.³¹ In case losses exceeded profits, banks had to reduce their (regulatory) capital³² by additional losses exceeding profits.

3 Macro Stress Test Scenarios

3.1 The Regional CESEE Shock Scenario

3.1.1 Macroeconomic Specification of the Regional CESEE Shock Scenario

The large and highly profitable business of the Austrian banking sector in CESEE places particular relevance on a scenario in which a shock in the region feeds through to the Austrian economy. Austrian banks are affected directly through their local exposure and indirectly through a deterioration of the Austrian economy. After consultation with the IMF, the OeNB designed the Regional CESEE Shock scenario, which

²⁹ Currently the exposure of Austrian banks' foreign subsidiaries is not included due to data limitations. The new reporting regulation, which was introduced in January 2008, will remedy these limitations.

³⁰ Subsequently banks below a CAR threshold of 4% are referred to as insolvent.

³¹ These assumptions were necessary, particularly under the BU approach, to guarantee comparability of BU and TD results as well as of results across participating banks. However, banks were asked to report the results twice, once based on all OeNB assumptions, and once based on their own assumptions.

³² Regulatory capital was defined as eligible tier I and tier II capital.

focuses on a sudden deterioration of market sentiment and reflects the following considerations:

- A change in sentiment in financial markets toward CESEE and, as a consequence, less access to and a reduction in external finance. The change in sentiment may be due to (a) a persistence of macroeconomic imbalances, or (b) a further unexpected worsening of these imbalances rather than an expected turnaround, or (c) a further tightening of liquidity at major international players in CESEE;
- Regional contagion across CESEE due to (a) insufficient risk differentiation by international investors across countries, or (b) due to common creditor links;
- A rise of policy as well as market interest rates across the maturity spectrum, in combination with a fall in equity prices;
- A dampening effect on domestic demand (growth) and thus on GDP (growth), amplified by other adjustments in the economy (e.g. fiscal tightening, temporary stagnation in wage growth, lower private-sector credit demand, etc.);
- Shadowing of the euro by the NMS-04 and NMS-07 to avoid potential monetary policy reactions in the region;
- The simultaneity of all shocks, with the third quarter of 2007 as their starting point.

The Regional CESEE Shock scenario was simulated with the global economic model NiGEM. The sudden deterioration of market sentiment in CESEE was assumed to have an effect via four channels: (a) equity prices,

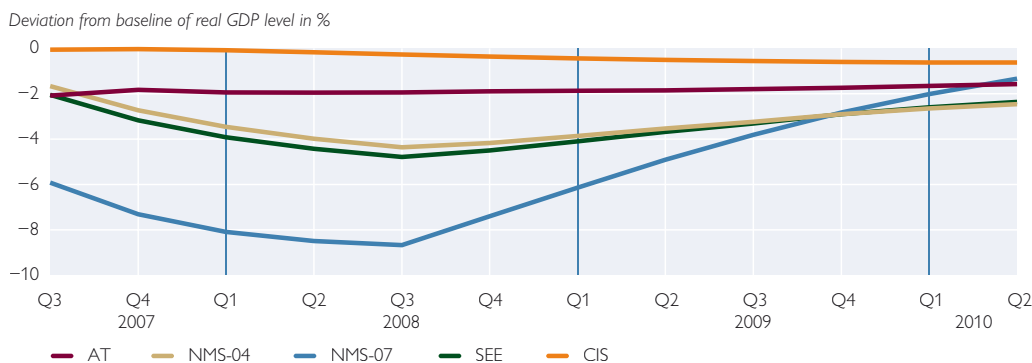
(b) the term spread risk premium,³³ (c) short-term interest rates, and (d) an endogenous shock to domestic demand. First, within the model's logic, reducing equity prices leads to a reduction of domestic demand in all countries concerned, as the value of equities affects wealth and hence consumption. Second, raising the term spread risk premium is an obvious way to emulate a financial crisis. If term spread risk premiums are raised, the user cost of capital rises, investment falls and output declines. Third, a loss of confidence in the regions' economies forces money markets to react; thus, short-term interest rates will increase. Fourth, the financial shock as described above leads to an additional negative impact on domestic demand, e.g. through fiscal tightening and/or other amplification channels.

3.1.2 Impact of the Regional CESEE Shock Scenario on the CESEE Economies

The assumed deterioration of market sentiment led to an initial drop of the real GDP level by 5.9% for the NMS-07 and by 1.7% for the NMS-04, respectively (see chart 2). Although CIS economies were not initially shocked, their real GDP level fell slightly due to modeled spillover effects from other CESEE countries. For both NMS groups, deviations from the baseline scenario reached their trough in the fifth quarter after the initial shock. The short-term dynamics were mainly driven by the shortfall of domestic demand, while decreasing asset prices had a more gradual, although more persistent, impact.

³³ The term spread risk premium drives a wedge between the development of short-term rates and the long-term rate at a future point in time, i.e. it represents the markup of long-term rates.

Impact of the Regional CESEE Shock Scenario on GDP



Source: OeNB.

Note: GDP for SEE is calculated as the GDP weighted average of the growth rates for the NMS-04 and the NMS-07.

Due to the limited capabilities of NiGEM, GDP growth for SEE was calculated as the GDP-weighted average of the growth rates for the NMS-04 and the NMS-07. This procedure is well justified from a risk assessment perspective of a macro stress test for the Austrian banking system, considering the exposure in SEE, but limits the economic interpretability of the scenario.

3.1.3 Impact of the Regional CESEE Shock Scenario on the Austrian Economy

The impact of the Regional CESEE Shock scenario on the Austrian economy was simulated using the Austrian Quarterly Model of the OeNB. The transmission of the CESEE shock to the Austrian economy works mainly through the export channel, taking into account indirect effects via third countries. Demand for Austrian exports dropped by up to 1.5%. This negative effect was amplified by a loss in price competitiveness of Austrian exporters due to the declining price levels in the CESEE countries. Effects via nominal exchange rate movements were negligible. Given the high exposure of the

Austrian economy to the region, two additional confidence effects were modeled. First, the risk premium was assumed to increase by 100 basis points, which caused an increase of external financing costs in the corporate sector and hence investments to fall. Second, the drop in confidence triggered an increase in the saving ratio of private households by 2 percentage points, thereby dampening private consumption.

The entire negative impact of both confidence effects was assumed to hit the Austrian economy in the first quarter of the simulation period, i.e. the third quarter of 2007, while the shock in the CESEE regions and its transmission via the trade channel built up gradually. Consequently, Austrian GDP dropped by 2% below its baseline level³⁴ already in the third quarter of 2007 and recovered only marginally over the entire simulation horizon (see chart 2). Half of the drop in economic activity was caused by the direct transmission of the shock from the CESEE countries via the trade and competitiveness channel while the other half was caused indirectly via the confidence channel.

³⁴ The December 2007 forecast of the OeNB was used as a baseline (Ragacs and Vondra, 2007).

3.2 The Global Downturn Scenario

3.2.1 Macroeconomic Specification of the Global Downturn Scenario

Although the second scenario was as soundly modeled as the Regional CESEE Shock scenario, it should be interpreted purely as a stress testing exercise, since the aim of the scenario – in accordance with the IMF – was to generate an alternative path of the Austrian economy with zero growth of real GDP for at least eight quarters. To implement this alternative path, several variables for the external environment of the Austrian economy as well as domestic confidence variables were shocked in a rather ad-hoc manner. A rather crude economic interpretation of the scenario would be one of a global economic downturn with strong negative confidence spillovers to the Austrian economy. The Global Downturn scenario includes the following assumptions:

- A slump in global economic activity that causes the demand for Austrian exports to decline sharply;
- Lower global price pressures and an appreciation of the euro that triggers a decline in the international

price competitiveness of the Austrian economy;

- A reassessment of global risks that leads to an increase in risk premiums and a fall in equity prices;
- Spillover effects to the Austrian economy that are reinforced by strong negative domestic confidence effects. Households increase their precautionary savings, and the costs of external financing for firms rise sharply;
- The shock starting in the third quarter of 2007 and lasting for three years. The deterioration of the economic conditions builds up gradually, with the maximum effect being reached after four to eight quarters (depending on the variable).

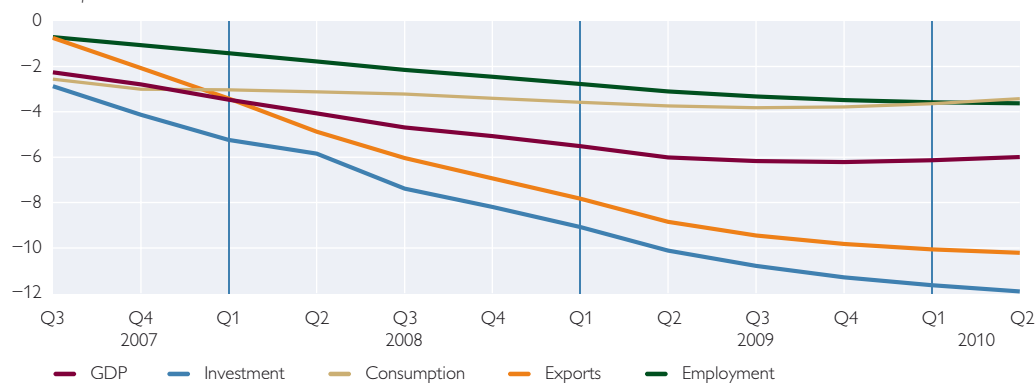
3.2.2 Impact of the Global Downturn Scenario on the Austrian Economy

The impact on the Austrian economy was simulated, again using the Austrian Quarterly Model of the OeNB, and turned out to be significant. In the simulation, economic activity in Austria is 6% below baseline levels after two years (see chart 3).

Chart 3

Impact of the Global Downturn Scenario on the Austrian Economy

Deviation from baseline levels in %



Source: OeNB.

Compared with the OeNB's latest macroeconomic forecast for the Austrian economy (December 2007), this implies two consecutive years with zero growth of real GDP. Such a long period of stagnation is an extraordinary event not observed during the last 30 years. The slump in economic activity is mainly caused by a decline in exports and business investments, while the negative impact on employment and private consumption is significantly smaller.

4 Macro Stress Test Results

4.1 Results of the Regional CESEE Shock Scenario

4.1.1 Impact of the Regional CESEE Shock on the Austrian Banking System

As pointed out in subsection 2.2.1, measuring the impact of the Regional CESEE Shock scenario on banks' credit risk relied on LLP ratios estimated by expert judgment. Table 1 shows the resulting annualized relative credit quality deterioration for the four CESEE regions for the reference date. The ex-

pected additional losses for a given one-year period can be calculated by multiplying the provisions as at mid-2007 by the deterioration from the table. In addition, the table provides increases of the aggregate domestic PD relative to the reference date implied by the scenario.³⁵

Moreover, the scenario assumed declining profits during the entire horizon. As the Regional CESEE Shock scenario was motivated by a confidence crisis in the region, overall net interest income was expected to be increasingly squeezed due to a lack of investor confidence in Austrian banks and hence higher refinancing costs. Quarterly profits (before adjustment for additional credit risk losses) were estimated to gradually decline up to 16.7% in the ninth quarter, where they broadly stagnated for the remainder of the scenario horizon.

4.1.2 Results of the Regional CESEE Shock Scenario

To assess the impact of the scenario in terms of the risk-bearing capacity of a particular bank, that bank's profits relative to the reference date and its stressed CARs³⁶ were examined. Chart 4 combines these two measures for the aggregate of participating banks under the TD as well as the BU approach. The bars show the use of aggregate profits for each quarter (TD: left bar, BU: right bar, both blue, measured in absolute values against the left-hand axis). Note that the initial size of the bars, which equals aggregate profits at the reference date, remains the same across

Table 1

Annual Deterioration of Credit Quality for Regional CESEE Shock

	Q2 08	Q2 09	Q2 10
Domestic PD	11.2	18.0	27.6
LLP ratio NMS-04	100	130	80
LLP ratio NMS-07	130	150	-30
LLP ratio SEE	80	120	30
LLP ratio CIS	30	70	110

Note: Domestic PD: average probability of default for Austrian exposure PD and LLP ratios as annual percentage increase.

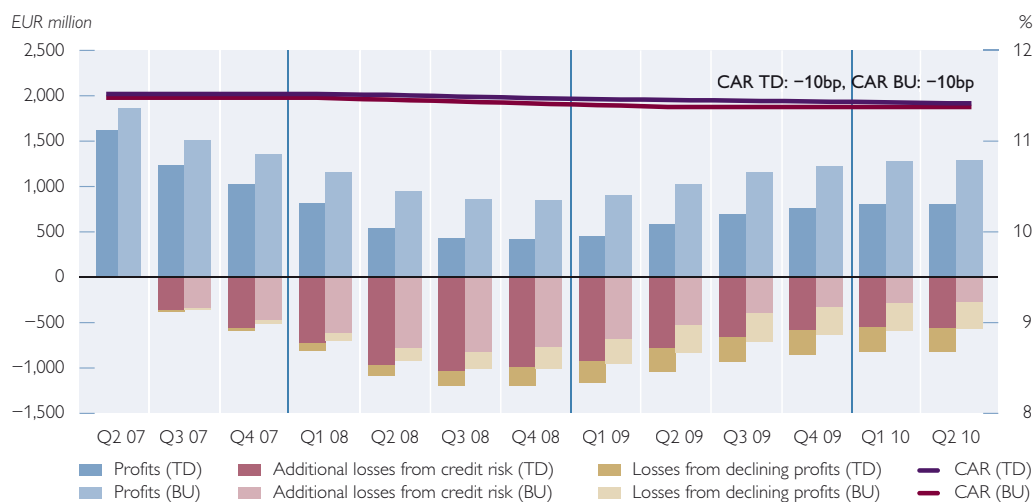
Source: OeNB.

³⁵ For the domestic loan portfolio, PDs were estimated with the model described in subsection 2.2.2.

³⁶ The stressed CAR was defined as: $(\text{regulatory capital} + \min(0, \text{profits} - \text{additional losses})) / \text{risk-weighted assets (RWAs)}$. Note that the losses implied by the scenario would lead to (a) a change in risk weights for affected asset classes, and (b) a reduction of assets through defaults. As neither original risk weights nor the size of the reduction are known, RWAs were kept constant over the scenario horizon, in line with the constant balance sheet assumption.

Chart 4

Impact on Profits under the Bottom-Up and the Top-Down Approaches for the Regional CESEE Shock Scenario



Source: OeNB.

the entire scenario.³⁷ Due to losses from the Regional CESEE Shock scenario, some of these profits, however, had to be used to shield the participating banks from taking direct hits against their capital. Hence the profit bar slides underneath the zero value of the x-axis, where the two driving factors – additional expected credit risk losses and the declining profits – are separated. Aggregated, banks remain profitable as long as the profit bar exceeds the zero line of the x-axis. To provide an idea of the dispersion of the results, the chart also shows the aggregate CAR of the participating banks for the TD as well as the BU approach (right-hand axis).

As chart 4 shows, the Regional CESEE Shock scenario had a considerable impact on profits. However the aggregate CAR was hardly affected and dropped by 10 basis points under the TD as well as the BU approach. The latter shows that not every bank remained profitable at all times, but also

that no individual bank faced solvency-threatening losses. Notwithstanding the comparable impact on capital of the two approaches, the impact on aggregate profits was substantially larger for the TD than for the BU stress tests. In absolute terms, additional losses for the six banks amounted to about EUR 6.3 billion under the BU approach compared to EUR 10 billion under the TD approach.

This difference is attributable in the first place to the more conservative modeling assumptions of the OeNB as compared to BU banks, with the use of a 100% LGD ratio single-handedly doubling the OeNB's TD losses compared to most of the BU results. In addition, slightly diverging exposures and their assignment to different domestic economic sectors and/or countries (e.g. cross-border loans of subsidiaries), as well as different starting levels for PDs and LLP ratios contributed to these results. The level of PD estimates

³⁷ This is another consequence of the constant balance sheet assumption.

varied widely among participating banks, but appeared to be rather optimistic compared to the data available at OeNB. This is an indication of estimates solely based on the upswing of the economic cycle in the region. The LLP ratios of the same banks, however, far exceed their PDs, which showed that provisions are being built beyond the expected PDs based on recent observations.

Turning to the aggregate TD approach impact of the Regional CESEE Shock scenario, results indicate that some banks could not cover all addi-

tional expected credit risk losses, as the stressed aggregate CAR was reduced by about 0.15 percentage points, even though total aggregate profits were by far sufficient to cover the aggregate additional losses (see table 2).

Surprisingly, the Regional CESEE Shock scenario hit small (CAR – 0.49 percentage points) and medium-sized banks (–0.37 percentage points) harder than large and also the participating six banks, with CAR reductions of 0.09 percentage points and 0.10 percentage points, respectively. The impact on small and medium-sized banks

Table 2

Impact on the Capital Adequacy Ratio under the Top-Down Approach for the Regional CESEE Shock Scenario

Regional CESEE Shock: Impact on CAR¹

	CAR June 07	Quarterly CAR from Sep 07 to June 10												Overall impact ²	
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12		
Total System	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.5	12.5	12.5	12.5	12.5	12.5	12.5	–0.15
Aggregates by size³															
Big banks (6)	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.4	11.4	11.4	11.4	–0.10	
Large banks (22)	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.2	13.2	13.2	13.2	–0.09	
Medium-sized banks (39)	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.1	18.1	18.0	18.0	17.9	17.9	–0.37	
Small banks (635)	16.2	16.1	16.1	16.1	16.1	16.1	16.0	16.0	15.9	15.9	15.8	15.7	15.7	–0.49	
Aggregates by sector³															
Joint stock banks (34)	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.5	13.5	13.5	13.5	13.5	–0.13	
Savings banks (8)	10.9	10.9	10.9	10.9	10.9	10.9	10.8	10.8	10.8	10.8	10.8	10.8	10.8	–0.03	
State mortgage banks (5)	10.5	10.5	10.5	10.5	10.4	10.3	10.2	10.2	10.2	10.2	10.2	10.2	10.1	–0.39	
Raiffeisen banks (561)	13.1	13.1	13.1	13.1	13.1	13.1	13.0	13.0	13.0	13.0	13.0	13.0	13.0	–0.08	
Volksbanken (64)	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.2	12.2	12.2	12.1	12.1	12.1	–0.23	
Special purpose banks (30)	16.2	16.1	16.1	16.1	16.0	16.0	15.9	15.8	15.7	15.5	15.4	15.2	15.0	–1.16	
Distribution of banks' CAR according to share in total number of banks															
Over 12%	75.6	75.5	75.5	75.5	75.5	75.5	74.8	74.6	73.9	73.5	73.2	72.4	71.8	–3.85	
10% to 12%	16.7	16.7	16.5	16.5	16.4	16.1	16.7	16.1	16.4	16.7	16.2	16.8	17.1	0.43	
8% to 10%	7.7	7.8	7.8	7.8	7.8	8.1	8.3	8.5	8.7	8.7	9.3	9.1	9.1	1.42	
4% to 8%	0.0	0.0	0.1	0.1	0.3	0.3	0.3	0.6	0.7	0.9	1.0	1.1	1.1	1.14	
Under 4%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.3	0.3	0.6	0.9	0.85	
Distribution of banks' CAR according to share in total assets															
Over 12%	41.5	41.4	41.4	41.4	41.4	41.4	41.3	41.3	41.3	41.1	41.1	41.0	40.9	–0.56	
10% to 12%	52.5	52.5	52.5	52.5	52.5	52.5	52.6	52.4	52.4	52.5	52.5	52.6	52.6	0.07	
8% to 10%	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.1	6.1	6.1	6.2	6.1	6.2	0.20	
4% to 8%	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.08	
Under 4%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.21	

Source: OeNB.

¹ Figures in percent if not stated otherwise.

² Change of CAR in percentage points relative to baseline.

³ Number of banks in brackets, see subsection 1.2.2 for definition of sizes.

was not driven by these banks' (often nonexistent) CESEE exposure, but by the deteriorating macroeconomic environment in Austria, a modeled consequence of the initial CESEE shock. In most cases the explanation could be found in these banks' profitability, which was far lower than for their larger counterparts at the reference date. Smaller banks were therefore shielded less from additional credit risk losses. These banks, however, did show substantially higher initial CAR levels, which granted them a far greater cushion to deal with these additional losses, at least at an aggregate level.

Looking at the CAR distribution, some small banks ended up below the 8% level (undercapitalized) and a few even fell below the 4% threshold (insolvent). However, the undercapitalized banks accounted for only about 0.1% of the total assets of the Austrian banking system, and the insolvent ones for 0.2%, confirming that only very small banks were affected. In addition, virtually all of them are organized in one of the tiered sectors of the Austrian banking system and would most likely benefit from a solution within their sector³⁸ thus preventing actual defaults.

To evaluate the robustness of the Regional CESEE Shock scenario results, the OeNB performed various sensitivity analyses, which were based on slightly modified scenario assumptions about the economic development in Austria as well as in the CESEE region. For Austria, a permanent additional increase of the domestic household savings rate by 2 percentage points was assumed and for CESEE the more severe credit quality deterioration of

the NMS-07 was applied to varying other CESEE regions. The combination of these two parameters led to seven additional sensitivity checks for the Regional CESEE Shock scenario, which in all cases only showed a slight deterioration in terms of CAR as compared to the original scenario. Some of them, however, led to significantly more impact in terms of profitability, but even under the most severe assumptions,³⁹ the profits of the six largest banks were sufficient to cover most of the additional credit risk losses, and all but one bank remained above a CAR of 10%. Even the most severely hit bank – in terms of CAR – remained well above 8%.

4.2 Results of the Global Downturn

4.2.1 Impact of the Global Downturn Scenario on the Banking System

In contrast to the Regional CESEE Shock scenario, in the Global Downturn scenario only the impact on the domestic loan portfolio was considered. The PD of the overall Austrian economy increased from about 2.8% in the second quarter 2007 to roughly 5.3% after the three-year horizon – about 2.2 percentage points more than predicted by the model's forecast for the baseline scenario. By analogy to the Regional CESEE Shock scenario, the Global Downturn scenario also had a significant impact on banks' quarterly profits. Based on the methodology described above, quarterly profits before additional credit risk losses due to increased PDs are assumed to decline up to 17.1% over the three-year horizon relative to the reference date.

³⁸ This would typically imply a merger or a capital injection organized within the sector.

³⁹ The most severe impact was observed by taking the credit risk measure changes of the NMS-07 for the entire CESEE region and at the same time increasing the domestic household saving rate by 2 percentage points over the entire observation period.

4.2.2 Results of the Global Downturn Scenario

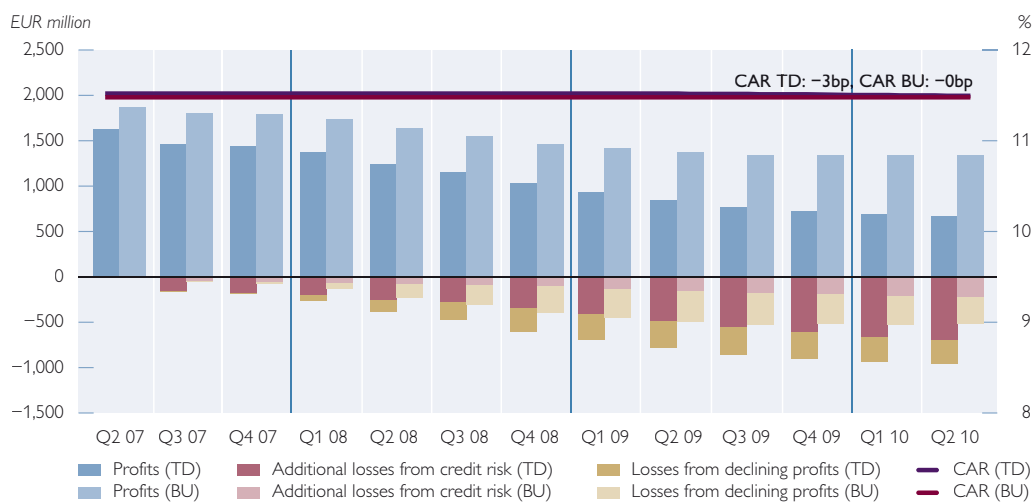
Chart 5 displays the results of both approaches for the Global Downturn scenario on an aggregate level for the six banks that participated in the BU exercise in the same way as described in the corresponding subsection 4.1.2 for the Regional CESEE Shock scenario. As can be seen, the scenario has a considerable impact on profits, though aggregate capital is not affected. However, the impact of the TD stress tests was significantly higher than the BU results. In absolute terms, additional losses for the six banks amounted to about EUR 1.6 billion under the BU approach compared to EUR 4.9 billion under the TD approach. One bank even showed losses at the end of the three-year horizon under the TD approach, though capital is only slightly affected, leading to a decrease of the aggregated CAR of the six banks by a mere 3 basis points.

The difference between the two approaches can be attributed to the worst-

case assumption principle mentioned above. The fact that TD losses are about three times higher than BU losses in case of the Global Downturn scenario compared to a factor below two for the Regional CESEE Shock scenario can be largely explained by the following: For individual Austrian customers that have loans at more than one bank, and hence are rated by more than one bank, the TD model applied the highest (most risky) rating, whereas banks naturally used their own internal ratings. As larger banks generally possess more sophisticated risk management tools, their ratings are often less conservative than those of smaller banks, which certainly biases TD losses upward. Once TD stress tests were recalculated based on the PDs actually reported by banks, aggregated losses over the stress horizon amounted to roughly EUR 2.8 billion, which is still considerably more than the EUR 1.6 billion BU losses. The remaining difference can be traced back to lower PDs used by banks for loans falling below the reporting

Chart 5

Impact on Profits under the Bottom-Up and the Top-Down Approach for the Global Downturn Scenario



Source: OeNB.

threshold of the Central Credit Register and/or more optimistic assumptions regarding LGDs.

Under the TD approach, stress tests were calculated for each individual Austrian bank. Due to the fact that some banks could not cover the additional expected credit risk losses, the overall CAR dropped by about 0.22 percentage points, although aggregate profits were still sufficient to cover the additional losses (see table 3). The largest impact on the aggregated level struck small banks, which showed a 1.06 percentage point reduction of their aggregate CAR to 15.1%. Some very small

banks fell below the 8% level (undercapitalized), and even fewer fell below the 4% threshold (insolvent). However, the undercapitalized banks accounted for only about 1.4% of total assets of the Austrian banking system, and the insolvent ones for less than 0.1%, which confirms that only very small banks were affected severely by the stress scenario. As for the Regional CESEE shock scenario, the argument concerning intrasector solutions preventing actual defaults holds.

Similar to the Regional CESEE Shock scenario, sensitivity analyses have also been performed for the Global

Table 3

Impact on the Capital Adequacy Ratio under the Top-Down Approach for the Global Downturn Scenario

Global Downturn: Impact on CAR¹

	CAR June 07	Quarterly CAR from Sep 09 to June 10												Overall impact ²
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	
Total System	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.5	12.5	12.5	12.4	12.4	-0.22
Aggregates by size³														
Big banks (6)	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	-0.03
Large banks (22)	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.2	13.2	13.1	13.1	13.0	12.9	-0.42
Medium sized banks (39)	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.1	18.1	18.0	17.9	17.7	17.6	-0.67
Small banks (635)	16.2	16.1	16.1	16.1	16.1	16.1	16.0	16.0	15.8	15.7	15.5	15.3	15.1	-1.06
Aggregates by sector³														
Joint stock banks (34)	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.5	13.5	13.5	-0.13
Savings banks (8)	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.8	10.8	10.8	-0.03
State mortgage banks (5)	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	-0.04
Raiffeisen banks (561)	13.1	13.1	13.1	13.1	13.0	13.0	13.0	13.0	13.0	12.9	12.8	12.7	12.6	-0.43
Volksbanken (64)	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.2	12.2	12.2	12.1	12.1	-0.19
Special purpose banks (30)	16.2	16.1	16.1	16.1	16.1	16.1	16.0	15.9	15.8	15.6	15.4	15.1	14.8	-1.32
Distribution of banks' CAR according to share in total number of banks														
Over 12%	75.6	75.6	75.5	75.5	75.2	75.1	74.5	73.4	72.6	71.5	70.7	69.1	67.9	-7.69
10% to 12%	16.7	16.5	16.7	16.7	16.4	16.4	16.7	17.2	16.7	17.5	17.9	17.1	16.4	-0.28
8% to 10%	7.7	7.8	7.7	7.7	8.3	8.3	8.5	8.7	9.5	9.0	9.3	10.4	10.5	2.85
4% to 8%	0.0	0.0	0.1	0.1	0.1	0.3	0.3	0.6	1.0	1.7	1.9	3.0	4.6	4.56
Under 4%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.3	0.3	0.4	0.6	0.57
Distribution of banks' CAR according to share in total assets														
Over 12%	41.5	41.5	41.4	41.4	41.4	41.4	41.3	40.7	40.6	40.4	40.3	40.2	40.0	-1.43
10% to 12%	52.5	52.5	52.5	52.5	52.6	52.6	53.0	53.0	53.1	53.2	52.5	51.2	51.2	-1.39
8% to 10%	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.2	6.3	6.2	6.3	6.8	7.3	1.36
4% to 8%	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.4	1.4	1.36
Under 4%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.10

Source: OeNB.

¹ Figures in percent if not stated otherwise.

² Change of CAR in percentage points relative to baseline.

³ Number of banks in brackets, see subsection 1.2.2 for definition of sizes.

Downturn scenario. They considered an additional increase in the domestic savings rate by 2 percentage points and resulted in an even more severe economic downturn in Austria. In addition contagion risk, i.e. additional losses in the interbank market due to insolvent banks, was considered. However, the impact was still moderate: even if the savings rate was increased and contagion risk was taken into account simultaneously, results for the six largest banks remained the same in qualitative terms. The number of small banks becoming insolvent increased slightly, mainly due to contagion, however, their share in total assets was still below 0.4% of total assets of the Austrian banking system. Again, it should be noted that this contagion is more of hypothetical nature as these banks are mostly organized within tiered sectors.

5 Sensitivity Analyses

In addition to the macroeconomic stress tests described in sections 2 to 4, sensitivity analyses were applied to assess the credit risk emanating from foreign currency lending, the most important types of market risk and liquidity risk. A sensitivity analysis employs a scenario that is restricted to the change of a single risk factor or of a limited set of risk factors, ignoring possible interactions with other risk factors. In general, scenario analyses do not make use of sophisticated modeling but establish a straightforward link between the scenario and its impact. In our setup, no profits were considered as cushions against losses, as the analyses focused on the short-term impact.

5.1 Foreign Currency Lending

The share of foreign currency lending in total lending to domestic customers stood at 17% in June 2007, representing a volume of EUR 48.5 billion in outstanding loans. For private households, this share amounts to 29% and for the corporate sector to 9%. With these figures, Austria is quite an exception within the euro area. 90% of total foreign currency lending is denominated in Swiss francs, 3% in Japanese yen.⁴⁰

The scenarios consisted in a 10% appreciation of the Swiss franc and a 20% appreciation of the Japanese yen vis-à-vis the euro, thus covering the 95% quantile of yearly exchange rate changes. In addition to exchange rate fluctuations, another risk of typical Austrian foreign currency loans stems from unfavorable changes in the value of the repayment vehicle, as the vast majority of these loans is arranged as bullet loans.⁴¹ For the scenario regarding the repayment vehicle, we assumed a deviation of –15% from the expected performance. The methodology of the scenario analyses for foreign currency lending is described in Boss et al. (2004), with a straightforward adaptation for the incorporation of repayment vehicles: The loss resulting from the impairment of the repayment vehicle is treated in the same way as the loss resulting from higher loan repayments triggered by a foreign currency appreciation. Both losses are assumed to reduce the income of foreign currency lenders in the current year, impairing their repayment ability. It should be noted that this is a quite conservative

⁴⁰ Another 6% are U.S. dollar loans. However, they are usually naturally hedged through real economic activity and hence not affected by foreign exchange fluctuations.

⁴¹ The repayment vehicle is created to repay the principal at maturity. It is set up e.g. in the form of a life insurance policy or an investment fund. For private households, the share of bullet loans in total Swiss franc and Japanese yen loans is over 85%.

assumption, as foreign currency loans typically have maturities of around 20 years and can usually be switched to euro during their lifetime. Scenario analyses for foreign currency lending were run only in a TD exercise.

For the Swiss franc loan portfolio, a sizable decline in CAR is observed when the Swiss franc appreciation (+10%) scenario and the repayment vehicle scenario (−15%) are combined: For the overall banking system, the decrease in CAR amounts to 1.4 percentage points. For the six largest banks, the aggregated decrease in CAR is 0.7 percentage points. Small and medium-sized banks are affected most, with a CAR decrease of 1.8 percentage points. Under this scenario, a few banks representing 0.2% of total assets show CARs below 4% and some additional banks accounting for 1.2% of total assets fall below 8%. However, the result can largely be explained by the conservative assumptions mentioned above. In addition, only small banks are more severely affected, hence the arguments on sector solutions also apply here. In contrast to Swiss franc loans, the impact on the Japanese yen loan portfolio turned out to be negligible even at the level of the most exposed individual banks.

5.2 Market Risks

Regarding market risks, equity prices, interest rates, exchange rates and volatilities were considered as risk factors. Market risk sensitivity analyses were performed as a TD and a BU exercise, except for volatility risk that could not be treated under the TD approach due to a lack of data. Market risk positions

included all on and off balance sheet positions of the banking and trading book, including nonbank activities (e.g. insurance subsidiaries).⁴² Scenario construction was based on the largest historical movements of the respective risk factors over a three-month horizon.

BU stress tests were confined to the most relevant market risk factors for Austrian banks. Hence, the following scenarios were taken into account under both approaches: parallel upward and downward shifts of the euro yield curve by 200 basis points, a steepening of the yield curve by 200 basis points (linear spread between the overnight and the ten-year rate), depreciation and appreciation of the euro against all other currencies by 15% and a decrease of domestic as well as nondomestic stock prices by 35%. In addition, banks were asked to perform sensitivity analyses for an increase in interest rate volatility by 200 basis points at all maturities and a corresponding decrease by 100 basis points as well as for additional scenarios according to their internal risk management practices.

General differences between the TD and the BU approach can be traced to the facts that (a) foreign subsidiaries and nonbank subsidiaries were not included in the TD stress tests due to the unavailability of data, and (b) TD stress tests relied on aggregated supervisory data, thus representing partial information. If banks hold large and complicated derivative positions, this can even lead to an impact with the opposite sign of the impact under BU calculations, which are based on individual instruments.

⁴² Due to data limitations, this was not possible in all cases, neither under the TD nor under the BU approach.

Table 4

Results of Bottom-Up and Top-Down Sensitivity Stress Tests for Market Risks

Scenario	Bottom-Up	Top-Down
	Change of CAR in percentage points	
Interest Rate Risk		
Parallel upward shift of euro yield curve by 200 basis points	-0.16	-0.34
Parallel downward shift of euro yield curve by 200 basis points	0.13	0.39
Steepening of euro yield curve through 200 basis points increase of ten-year rate	-0.08	-0.23
Equity Price Risk		
Decrease in domestic equity prices by 35%	-0.04	-0.09
Decrease in nondomestic equity prices by 35%	-0.08	-0.08
Foreign Exchange Rate Risk		
Depreciation of euro by 15%	-0.14	0.08
Appreciation of euro by 15%	0.19	-0.08
Volatility Risk		
Increase by 200 basis points	0.00	n/a
Decrease by 100 basis points	0.00	n/a
Increase by 40%	0.00	n/a
Decrease by 40%	0.00	n/a

Source: OeNB.

Results of sensitivity analyses for market risks are shown in table 4 for the aggregate of the six participating banks. Regarding interest rate risk, the two approaches produced comparable results for the direction of scenario impact. Reasons for differences in the size of the impact apart from those stated above can be derived from a more accurate matching of the repricing maturities of interest rate-sensitive instruments and the term structure in the case of the BU approach. For the equity price scenarios, no significant differences in the results were produced. The largest divergence between the BU and TD approaches can be observed for foreign exchange rate risk, where the impact even shows opposite signs. In addition to the general difference regarding derivative instruments mentioned above, this large divergence can be explained by the fact that some of the banks included their CESEE subsidiaries in the calculation base. Furthermore, due to data limitations, the

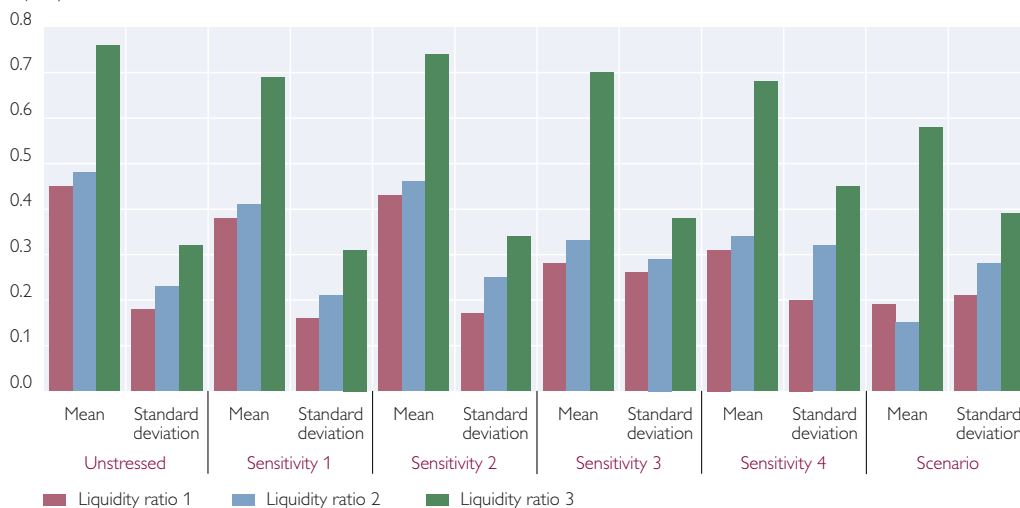
TD exercise comprised exposures in U.S. dollars, Japanese yen, Swiss francs and pounds sterling only. BU stress tests for volatility risk show that this risk category is virtually irrelevant for the large Austrian banks.

Under the TD approach, additional sensitivity analyses were performed for a wide range of scenarios for all risk factors, including various movements of the yield curve in the most important currencies combined with changes in the respective exchange rates and different scenarios regarding equity price risk. Altogether, the results of market risk BU and TD sensitivity analyses suggest that the largest loss potential emanates from an upward shift of the euro yield curve. Yet, the impact of this scenario appears quite limited. It has to be borne in mind, though, that – according to the nature of sensitivity analysis – feedback effects of the scenarios on credit risk are not accounted for.

Chart 6

Liquidity Stress Test Results

Liquidity ratio 1% = 0.01



Source: OeNB.

Note: Individual bank data cannot be published. Unweighted averages across the six banks are reported.

5.3 Liquidity Risk

Liquidity risk stress tests for the six largest banks were mainly conducted by the OeNB.⁴³ In addition, participating banks were asked to describe their liquidity management in qualitative terms and to perform a stress test assuming a disruption in the money market. However, as all banks reported small impacts of their BU stress tests, the results of TD liquidity stress tests will be discussed below.

All of the six largest banks had limited maturity mismatches at the short end of the balance sheet and sufficient volumes of liquid assets to cover them. In addition, banks that belong to a tiered sector fulfill their liquidity requirements by deposits with the central institution, which in turn has to hold only 50% of these deposits as minimum liquidity requirements and thus benefits from economies of scale in liquidity reserve management. For the stress tests, three liquidity ratios (liquid as-

sets over short-term liabilities) were defined, which were all based on the reported residual time to maturity structure of banks' assets and liabilities at the reference date, but included different definitions of liquid assets. The denominators (short-term liabilities) were identical in all three ratios and consisted of bank and nonbank on balance sheet liabilities with a residual time to maturity of up to three months. In ratio 1, the numerator was defined as cash, deposits at central banks, debt instruments,⁴⁴ listed bonds and listed equities. In ratio 2, the numerator consisted of the items under ratio 1 but also included overnight loans to banks and nonbanks minus overdrafts. Under ratio 3, the numerator equaled the numerator in ratio 2 plus 50% of nonbank loans and 100% of interbank loans with residual maturities between two days and three months. In the unstressed system, ratio 1 amounted to 45%, ratio 2 to 48%, and ratio 3 to 76% (see chart 6).

⁴³ Concerning the role of banks' liquidity management for central banks, see Schmitz and Ittner (2007).

⁴⁴ Debt instruments admitted for refinancing at central banks of the European System of Central Banks.

Four sensitivity analyses were conducted: (a) liquid bonds minus 25%, (b) equity portfolio minus 35%, (c) withdrawal of 40% of all interbank short-term funding, and (d) withdrawal of 50% of nonbank deposits. In addition, a scenario analysis that combined a severe disruption of the money and credit markets (a market shock) with an idiosyncratic shock (a name crisis) for each bank was performed. None of the four sensitivity analyses posed liquidity problems for any of the six banks (chart 6).

In the scenario, a credit crisis affected the bond and equity market (bonds and equities minus 20% and 30%, respectively). The low weight of nonbank loans in ratio 3 of 50% was retained and the same weight introduced in ratio 2 to account for the potential profit and loss effects associated with the loss of market share that would result from not rolling over short-term loans to nonbank customers. Furthermore, potential liquidity problems of interbank counterparties due to the market shock were considered, and hence the weight of interbank loans in both ratio 2 and ratio 3 were reduced to 95%. In addition, each bank faced an idiosyncratic shock. Nonbank customers were said to withdraw 10% of sight deposits, 20% of one-month deposits, and 30% of three-month deposits. Sight deposits are generally of lower volume and thus more likely to be covered by deposit insurance than one- and three-month deposits. Also, interbank counterparties reduced lending to the bank. This impact was said to lead to a reduction of interbank overnight funding by 20%, of one-month funding by 30%, and of three-month loans by 40%. These high numbers reflect the combination of a market and an idiosyncratic shock and the higher responsiveness of banks than of nonbank customers to a

name crisis. Overall, the scenario was extreme and unprecedented in Austrian history. The scenario amounted to a negative cash flow of 35% of the sum of short-term loans and 10% of total assets which needed to be counterbalanced by the sale of liquid assets and/or the nonrenewal of short-term loans. The impact of the extreme scenario on all three ratios was substantial. Ratio 1 fell by 26 percentage points to 19%, ratio 2 by 33 percentage points to 15%, and ratio 3 by 18 percentage points to 58%. All banks remained liquid, which highlights the solid liquidity situation of the six largest Austrian banks.

6 Conclusion

Overall, the stress tests conducted for the FSAP 2007 showed that the Austrian banking system exhibits considerable resilience against shocks and hence confirmed results of the FSAP 2003 and the regular stress tests calculated by the OeNB. The main reasons for this resilience are Austria's generally well-capitalized banking system and its focus on the traditional lending business, which facilitates credit risk management through close customer relations. Consequently, credit risk is the most important source of risk in the Austrian banking sector, mostly stemming from (a) exposures in CESEE, from (b) domestic lending, and from (c) credit risk induced by foreign currency lending. The two macro stress tests presented in this paper addressed the first risk factor via the Regional CESEE Shock scenario, assuming a severe regional recession, and the second risk factor via the Global Downturn scenario with the assumption of two consecutive years of zero GDP growth in Austria. Although both scenarios put a substantial strain on the Austrian banking system, capital buf-

fers remained intact for all Austrian banks except for a few very small, unprofitable banks. Unlike the largest Austrian banks, all of which remained well above the regulatory threshold of 8%, some of them became undercapitalized and in a few cases even insolvent. As these banks accounted for a very limited share of aggregate total assets and were mostly organized within a tiered sector, problems would most likely be solved within these sectors. Finally, credit risk induced by foreign currency lending was covered by a sensitivity analysis and produced qualitatively similar results to those of the macro stress tests. Stress tests for market risks confirmed the minor importance of the latter. Interest rate fluctuations posed the most prominent source of market risk. Regarding liquidity risk, stress tests confirmed the shock resilience of the Austrian banking system, as many banks have access to stable funding sources through deposits.

The FSAP 2007 also spurred further development of the stress testing capacities at the OeNB. For the first time, banks were asked to calculate standardized stress tests by means of their own internal risk management tools. Importantly, macro stress tests conducted by the OeNB showed a substantially higher impact than the ones calculated by banks. To a large extent, this can be attributed to the more con-

servative assumptions in the absence of reliable and/or detailed information at the OeNB. Given the favorable economic conditions in the recent past, credit risk measures used by banks might, however, turn out to be overly optimistic in some cases. Additionally, the large banks' generally high profitability and its impact on the positive results of the macro stress tests raises the issue of modeling risk, which highlights the importance of cooperation between the OeNB and the large commercial banks in the area of stress testing. In addition, options for further improvement of OeNB's stress testing models were pointed out. In particular, stress testing in a multiperiod environment raises questions about banks' behavior, e.g. portfolio adjustments and the treatment of profits, but even more so regarding banks' and authorities' reaction to a crisis. These issues have been addressed, but as the many economic disclaimers throughout the paper indicate, there is still ample room for further research. Finally, results have confirmed the importance of the CESEE region for the Austrian banking sector. Hence, the integration of Austrian subsidiaries into existing tools – in particular the Systemic Risk Monitor – will be one of the main priorities for the OeNB with respect to stress testing in the near future.

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