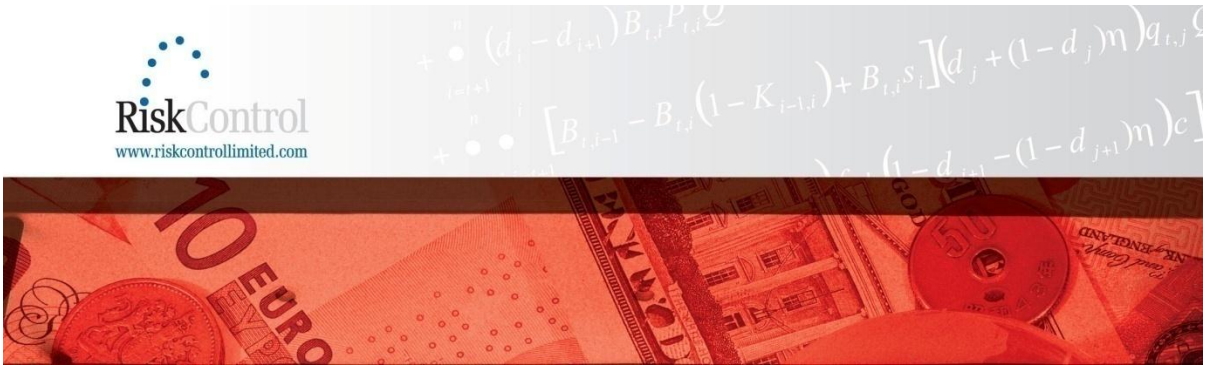

Top Down Stress Testing for Bank Financial Statements: A Case Study

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Executive Summary

This note shows through a case study how Risk Control's *Stress Controller*^{TM} software may be used to implement top down stress testing of a bank. The calculations are based on the publicly available financial statement and Pillar 3 disclosures of a large UK bank.

We show how the balance sheet, P&L and key financial ratios are affected by scenarios involving recessions in America, Europe and the UK. A set of equations is constructed to describe the evolution of the bank's financial statements.

Changes in the credit quality of the bank's loan book and fluctuations in the value of mark-to-market exposures affect asset values and income through provisions and mark-to-market asset write-offs. For a base case and for each of the stress scenarios, predictions are supplied for the bank's key variables.

The results show how the bank's impairment provisions rise, and capital, asset growth, returns on equity and profitability are depressed by the different recession scenarios. A UK-based recession has a larger impact than the other recession scenarios but shows a more rapid recovery.

Note that the framework used here may be used either with coarse, public data to perform top down stress testing or with highly granular internal bank data for bottom-up stress testing purposes. The financial statement modeling is highly flexible since equations may be written first in Excel, converted into scripts and then imported into the software for use at run-time to perform calculations.

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Introduction

This note presents the results of an illustrative set of forecasts for the balance sheet of a major bank conditional on several macroeconomic scenarios.

The calculations are performed using Risk Control's software *Stress Controller*^{TM}. This software permits the user to formulate a macroeconomic scenario and then to forecast conditional time paths for a wider set of macroeconomic variables for different geographical regions. The impact of the macroeconomic variable time paths on a bank's portfolio may then be calculated and estimates of provisions may be fed into a model of the bank's financial statements.

As an example bank, we have chosen Barclays Group PLC (hereafter referred to as the bank). The calculations presented here are based entirely on publicly disclosed data and have not been sanctioned or endorsed in any way by the bank. This bank has been selected as the example used in our case study because of its importance as a major UK bank with a strong international presence.

Using publicly available information from the bank's annual report and Pillar 3 risk disclosures, we have:

1. Prepared appropriate historical macro data for the geographical regions within which the bank operates (i.e. Europe, UK, the Americas, Africa and the Middle East and Asia),
2. Extractedinformation from the bank's annual report on its historical financial statements,
3. Generateda set of user-defined financial statements modeling equations.
4. Performed stressed financial forecasting calculations under different scenarios.

The scenarios we analyze are a base case and three stress scenarios. The three stress scenarios consist of 3-year recessions in (i) Europe, (ii) UK and (iii) the Americas respectively. In each case, the recession is specified to be negative shocks to real GDP of 2% and 1% in the first 2 quarters and of 0.5% in the subsequent 10 quarters.

The results are intuitive and convincing with capital ratios and indicators of profitability in the stress scenario cases following paths markedly below the baseline paths and with impairment provisions boosted and loan and deposit growth depressed compared to the base case.

Two important advantages of the software are as follows. First, the calculations presented here illustrate how one may use *Stress Controller*^{TM} to analyze bank financial statements and the vulnerability a bank exhibits with respect to macroeconomic shocks of different types even with relatively simple public data. *Stress Controller*^{TM} may also be used with complex and elaborate bank exposure data (for example, with tens or hundreds of thousands of underlying individual or semi-aggregated exposures) to perform bottom up stress analyses.

Second, the financial statement model employed consists of a set of equations linking balance sheet and P&L quantities (i) to macroeconomic variables, (ii) to provisions and mark-to-market write-offs based on exposures representing the bank's assets, (iii) to user supplied parameters and variables (for example, capital injections and dividend payout rates). These equations may be created by the user of *Stress Controller*^{TM} and then imported as part of the data employed. At run-time, the software uses them to perform calculations. This approach ensures maximum flexibility.

1. Generating Consistent Macroeconomic Scenarios

In devising stress tests, one must first accomplish the (often challenging) task of generating consistent time paths for multiple macroeconomic variables. For example, one may wish to consider the impact of a recession in the US affecting say US GDP. However, this raises the issue of what is the impact on European or Asian GDP and also what happens to interest rates, exchange rates, inflation and commodity prices?

Risk Control's *Stress Controller*^{TM} software contains an embedded macroeconomic model in which one may specify a series of shocks to a particular variable and calculate conditional forecasts of this and other variables into the future. The macroeconomic model employed is a statistical model commonly referred to as a Global Vector Autoregressive or GVAR model. Such models have been extensively used by academics and practitioners in economic forecasting units in central banks and other bodies to forecast macro time series.

It is important to allow for contagion between regions in the propagation of macroeconomic scenarios.GVAR models suppose that for each geographical region there exists a vector of macroeconomic variables which evolve linearly over time as non-stationary but cointegrated time series. The variables in each region are affected by their own lagged values and by weighted sums of variables from other regions.

The GVAR model included in *Stress Controller*^{TM} is highly flexible in that one may readily change the countries and regions. In the exercise reported in this note, we adopt a set of regions consistent with the bank's approach to categorizing its loan exposures. Specifically, we suppose that the regions comprise: (a) UK, (b) Europe (excluding the UK), (c) the Americas (comprising South, Central and North American countries), (d) the Middle East and Africa, and (e) Asia.

To set up scenarios within *Stress Controller*^{TM}, one operates through the web-based interface. Scenarios are stored within an underlying relational database and repeated calculations may be performed for a given scenario after amendments are made to the scenario itself or after the underlying data has been updated. Figure 1 shows the list of scenarios within the *Stress Controller*^{TM} web-based interface.

Figure 2 shows a screen shot during the editing of a scenario. Scenarios consist of sequences of period-by-period shocks to macroeconomic variables. Non-interest-rate macro time series are stored in log form. Hence, a shock of negative one unit in a given quarter to a scenario variable such as GDP corresponds to a minus 1% innovation.

Stress Controller^{TM} produces time paths of macroeconomic variables such as those shown in Figure 3. These time series are the mean values of the variables in question conditional on the assumed shocks to the scenario variables.

Note that, as an alternative to generating macroeconomic scenarios within *Stress Controller*^{TM} one may import a scenario in the form of a set of time series for different macroeconomic variables. Hence, one may work with scenarios generated by regulators or a bank

economicsdepartment, importing the scenario time series into the application and then performing additional calculations with them.

Figure 1: The *Stress Controller*^{TM} Web Application

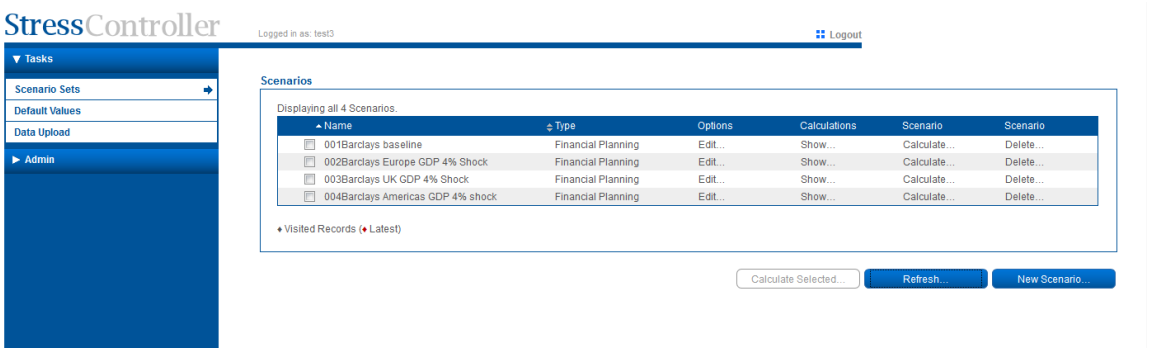


Figure 2: Editing Scenarios - Shocks to GDP

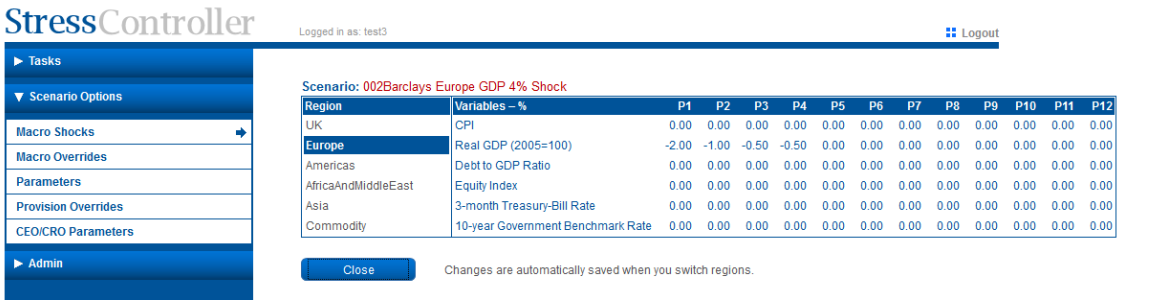
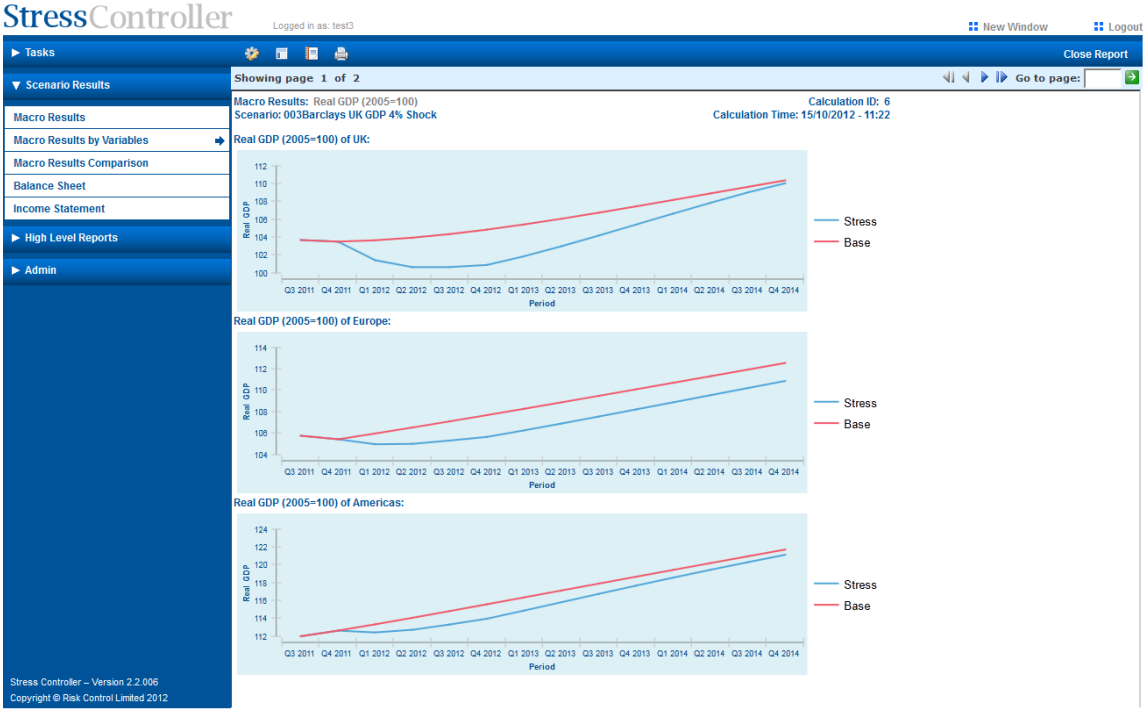


Figure 3: Results on GDP time paths for different regions



2. The Bank's Loan Portfolio

Loan Data

This section presents a description of the bank's loan books based on its Pillar 3 disclosures as recorded in its annual report. The bank provides information on the breakdown of its loan book by region, sector, credit quality, and asset class. Table 1 shows the matrix of sector and region loan volumes. These figures are taken directly from the bank's 2011report except for small changes. (For example, the division between wholesale to customer and wholesale to bank for the Government and central bank category is based on other data disclosed by the bank.)

Table 2 shows the distribution by credit quality. The figures here reflect our assumption that the breakdown by credit quality of Wholesale to bank, Wholesale to customer and Other retail are the same.
Table 3 contains information about the probability of default (PD) for different asset classes and credit quality groups. These figures are chosen to be representative numbers within PD ranges provided for each category by the bank. The bank provides information on both PDs and loss rates. Using these, we infer the recovery rates specified in the right hand column.

Table 1: Re-organized break down by region and sector

Industrial sectors	credit class	UK	Europe	Americas	Africa and Middle East	Asia	Total
Banks	Wholesale to bank	9,251	13,503	13,349	2,956	5,648	**44,707**
Other financial institutionsa	Wholesale to customer	18,474	20,059	44,965	2,264	3,888	**89,650**
Manufacturing	Wholesale to customer	6,185	3,341	1,396	1,439	543	**12,904**
Construction	Wholesale to customer	3,391	771	32	348	65	**4,607**
Property	Wholesale to customer	16,230	3,193	869	3,600	212	**24,104**
Government and central bank	Wholesale to customer	341	2,326	627	2,123	713	**6,129**
Government and central bank	Wholesale to bank	152	1,039	280	949	318	**2,739**
Energy and water	Wholesale to customer	1,599	2,448	2,165	818	384	**7,414**
Wholesale and retail distribution and leisure	Wholesale to customer	10,308	3,008	656	2,073	161	**16,206**
Business and other services	Wholesale to customer	16,473	4,981	1,584	2,907	355	**26,300**
Home loans	Home loans	112,260	38,508	566	19,437	501	**171,272**
Cards, unsecured loans and other personal lending	Cards	27,409	6,417	9,293	6,158	785	**50,062**
Other wholesale	Wholesale to customer	3,181	2,112	499	2,841	223	**8,856**
Other retail	Other retail	5,182	3,442	813	4,630	363	**14,430**
		230,436	**105,148**	**77,094**	**52,543**	**14,159**	**479,380**

Source: the table 'Loans by region and sector' on page 93 of the bank's Annual Report 2011.

Table 2: Distribution of credit quality of L&A

Asset classes	Performing strong	Performing satisfactory	Performing higher risk	Past due not impaired	Impaired collectively	Impaired individually	Total
Wholesale to bank	0.6516	0.2490	0.0193	0.0382	0.0033	0.0386	1
Wholesale to customer	0.6516	0.2490	0.0193	0.0382	0.0033	0.0386	1
Home loans	0.7786	0.1502	0.0063	0.0007	0.0620	0.0022	1
Cards	0.2061	0.6575	0.0150	0.0050	0.1062	0.0102	1
Other retail	0.6516	0.2490	0.0193	0.0382	0.0033	0.0386	1

Source: the table 'Credit quality of L&A' on page 104 of the bank's Annual Report 2011.

Table 3: Calibrated PD for different asset class and credit quality groups

	PD (%)						
Asset classes	Performing strong	Performing satisfactory	Performing higher risk	Past due not impaired	Impaired collectively	Impaired individually	recovery ratio
Wholesale to bank	0.01	0.02	0.03	15	20	20	0.99
Wholesale to customer	0.01	0.6	11	15	20	20	0.6
Home loans	0.3	2	10	15	20	20	0.7
Cards	0.6	5	12	15	20	20	0.5
Other retail	0.4	2	10	15	20	20	0.55

Source: the table 'Internal measures of credit quality' on page 105 of the bank's Annual Report 2011.

Table 4: Target and calibrated loss rates

Asset classes	amount weight of each class	calibrated weighted average LGD (bps)	target loss rate (bps)	total loss rate from report (bps)	calibrated total loss rate (bps)
Wholesale to bank	0.099	1.423	1.265	79.060	84.045
Wholesale to customer	0.409	71.176	69.430		
Home loans	0.357	56.750	50.000		
Cards	0.104	299.733	300.000		
Other retail	0.030	106.326	102.730		

In Table 4, we confirm that the calibrated loss rates approximately match the reported loss rates quoted by the bank. To achieve this we adjust the PD and recovery rates in Table 3 to ensure that, for each asset class, the loss given default rate from our model (displayed in second column of Table 4) matches the target loss rate disclosed by the bank (displayed in the third column of Table 4).

Loan Modeling and Sensitivities

One may model loans within *Stress Controller*^{TM} either as individual rated exposures or as diversified pool exposures with a default rate that evolves over time. For public data analysis such as the exercise reported in this paper, we use diversified pool exposures.

In separate publications, we have shown how to derive simple but rigorous models of the dynamic behavior of loss rates on pools of homogeneous loans. These may be modeled unconditionally or conditional on macroeconomic variables. In the latter case, the default rate evolves as an auto-correlated time series driven by shocks to macro variables like GDP, interest rates or unemployment.

The sensitivities we employ in this case study are sector-specificand asset-class-specific and draw on the estimates we have obtained in a series of past studies of the macroeconomic impact on loan books using data from different banks and a range of public data sources.

3. Modeling Financial Statements

The Bank's Financial Statements

In Figures 4 and 5, the historical consolidated summary financial statements of the bank are presented for the past 5 years. These historical financial statements are imported into *Stress Controller*^{TM} and serve as the starting point for forecasts of future financial statements conditional on macroeconomic scenarios.[1]

Figure 4: Historical B/S from the Bank's Annual Report

As at 31 December	2011 £m	2010 £m	2009 £m	2008 £m	2007 £m
Assets					
Cash, balances at central banks and items in the course of collection	**108,706**	99,014	83,076	31,714	7,637
Trading portfolio assets	**152,183**	168,867	151,344	185,637	193,691
Financial assets designated at fair value	**36,949**	41,485	42,568	121,199	147,480
Derivative financial instruments	**538,964**	420,319	416,815	984,802	248,088
Available for sale financial investments	**68,491**	65,110	56,483	64,976	43,072
Loans and advances to banks	**47,446**	37,799	41,135	47,707	40,120
Loans and advances to customers	**431,934**	427,942	420,224	461,815	345,398
Reverse repurchase agreements and other similar secured lending	**153,665**	205,772	143,431	130,354	183,075
Other assets	**25,189**	23,337	23,853	24,776	18,800
Total assets	**1,563,527**	1,489,645	1,378,929	2,052,980	1,227,361
Liabilities					
Deposits and items in the course of collection due to banks	**92,085**	79,296	77,912	116,545	92,338
Customer accounts	**366,032**	345,788	322,429	335,505	294,987
Repurchase agreements and other similar secured borrowing	**207,292**	225,534	198,781	182,285	169,429
Trading portfolio liabilities	**45,887**	72,693	51,252	59,474	65,402
Financial liabilities designated at fair value	**87,997**	97,729	87,881	146,075	167,128
Derivative financial instruments	**527,910**	405,516	403,416	968,072	248,288
Debt securities in issue	**129,736**	156,623	135,902	149,567	120,228
Subordinated liabilities	**24,870**	28,499	25,816	29,842	18,150
Other liabilities	**16,522**	15,705	17,062	18,204	18,935
Total liabilities	**1,498,331**	1,427,383	1,320,451	2,005,569	1,194,885
Shareholders' equity					
Shareholders' equity excluding non-controlling interests	**55,589**	50,858	47,277	36,618	23,291
Non-controlling interests	**9,607**	11,404	11,201	10,793	9,185
Total shareholders' equity	**65,196**	62,262	58,478	47,411	32,476
Total liabilities and shareholders' equity	**1,563,527**	1,489,645	1,378,929	2,052,980	1,227,361

Figure 5: Historical I/S from the Bank's Annual Report

For the year ended 31 December	2011 £m	2010 £m	2009 £m	2008 £m	2007 £m
Continuing operations					
Net interest income	**12,201**	12,523	11,918	11,469	9,598
Non-interest income net of claims and benefits on insurance contracts	**20,091**	18,917	17,205	9,730	11,446
Total income net of insurance claims	**32,292**	31,440	29,123	21,199	21,044
Credit impairment charges and other provisions	**(3,802)**	(5,672)	(8,071)	(5,419)	(2,795)
Impairment of investment in BlackRock, Inc.	**(1,800)**	–	–	–	–
Operating expenses	**(20,777)**	(19,971)	(16,715)	(13,391)	(12,096)
Other	**(34)**	268	248	2,747	70
Profit before tax	**5,879**	6,065	4,585	5,136	6,223
Taxation	**(1,928)**	(1,516)	(1,074)	(453)	(1,699)
Profit after tax from continuing operations	**3,951**	4,549	3,511	4,683	4,524
Profit for the year from discontinued operations, including gain on disposal	**–**	–	6,777	604	571
Profit after tax	**3,951**	4,549	10,288	5,287	5,095
Profit attributable to equity holders of the Parent	**3,007**	3,564	9,393	4,382	4,417
Profit attributable to non-controlling interests	**944**	985	895	905	678
	3,951	4,549	10,288	5,287	5,095

[1]The calculations are performed on a quarterly basis so the data is imported after converting the annual reports into quarterly data.

Modeling the Bank's Balance Sheet

Detailed description of the equations used in modeling the bank's balance sheet and P&L are provided in the Appendix. Key assumptions of the modeling approach are as follows.

1. We view the bank's financial statement as balance-sheet driven. Both sides of the balance sheet are assumed to be directly affected by the macro-economy. The asset side is also affected through the impact of macro shocks on provisions and changes in mark-to-market values.

2. Loans and deposits are assumed to be linked to (a) GDP growth in the relevant region, and (b) its own historical trend. The relative importance of (a) and (b) and the sensitivity to macro shocks vary for different loans and deposits. The approach employed in this case study could easily be generalized to include interest rates or other macroeconomic variables such as unemployment rates but we have preferred in this exercise to keep the analysis as simple as possible.

3. Marked-to-market assets and liabilities are assumed to be sensitive to relevant macro indicators, in particular to GDP or national equity indices.

4. Items such as 'Cash' and 'Others Assets/Liabilities/Expenses' are modeled as moving averages of the previous balances.

5. All Balance Sheet items, except 'Cash' and 'Other Assets/Liabilities', have been modeled taking into account inflation.

6. Income is modeled based on the forecasted balance-sheet. Both interest and non-interest income are modeled as being affected by the combined changes in loan-type assets and non-loan type assets, but with different weights on different types of assets (e.g. weight of loan-type assets on interest income is 0.8 but on non-interest income is 0.2) and the weights are user-defined parameters. For interest income, the impact from changes of forecasted interest rates is modeled

7. The credit impairment charge is calculated as the expected losses of loans and advances to retail and wholesale customers, taking into account the lagged impact of macroeconomic variables on provisions. (Recall that loans are modeled as diversified pool exposures.)

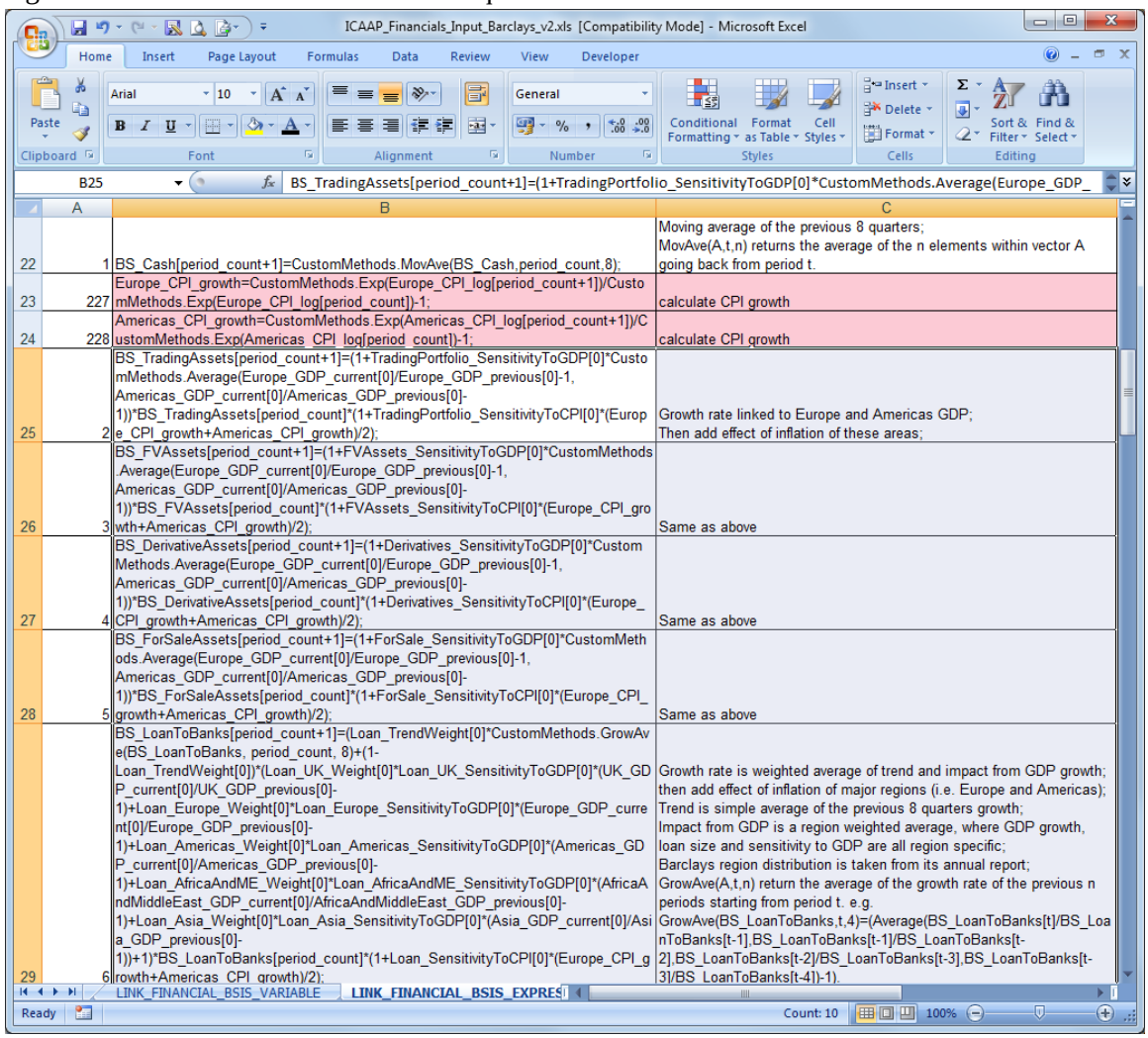
8. We view the operating expenses of the bank as controlled by the management rather than reacting passively to changes in the size of the bank's balance-sheet. We therefore allow the user to input the forecasted rate of change of operating expenses.

9. To balance the balance sheet at the end of each forecasting, we adjust the gap between forecast 'Total Assets' and 'Total Liabilities and Shareholder Equities', allowing this gap to be absorbed by multiple items employing user-defined weights. The items adjusted to balance assets and liabilities are referred to as the B/S 'balancing items'.

10. We model shareholders' equity changes as influenced by: (i) retained earnings from the forecast Income Statements, (ii) dividend payouts based on user defined 'dividend payout ratios' and (iii) reserve and employee share scheme changes which are also user-defined.

The equations for the financial statements analysis are treated in *Stress Controller*^{TM}as part of the data of the model. They are imported from a 'feeder' Excel workbook. A screenshot of the equations stored in such a workbook is provided in Figure 6.

Figure 6: Screen shot of Balance Sheet Equations in an Excel workbook.

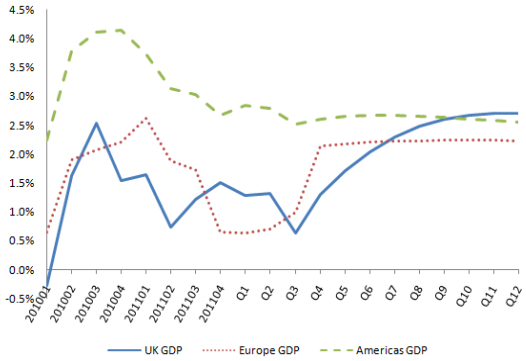


	A	B	C
22	1	BS_Cash[period_count+1]=CustomMethods.MovAve(BS_Cash,period_count,8);	Moving average of the previous 8 quarters; MovAve(A,t,n) returns the average of the n elements within vector A going back from period t.
23	227	Europe_CPI_growth=CustomMethods.Exp(Europe_CPI_log[period_count+1])/CustomMethods.Exp(Europe_CPI_log[period_count])-1;	calculate CPI growth
24	228	Americas_CPI_growth=CustomMethods.Exp(Americas_CPI_log[period_count+1])/CustomMethods.Exp(Americas_CPI_log[period_count])-1;	calculate CPI growth
25	2	BS_TradingAssets[period_count+1]=(1+TradingPortfolio_SensitivityToGDP[0]*CustomMethods.Average(Europe_GDP_current[0]/Europe_GDP_previous[0]-1, Americas_GDP_current[0]/Americas_GDP_previous[0]-1))*BS_TradingAssets[period_count]*(1+TradingPortfolio_SensitivityToCPI[0]*(Europe_CPI_growth+Americas_CPI_growth)/2);	Growth rate linked to Europe and Americas GDP; Then add effect of inflation of these areas;
26	3	BS_FVAssets[period_count+1]=(1+FVAssets_SensitivityToGDP[0]*CustomMethods.Average(Europe_GDP_current[0]/Europe_GDP_previous[0]-1, Americas_GDP_current[0]/Americas_GDP_previous[0]-1))*BS_FVAssets[period_count]*(1+FVAssets_SensitivityToCPI[0]*(Europe_CPI_growth+Americas_CPI_growth)/2);	Same as above
27	4	BS_DerivativeAssets[period_count+1]=(1+Derivatives_SensitivityToGDP[0]*CustomMethods.Average(Europe_GDP_current[0]/Europe_GDP_previous[0]-1, Americas_GDP_current[0]/Americas_GDP_previous[0]-1))*BS_DerivativeAssets[period_count]*(1+Derivatives_SensitivityToCPI[0]*(Europe_CPI_growth+Americas_CPI_growth)/2);	Same as above
28	5	BS_ForSaleAssets[period_count+1]=(1+ForSale_SensitivityToGDP[0]*CustomMethods.Average(Europe_GDP_current[0]/Europe_GDP_previous[0]-1, Americas_GDP_current[0]/Americas_GDP_previous[0]-1))*BS_ForSaleAssets[period_count]*(1+ForSale_SensitivityToCPI[0]*(Europe_CPI_growth+Americas_CPI_growth)/2);	Same as above
29	6	BS_LoanToBanks[period_count+1]=(Loan_TrendWeight[0]*CustomMethods.GrowAve(BS_LoanToBanks, period_count, 8)+(1-Loan_TrendWeight[0])*(Loan_UK_Weight[0]*Loan_UK_SensitivityToGDP[0]*(UK_GDP_current[0]/UK_GDP_previous[0]-1)+Loan_Europe_Weight[0]*Loan_Europe_SensitivityToGDP[0]*(Europe_GDP_current[0]/Europe_GDP_previous[0]-1)+Loan_Americas_Weight[0]*Loan_Americas_SensitivityToGDP[0]*(Americas_GDP_current[0]/Americas_GDP_previous[0]-1)+Loan_AfricaAndME_Weight[0]*Loan_AfricaAndME_SensitivityToGDP[0]*(AfricaAndMiddleEast_GDP_current[0]/AfricaAndMiddleEast_GDP_previous[0]-1)+Loan_Asia_Weight[0]*Loan_Asia_SensitivityToGDP[0]*(Asia_GDP_current[0]/Asia_GDP_previous[0]-1))+1)*BS_LoanToBanks[period_count]*(1+Loan_SensitivityToCPI[0]*(Europe_CPI_growth+Americas_CPI_growth)/2);	Growth rate is weighted average of trend and impact from GDP growth; then add effect of inflation of major regions (i.e. Europe and Americas); Trend is simple average of the previous 8 quarters growth; Impact from GDP is a region weighted average, where GDP growth, loan size and sensitivity to GDP are all region specific; Barclays region distribution is taken from its annual report; GrowAve(A,t,n) return the average of the growth rate of the previous n periods starting from period t. e.g. GrowAve(BS_LoanToBanks,t,4)=(Average(BS_LoanToBanks[t]/BS_LoanToBanks[t-1],BS_LoanToBanks[t-1]/BS_LoanToBanks[t-2],BS_LoanToBanks[t-2]/BS_LoanToBanks[t-3],BS_LoanToBanks[t-3]/BS_LoanToBanks[t-4])-1).

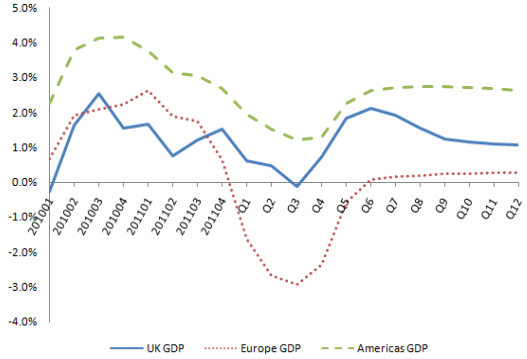
To take an example, the item 'Trading portfolio assets' is modeled as:

BS_TradingAssets[period_count+1]=(1+TradingPortfolio_SensitivityToGDP[0]*CustomMethods.Average(Europe_GDP_current[0]/Europe_GDP_previous[0]-1, Americas_GDP_current[0]/Americas_GDP_previous[0]-1))*BS_TradingAssets[period_count]*(1+TradingPortfolio_SensitivityToCPI[0]*(Europe_CPI_growth+Americas_CPI_growth)/2);

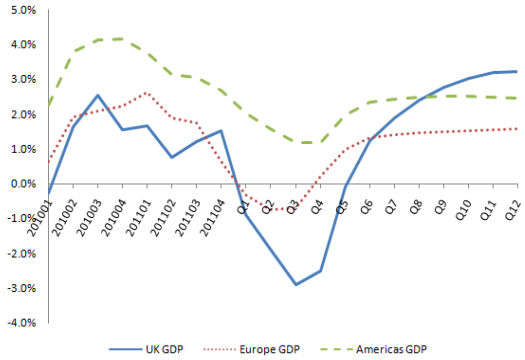
Figure 7:ForecastedGDPyear-on-year growth under 4 scenarios



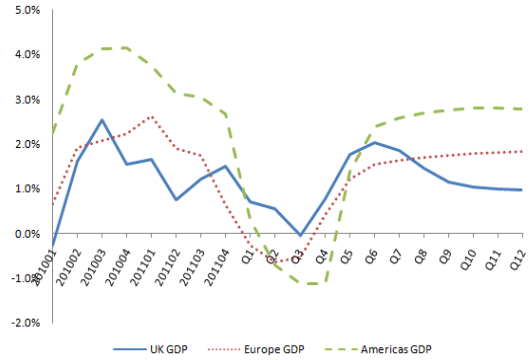
Base Case



Europe Recession



UK Recession



Americas Recession

Note: In Figure 1 we plot out, in each scenario, the historical year-on-year GDP growth for the past 8 quarters and the forecasted year-on-year GDP growth for the future 12 quarters.

Before the above equation is executed, all the variables employed in the equation must be declared by importing a user workbook containing the definition of each variable. Further details of how the equations are specified and used within *Stress Controller*^{TM} are provided in the Appendix.

4. Results

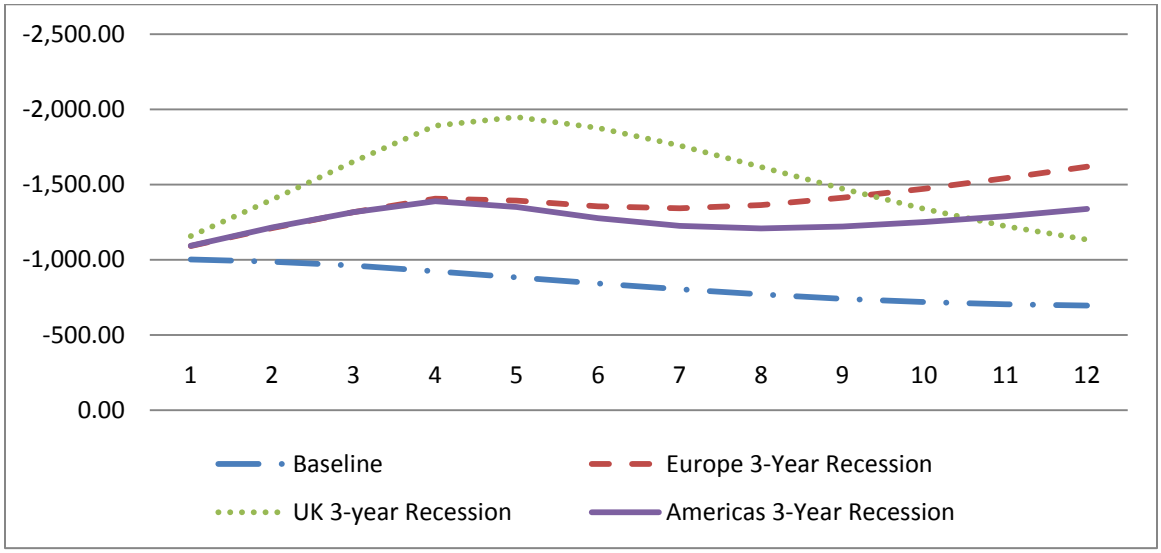
Using the approach described above, we performed an analysis of the impact of several stress scenarios on the bank's financial statements and key risk indicators. We present below results for (i) a base case (i.e., an unconditional forecast), (ii) a European recession, (iii) a UK recession, and (iv) a recession in America.

Figure 7 shows the time paths of real GDP 1-year growth rates for the UK, Europe and America. The time paths are shown for the base case and the three stress cases described above. We display quarterly data up to the end of 2011 followed by projections quarter by quarter until the end of 2014. Note that we start the forecast calculations in Q1 2012 because the financial statement data available is for the end of 2011.

The recession scenarios assume a sequence of shocks to real GDP in the geographical region in question. In all cases, the shocks are -2% in Q1, -1% in Q2 and -0.5% in Q3, Q4,.., Q12. These shocks sum to a cumulative negative shocks of 8% over 3 years.

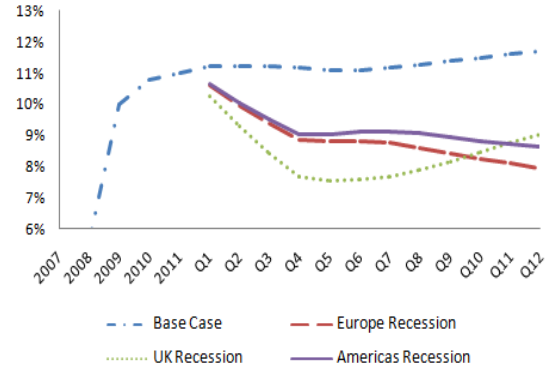
As one might expect, the impact of a recession is greatest for the region itself. However, recessions in each region have serious implications for outcomes in other regions. Note that the fact that American and European GDP growth rates are affected by a UK recession does not imply a direct causal relationship. Instead, the implication is that when a recession occurs in the UK, on average one would expect recessions of the magnitude shown in the other regions.

Figure 8: Forecasted credit impairment provisions under 4 scenarios (£m)

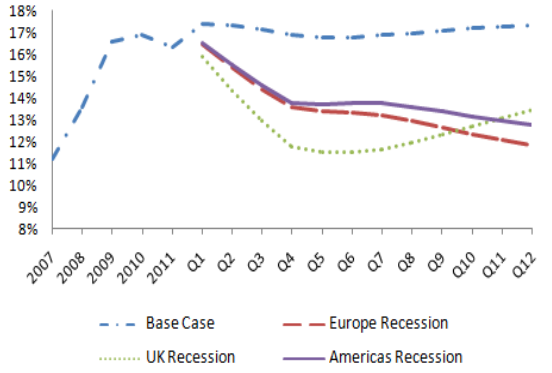


Note: based on the credit risk modeling of a static credit portfolio, we have also taken into account (a) the variation of the loans over the forecasted period and (b) the lag effect of GDP shock to the provision of credit loans.

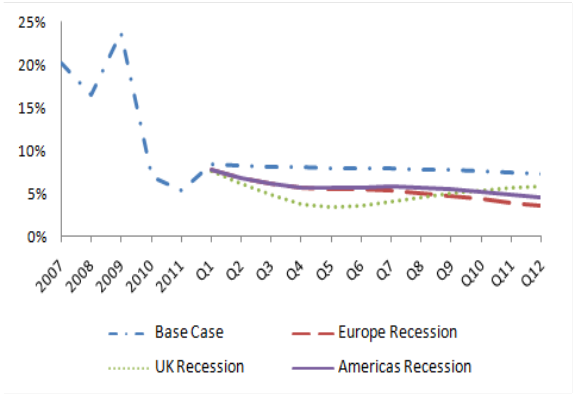
Figure 9: Key Performance Indicators under 4 scenarios



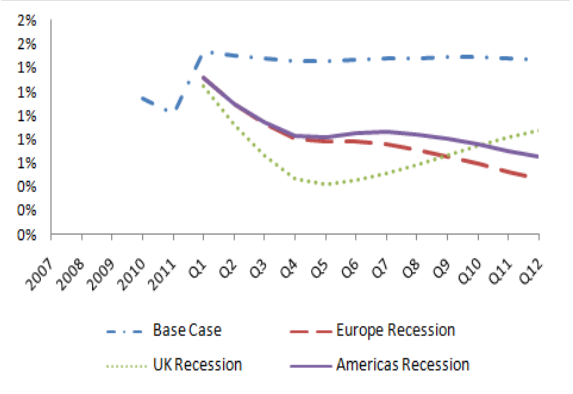
Core Tier 1 Capital Ratio



Total Capital Ratio



Annualized Return on Equity



Annualized Return on RWA

Note: We plot out the KPI measure for the previous 5 years and future 12 forecasted quarters.

Table 5: Extracted items from forecasted quarterly balance sheet (£m)

Base Case	2010	2011	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Cash and Mark-to-Market Assets	794,795	905,293	901,894	907,980	914,382	920,548	926,410	932,096	937,563	942,768	947,664	953,655	959,594	965,447
Total Loans	465,741	479,380	482,535	485,911	489,488	493,243	497,160	501,214	505,381	509,642	513,982	518,383	522,833	527,321
Other Assets	229,109	178,854	202,718	204,878	205,730	204,747	201,700	199,846	199,333	200,332	203,031	203,075	202,852	202,494
Total Assets	**1,489,645**	**1,563,527**	**1,587,148**	**1,598,769**	**1,609,600**	**1,618,538**	**1,625,270**	**1,633,155**	**1,642,277**	**1,652,742**	**1,664,677**	**1,675,113**	**1,685,279**	**1,695,261**
Deposits	425,084	458,117	451,050	454,604	458,673	462,526	465,923	469,050	471,938	474,577	476,931	480,471	483,984	487,406
Mark-to-Market Liabilities	801,472	869,086	881,228	886,616	891,438	895,583	898,938	902,792	907,190	912,187	917,848	922,650	927,345	932,000
Other Liabilities	200,827	171,128	187,936	188,869	189,042	188,185	186,340	185,382	185,318	186,215	188,173	188,283	188,242	188,137
Total Liabilities	**1,427,383**	**1,498,331**	**1,520,214**	**1,530,088**	**1,539,152**	**1,546,295**	**1,551,201**	**1,557,223**	**1,564,446**	**1,572,978**	**1,582,951**	**1,591,404**	**1,599,572**	**1,607,544**
Total Equity	62,262	65,196	66,934	68,681	70,448	72,243	74,069	75,932	77,831	79,764	81,726	83,709	85,707	87,717
Total Liabilities and Equity	**1,489,645**	**1,563,527**	**1,587,148**	**1,598,769**	**1,609,600**	**1,618,538**	**1,625,270**	**1,633,155**	**1,642,277**	**1,652,742**	**1,664,677**	**1,675,113**	**1,685,279**	**1,695,261**

UK Recession	2010	2011	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Cash and Mark-to-Market Assets	794,795	905,293	898,512	902,084	906,901	911,864	916,580	921,152	925,517	929,620	933,405	938,179	942,911	947,562
Total Loans	465,741	479,380	478,178	479,167	481,288	483,448	485,659	488,054	490,682	493,538	496,603	499,855	503,266	506,704
Other Assets	229,109	178,854	202,855	204,917	205,643	204,648	201,586	199,713	199,180	200,153	202,824	202,820	202,557	202,171
Total Assets	**1,489,645**	**1,563,527**	**1,579,545**	**1,586,169**	**1,593,832**	**1,599,959**	**1,603,825**	**1,608,919**	**1,615,379**	**1,623,311**	**1,632,832**	**1,640,855**	**1,648,734**	**1,656,437**
Deposits	425,084	458,117	448,628	449,990	452,585	455,418	457,882	460,149	462,259	464,191	465,905	468,731	471,567	474,287
Mark-to-Market Liabilities	801,472	869,086	876,543	879,859	883,662	886,773	889,134	892,013	895,438	899,453	904,114	907,946	911,634	915,252
Other Liabilities	200,827	171,128	187,605	188,188	188,294	187,510	185,637	184,621	184,492	185,315	187,192	187,187	187,089	186,939
Total Liabilities	**1,427,383**	**1,498,331**	**1,512,776**	**1,518,036**	**1,524,541**	**1,529,701**	**1,532,654**	**1,536,783**	**1,542,189**	**1,548,960**	**1,557,210**	**1,563,864**	**1,570,291**	**1,576,478**
Total Equity	62,262	65,196	66,769	68,133	69,292	70,258	71,171	72,137	73,191	74,351	75,622	76,990	78,443	79,959
Total Liabilities and Equity	**1,489,645**	**1,563,527**	**1,579,545**	**1,586,169**	**1,593,832**	**1,599,959**	**1,603,825**	**1,608,919**	**1,615,379**	**1,623,311**	**1,632,832**	**1,640,855**	**1,648,734**	**1,656,437**

Table 6: Extracted items from forecasted quarterly income statements (£m)

Base Case	2010 annual	2011 annual	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Total Income	31,440	32,292	8,126	8,181	8,238	8,297	8,357	8,419	8,481	8,544	8,607	8,671	8,735	8,799
Credit Impairment Charge	-5,672	-3,802	-1,003	-988	-962	-923	-883	-843	-804	-770	-741	-719	-704	-695
Total Expenses	-19,703	-22,611	-5,217	-5,274	-5,332	-5,392	-5,453	-5,505	-5,558	-5,612	-5,665	-5,724	-5,783	-5,841
Profit before Tax	6,065	5,879	1,906	1,919	1,944	1,982	2,022	2,071	2,118	2,162	2,201	2,228	2,249	2,263
Profit after Tax	4,549	3,951	1,525	1,535	1,555	1,586	1,617	1,656	1,695	1,730	1,761	1,783	1,799	1,810

UK Recession	2010 annual	2011 annual	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Total Income	31,440	32,292	8,064	8,088	8,131	8,176	8,224	8,274	8,325	8,377	8,430	8,483	8,537	8,590
Credit Impairment Charge	-5,672	-3,802	-1,157	-1,399	-1,652	-1,892	-1,948	-1,877	-1,759	-1,617	-1,472	-1,338	-1,223	-1,133
Total Expenses	-19,703	-22,611	-5,217	-5,274	-5,332	-5,392	-5,453	-5,505	-5,558	-5,612	-5,665	-5,724	-5,783	-5,841
Profit before Tax	6,065	5,879	1,690	1,415	1,147	893	824	892	1,008	1,149	1,293	1,421	1,531	1,615
Profit after Tax	4,549	3,951	1,352	1,132	917	714	659	714	807	919	1,034	1,137	1,225	1,292

Figure 8 shows the path of credit impairment provisions under the four scenarios considered. The impairments are driven by the impact of GDP shocks on the expected losses of the diversified pool exposures included in the software to describe the bank's loan book. These are broken down by sector, credit quality and geographical region.

As one may observe from Figure 8, impairment provisions are slightly downward sloping in the base case but rise significantly in the three recession scenarios, showing particular ly striking growth in the UK recession scenario. In this latter scenario, one may note that provisions start to decline towards the end of the period, reflecting the bounce back in growth that occurs in the UK when the recession is primarily a UK phenomenon (see Figure 7).

Figure 9 presents a series of plots of key financial indicators under the four scenarios. Capital, measured in different ways, is down in all three recession scenarios. Capital recovers towards the baseline path in the UK recession scenario by the end of the period but remains stubbornly low in the Europe and Americas recession scenarios.

The figures for returns on equity and Risk Weighted Assets shown in Figure 9 again show consistent patterns of decline as the recessions emerge. In the case of the UK recession scenario, returns recover towards baseline levels towards the end of the period under consideration.

Tables 5 and 6 and Figures 10 and 11 show selected items from the bank's balance sheet and income statements. Loan and deposit growth are depressed in the recession scenarios. Total income and profits are down, the latter being hit most badly in the UK recession scenario but then recovering relatively quickly in this case.

Figure 10: Extracted items from forecasted quarterly balance sheet (£m)

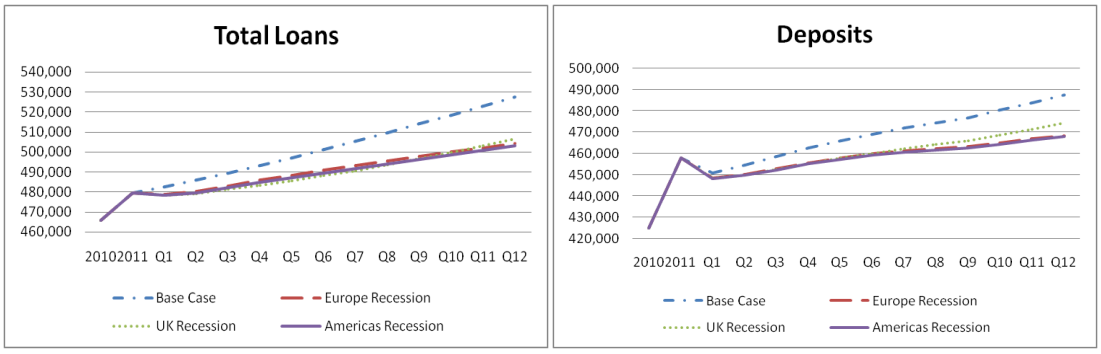
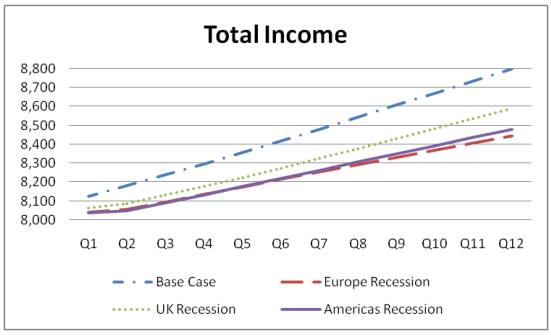
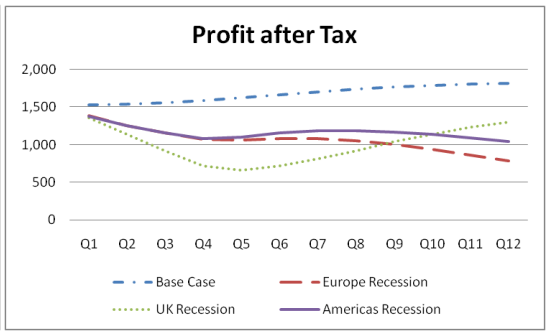


Figure 11: Extracted items from forecasted quarterly income statements (£m)





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Appendix

Section A.1: Introduction

This Appendix provides information on how one may write a financial statement model for a bank for use in *Stress Controller*^{TM}. We present an illustrative model fora particular bank, namely the Barclays Group PLC. TheAppendix is organized as follows.In section A.2, we give a specific example of how to declare all the variables that will be employed in an example equation. In section A.3, we explain how each balance sheet (B/S) item within the 'Assets' and 'Liabilities' categories are forecast. In section A.4, we illustrate the forecasting of the income statement (I/S) and in section A.5, the forecasting of B/S items within the 'Shareholders' equity' category. Finally, in A.6, we show how one balance the B/S by recalculating the 'balancing items'.

Section A.2: Variables Declaration

Before the equations of financial statements modeling can be executed, variables employed in the equations must be loaded into the database by importing a user workbook in which the definition of each variable is specified.

The definition of each variable is stored in a string consisting of four sections. Each section must adhere to certain rules. The four sections are:

(1) Major category:

(2) Name of the variable

(3) Minor category

(4) Indicators for database management

The sections are separated by hyphens. (Note that the hyphen symbol is therefore a reserved character that should not be used for other purposes.)

To illustrate the declaration of variables, consider the B/S variable: 'Trading portfolio assets'. This is modeled as:

```
BS_TradingAssets[t+1]=(1+TradingPortfolio_SensitivityToGDP[0]*
                       CustomMethods.Average(Europe_GDP[t+1]/Europe_GDP[t]-1,
                       Americas_GDP[t+1]/Americas_GDP[t]-
                       1))*BS_TradingAssets[t]*(1+TradingPortfolio_SensitivityToCPI
                       [0]*(Europe_CPI_growth+Americas_CPI_growth)/2);
```

For the above equation to be valid, the user must declare the variables it includes as follow:

(1) BS_TradingAssets Group-Trading portfolio assets-BS-1-1-3-0

- 'Group': this indicates the variable is group level data;
- 'BS': this indicates the variable is from the B/S;

- ‘Trading portfolio assets’: this is the name of the variable as it appears in the B/S;
- ‘1-1-3-0’: this code specifies that the variable (i) will be saved in the database, (ii) will be displayed in the interface, (iii) will have the relative position 3 in the interface and (iv) will not be highlighted.

The time series indicator [t+1] implies that this variable has a time dimension, and [t+1] represents the period to be calculated and [t] the first lag.

(2) TradingPortfolio_SensitivityToGDP Parameter-Group TradingPortfolio_SensitivityToGDP-SCALAR-1-1-1-0

‘Parameter’: this is a user-defined parameter that will be imported from a user-supplied workbook;

‘SCALAR’: this indicates the parameter is scalar valued (and has no time dimension);

‘Group TradingPortfolio’: this is the name of the parameter in the user-supplied workbook;

The time series indicator [0] implies that this variable has no time-series dimension.

(3) Europe_GDP Macro-Europe:Real GDP (2005=100)-MACRORESULT-1-1-1-0

‘Macro’: this indicates the variable is a variable supplied by the macro model;

‘MACRORESULT’: this item should be fetched from the macro results within *Stress Controller*^{TM};

‘Europe:Real GDP (2005=100)’: this is the name of the macro variable;

The time series indicator [t+1] implies that this variable has time dimension, and [t+1] represents the period to be calculated and [t] its first lag.

Section A.3: B/S-Assets and Liabilities

In this section, we explain the modeling of each B/S item.

Assets

1. Cash, balance at central banks and items in the course of collection

   This item is estimated as the average of the previous 8 quarters.Note that this item may be adjusted in the rebalancing of the balance sheet.

   BS_Cash[t+1]=CustomMethods.MovAve(BS_Cash,t,8);

2. Trading portfolio assets

   The growth rate of this item is estimated as being sensitive to the GDP growth rates of Europe and Americas, where sensitivity is a user-defined parameter. Modeling has taken

into account inflation changes. Please note that this item might be recalculated for rebalancing the balance sheet.

3. BS_TradingAssets[period_count+1]=(1+TradingPortfolio_SensitivityToGDP[0]*CustomMethods.Average(Europe_GDP_current[0]/Europe_GDP_previous[0]-1, Americas_GDP_current[0]/Americas_GDP_previous[0]-1))*BS_TradingAssets[period_count]*(1+TradingPortfolio_SensitivityToCPI[0]*(Europe_CPI_growth+Americas_CPI_growth)/2);Financial assets designated at fair value

   Same as above, while sensitivity set as a separate parameter. Modeling has taken into account the inflation changes.

   BS_FVAssets[t+1]=(1+FVAssets_SensitivityToGDP[0]*CustomMethods.Average(Europe_GDP[t+1]/Europe_GDP[t]-1, Americas_GDP[t+1]/Americas_GDP[t]-1))*BS_FVAssets[t]
   (1+FVAssets_SensitivityToCPI[0](Europe_CPI_growth+Americas_CPI_growth)/2);

4. Derivative financial instruments assets

   As above except that the sensitivity is set as a separate parameter. Modeling has taken into account inflation.

   BS_DerivativeAssets[t+1]=(1+Derivatives_SensitivityToGDP[0]*CustomMethods.Average(Europe_GDP[t+1]/Europe_GDP[t]-1, Americas_GDP[t+1]/Americas_GDP[t]-1))*BS_DerivativeAssets[t]
   (1+Derivatives_SensitivityToCPI[0](Europe_CPI_growth+Americas_CPI_growth)/2);

5. Available for sale financial investments

   Same as above except that the sensitivity set as a separate parameter. Modeling has taken into account inflation.

   BS_ForSaleAssets[t+1]=(1+ForSale_SensitivityToGDP[0]*CustomMethods.Average(Europe_GDP[t+1]/Europe_GDP[t]-1, Americas_GDP[t+1]/Americas_GDP[t]-1))*BS_ForSaleAssets[t]
   (1+ForSale_SensitivityToCPI[0](Europe_CPI_growth+Americas_CPI_growth)/2);

6. Gross loans and advances to banks

   The growth rate of this item is estimated as the weighted average of (1) impact from trend and (2) GDP growth. The weights are user-defined parameters and impact from trend is calculated as the average growth rate of previous 8 quarters. The GDP growth is a region-weighted average where the weights are taken from the bank's annual report but can be user-defined. Modeling has taken into account inflation.

   BS_LoanToBanks[t+1]=(Loan_TrendWeight[0]*CustomMethods.GrowAve(BS_LoanToBanks, t, 8)+(1-Loan_TrendWeight[0])*(Loan_UK_Weight[0]*Loan_UK_SensitivityToGDP[0]*(UK_G

DP[t+1]/UK_GDP[t]-
1)+Loan_Europe_Weight[0]*Loan_Europe_SensitivityToGDP[0]*(Europe_GDP[t+1]/Europe_GDP[t]-
1)+Loan_Americas_Weight[0]*Loan_Americas_SensitivityToGDP[0]*(Americas_GDP[t+1]/Americas_GDP[t]-
1)+Loan_AfricaAndME_Weight[0]*Loan_AfricaAndME_SensitivityToGDP[0]*(AfricaAndMiddleEast_GDP[t+1]/AfricaAndMiddleEast_GDP[t]-
1)+Loan_Asia_Weight[0]*Loan_Asia_SensitivityToGDP[0]*(Asia_GDP[t+1]/Asia_GDP[t]-1))+1)*BS_LoanToBanks[t]
(1+Loan_SensitivityToCPI[0](Europe_CPI_growth+Americas_CPI_growth)/2);

7. Less: bank allowance for impairment

   This item should be calculated as the balance from last period plus a fraction of the total credit provision estimated for this period minus the write-off occurring in this period.

   The total credit provision is estimated based on the provision calculation results from the risk modeling section of *Stress Controller*^{TM}, taking into account (1) the lagged effects of macro-economic shock on the credit quality of loans and (2) changes in the forecast volume of loans.The relative impact and write-offsare user-defined input parameters.

   BS_Allowance_Banks[period_count+1]=BS_Allowance_Banks[period_count]+Ave_CreditPoolProvision_current*BS_LAToBanks_Scaling/4.0*Credit_Provision_FractionOfBank[period_count+1]-
   Loan_WriteOff_banks[period_count+1]*(Ave_CreditPoolProvision_current/Ave_CreditPoolProvision_previous);

8. Loans and advances to banks

   This is a dependent item.

   BS_NetLoanToBanks[t+1]=BS_LoanToBanks[t+1]-BS_Allowance_Banks[t+1];

9. Gross loans and advances to customers

   The treatment is similar to that of Gross loans and advances to banks. Modeling allows for inflation changes.

   BS_LoanToCustomers[t+1]=(Loan_TrendWeight[0]*CustomMethods.GrowAve(BS_LoanToCustomers, t, 8)+(1-
   Loan_TrendWeight[0])*(Loan_UK_Weight[0]*Loan_UK_SensitivityToGDP[0]*(UK_GDP[t+1]/UK_GDP[t]-
   1)+Loan_Europe_Weight[0]*Loan_Europe_SensitivityToGDP[0]*(Europe_GDP[t+1]/Europe_GDP[t]-
   1)+Loan_Americas_Weight[0]*Loan_Americas_SensitivityToGDP[0]*(Americas_GDP[t+1]/Americas_GDP[t]-
   1)+Loan_AfricaAndME_Weight[0]*Loan_AfricaAndME_SensitivityToGDP[0]*(Africa

AndMiddleEast_GDP[t+1]/AfricaAndMiddleEast_GDP[t-1)+Loan_Asia_Weight[0]*Loan_Asia_SensitivityToGDP[0]*(Asia_GDP[t+1]/Asia_GDP[t]-1))+1)*BS_LoanToCustomers[t]
(1+Loan_SensitivityToCPI[0](Europe_CPI_growth+Americas_CPI_growth)/2);

10. Less: customers allowance for impairment

    The treatment is similar to that of item 7 'Less: bank allowance for impairment'.

    BS_Allowance_Customers[period_count+1]=BS_Allowance_Customers[period_count]+BS_LAToCustomers_Scaling*Ave_CreditPoolProvision_current/4.0*(1-Credit_Provision_FractionOfBank[period_count+1])-Loan_WriteOff_customers[period_count+1]*(Ave_CreditPoolProvision_current/Ave_CreditPoolProvision_previous);

11. Loans and advances to customers

    This is a dependent item.

    BS_NetLoanToCustomers[t+1]=BS_LoanToCustomers[t+1]-BS_Allowance_Customers[t+1];

12. Reverse repurchase agreements and other similar secured lending

    This item is estimated as the average of the previous 8 quarters. Modeling allows for the effect of inflation.

    BS_RepoAssets[t+1]=CustomMethods.MovAve(BS_RepoAssets,t,8)
    (1+Other_SensitivityToCPI[0](Europe_CPI_growth+Americas_CPI_growth)/2);

13. Other assets

    This item is estimated as the average of the previous 8 quarters. Please be noted that this item might be recalculated for rebalancing the balance sheet.

    BS_OtherAssets[t+1]=CustomMethods.MovAve(BS_OtherAssets,t,8);

14. Total assets

    This is a dependent item.

    BS_TotalAssets[t+1]=BS_Cash[t+1]+BS_TradingAssets[t+1]+BS_FVAssets[t+1]+BS_DerivativeAssets[t+1]+BS_ForSaleAssets[t+1]+BS_NetLoanToBanks[t+1]+BS_NetLoanToCustomers[t+1]+BS_RepoAssets[t+1]+BS_OtherAssets[t+1];

Liabilities

15. Deposits and items in the course of collection due to banks

This item is estimated as the average of the previous 8 quarters. Modeling has taken into account the inflation changes. Note that this item may be recalculated when the balance sheet is rebalanced.

```
BS_DueToBanks[t+1]=CustomMethods.MovAve(BS_DueToBanks,t,8)
*(1+Deposit_SensitivityToCPI[0]*(Europe_CPI_growth+Americas_CPI_growth)/2);
```

16. Customer accounts

This item is calculated similarly to the gross loans and advances items. It shares the same region weights that are used in estimating 'Gross loans and advances to banks' and 'Gross loans and advances to customers'. Modeling allows for the impact of inflation. Note that this item may be recalculated when the balance sheet is rebalanced.

```
BS_Deposits[t+1]=(Deposit_TrendWeight[0]*CustomMethods.GrowAve(BS_Deposits, t,
8)+(1-
Deposit_TrendWeight[0])*(Loan_UK_Weight[0]*Deposit_UK_SensitivityToGDP[0]*(
UK_GDP[t+1]/UK_GDP[t]-
1)+Loan_Europe_Weight[0]*Deposit_Europe_SensitivityToGDP[0]*(Europe_GDP[t+1]
/Europe_GDP[t]-
1)+Loan_Americas_Weight[0]*Deposit_Americas_SensitivityToGDP[0]*(Americas_GD
P[t+1]/Americas_GDP[t]-
1)+Loan_AfricaAndME_Weight[0]*Deposit_AfricaAndME_SensitivityToGDP[0]*(Afri
caAndMiddleEast_GDP[t+1]/AfricaAndMiddleEast_GDP[t]-
1)+Loan_Asia_Weight[0]*Deposit_Asia_SensitivityToGDP[0]*(Asia_GDP[t+1]/Asia_G
DP[t]-1))+1)*BS_Deposits[t]
*(1+Deposit_SensitivityToCPI[0]*(Europe_CPI_growth+Americas_CPI_growth)/2);
```

17. Repurchase agreements and other similar secured borrowing

This item is estimated as the average of the previous 8 quarters. Modeling allows for the impact of inflation.

```
BS_RepoLiabilities[t+1]=CustomMethods.MovAve(BS_RepoLiabilities,t,8)
*(1+Other_SensitivityToCPI[0]*(Europe_CPI_growth+Americas_CPI_growth)/2);
```

18. Trading portfolio liabilities

The growth rate of this item is estimated in the same way as that of item 'Trading portfolio assets': linked to average GDP growth in Europe and Americas. It also shares the parameters of sensitivity to GDP as that used in estimating item 'Trading portfolio assets'. Modeling allows for the impact of inflation.

```
BS_TradingLiabilities[t+1]=(1+TradingPortfolio_SensitivityToGDP[0]*CustomMethods
.Average(Europe_GDP[t+1]/Europe_GDP[t]-1, Americas_GDP[t+1]/Americas_GDP[t]-
1))*BS_TradingLiabilities[t]
```

(1+TradingPortfolio_SensitivityToCPI[0](Europe_CPI_growth+Americas_CPI_growth)/2);

19. Financial liabilities designated at fair value

    The growth rate of this item is estimated in the same way as that of item ‘Financial assets designated at fair value’ in that it is linked to average GDP growth in Europe and Americas. It also shares the GDP sensitivity parameters used in estimating item‘Financial assets designated at fair value’. Modeling allows for the impact of inflation.

    BS_FVLiabilities[t+1]=(1+FVAssets_SensitivityToGDP[0]*CustomMethods.Average(Europe_GDP[t+1]/Europe_GDP[t]-1, Americas_GDP[t+1]/Americas_GDP[t]-1))*BS_FVLiabilities[t]
    (1+FVAssets_SensitivityToCPI[0](Europe_CPI_growth+Americas_CPI_growth)/2);

20. Derivative financial instruments liabilities

    The growth rate of this item is estimated in the same way as that of item ‘Derivative financial instruments assets’: linked to average GDP growth in Europe and Americas. It also share the parameters of sensitivity to GDP as that used in estimating item ‘Derivative financial instruments assets’. Modeling has taken into account the inflation changes.

    BS_DerivativeLiabilities[t+1]=(1+Derivatives_SensitivityToGDP[0]*CustomMethods.Average(Europe_GDP[t+1]/Europe_GDP[t]-1, Americas_GDP[t+1]/Americas_GDP[t]-1))*BS_DerivativeLiabilities[t]
    (1+Other_SensitivityToCPI[0](Europe_CPI_growth+Americas_CPI_growth)/2);

21. Debt securities in issue

    This item is estimated as the average of the previous 8 quarters. Please be noted that this item might be recalculated for rebalancing the balance sheet.Modeling has taken into account the inflation changes.

    BS_DebtIssue[t+1]=CustomMethods.MovAve(BS_DebtIssue,t,8)
    (1+Other_SensitivityToCPI[0](Europe_CPI_growth+Americas_CPI_growth)/2);

22. Subordinated liabilities

    This item is estimated as the average of the previous 8 quarters. Modeling has taken into account the inflation changes.

    BS_SubDebt[t+1]=CustomMethods.MovAve(BS_SubDebt,t,8)
    (1+Other_SensitivityToCPI[0](Europe_CPI_growth+Americas_CPI_growth)/2);

23. Other liabilities

    This item is estimated as the average of the previous 8 quarters. Please be noted that this item might be recalculated for rebalancing the balance sheet.

BS_OtherLiabilities[t+1]=CustomMethods.MovAve(BS_OtherLiabilities,t,8);

24. Total liabilities

    This is a dependent item.

    BS_TotalLiabilities[t+1]=BS_DueToBanks[t+1]+BS_Deposits[t+1]+BS_RepoLiabilities[t+1]+BS_TradingLiabilities[t+1]+BS_FVLiabilities[t+1]+BS_DerivativeLiabilities[t+1]+BS_DebtIssue[t+1]+BS_SubDebt[t+1]+BS_OtherLiabilities[t+1];

Section A.4: I/S

Continuing operations

25. Net interest income

    The growth rate of this item linked to the growth rate of both loan-type and non-loan-type assets. We also model the impact from the changes in the forecasted interest rates.

26. IS_IntIncome[period_count+1]=IS_IntIncome[period_count]*(IntIncome_Weight_On_Loan[0]*LoanAsset_growth+IntIncome_Weight_On_NonLoan[0]*NonLoanAsset_growth)*(1+IntIncome_Sensitivity_IntRate[0]*Average_Int_Change);Noninterest income net of claims and benefits on insurance contracts

    The growth rate of this item is linked to both loan-type and non-loan type assets forecasted in B/S.

    IS_NonIntIncome[period_count+1]=IS_NonIntIncome[period_count]*(NonIntIncome_Weight_On_Loan[0]*LoanAsset_growth+NonIntIncome_Weight_On_NonLoan[0]*NonLoanAsset_growth);

27. Total income net of insurance claims

    This is a dependent item.

    IS_TotalIncome[t+1]=IS_IntIncome[t+1]+IS_NonIntIncome[t+1];

28. Credit impairment charges and other provisions

    This item is estimated based on the provision calculation results from the risk modeling section of *Stress Controller*^{TM}, taking into account (1) the lagged effect of macro-economic shocks on the credit quality of loans and (2) forecast changes in the volume of loans. The sign is then changed and the annual amount is converted into a quarterly amount (Note that the calculation of risk modeling is based on the assumption of annual quantities.).

    IS_CreditCharges[t+1]=-1*BS_LATotal_Scaling*Ave_CreditPoolProvision_current/4.0;

29. Impairment of investment in BlackRock, Inc.

This item reports the extraordinary impairment associated with the Blackrock holding.

IS_ExtroImpairment[t+1]=Extrodinary_Impairment[t+1];

30. Operating expenses

    The growth rate of this item is user-supplied.

    IS_OPExpenses[t+1]=IS_OPExpenses[t]*(1+OperationExpense_growth[t+1]);

31. Other

    This item is estimated as the average of the previous 8 quarters.

    IS_OtherExpenses[t+1]=CustomMethods.MovAve(IS_OtherExpenses,t,8);

32. Profit before tax

    This is a dependent item.

    IS_PBT[t+1]=IS_TotalIncome[t+1]+IS_CreditCharges[t+1]+IS_ExtroImpairment[t+1]+IS_OPExpenses[t+1]+IS_OtherExpenses[t+1];

33. Taxation

    The average tax rate is a user-supplied parameter. The calculation of this item is then the bigger of zero and the user-supplied tax rate.

    IS_Tax[t+1]=-1*CustomMethods.Max(0,1*Tax_AverageRate[0]*IS_PBT[t+1]);

34. Profit after tax from continuing operations

    This is a dependent item.

    IS_PAT_ConOperation[t+1]=IS_PBT[t+1]+IS_Tax[t+1];

35. Profit for the year from discontinued operations, including gain on disposal

    This item will be user-defined.

    IS_DisconOperation[t+1]=Discontinued_GainLoss[t+1];

36. Profit after tax

    This is a dependent item.

    IS_PAT[t+1]=IS_PAT_ConOperation[t+1]-IS_DisconOperation[t+1];

37. Profit attributable to equity holders of the Parent

    This item is calculated using the user-supplied profit attribution ratio.

IS_ProfitToEq[t+1]=IS_PAT[t+1]*Profit_Attributable_Ratio[t+1];

38. Profit attributable to noncontrolling interests

    This is a dependent item.

    IS_ProfitToMI[t+1]=IS_PAT[t+1]-IS_ProfitToEq[t+1];

Section A.5: B/S

Shareholders equity

39. Shareholders equity excluding non-controlling interests

    This item is estimated as balance from last period plus any capital injection, which is a user-defined parameter in this case, attribution from profit of this period which has been calculated in the previous steps, dividend payout, reserve changes and employee share scheme changes.

    BS_Equity_Control[period_count+1]=BS_Equity_Control[period_count]+Capital_Injection[period_count+1]+IS_ProfitToEq[period_count+1]*(1-Dividend_Payout_Ratio[period_count+1])+Reserve_Control_Change[period_count+1]+Employee_Share_Schemes[period_count+1];

40. Noncontrolling interests

    Similar as the above item, the estimate of this items equals the balance from last period plus the contribution from profit of this period and other changes.

    BS_Equity_NoControl[period_count+1]=BS_Equity_NoControl[period_count]+IS_ProfitToMI[period_count+1]+MI_Equity_Change[period_count+1];

41. Total shareholders equity

    This is a dependent item.

    BS_TotalEquity[t+1]=BS_Equity_Control[t+1]+BS_Equity_NoControl[t+1];

42. Total liabilities and shareholders equity

    This is a dependent item.

    BS_TotalLiaAndEquity[t+1]=BS_TotalLiabilities[t+1]+BS_TotalEquity[t+1];

43. Cash, balance at central banks and items in the course of collection

    Dividend is assumed to be cash dividend so deduction is modeled.

    BS_Cash[period_count+1]=BS_Cash[period_count+1]-IS_ProfitToEq[period_count+1]*Dividend_Payout_Ratio[period_count+1];

44. Recalculate ‘Total Assets’, ‘Total Liabilites’ and ‘Total Liabilities and Shareholder Equities’ before rebalancing calculation

Section A.6: B/S

Balancing items

The ‘balancing items’ are chosen by the user to absorb the gap between total assets and total liabilities and equity generated during the item-by-item forecasting. They are re-calculated based on the results completed after Sections II to IV.

45. Cash, balance at central banks and items in the course of collection

    Here, we adopt the ‘one-side’ absorbing approach, under which the ‘balancing items’ within the assets category are only updated if total liabilities and equities is higher than he total assets in the period in question. If so, a user-supplied absorbing ratio is employed.

    BS_Cash[t+1]=BS_Cash[t+1]+CustomMethods.Max(0,BS_TotalLiaAndEquity[t+1]-BS_TotalAssets[t+1])*GapAbsorb_Asset_Cash[0];

46. Trading portfolio assets

    As above.

    BS_TradingAssets[t+1]=BS_TradingAssets[t+1]+CustomMethods.Max(0,BS_TotalLiaAndEquity[t+1]-BS_TotalAssets[t+1])*GapAbsorb_Asset_TradingPortfolio[0];

47. Other assets

    As above.

    BS_OtherAssets[t+1]=BS_OtherAssets[t+1]+CustomMethods.Max(0,BS_TotalLiaAndEquity[t+1]-BS_TotalAssets[t+1])*GapAbsorb_Asset_Other[0];

48. Deposits and items in the course of collection due to banks

    Similar to assets ‘balancing items’, the ‘balancing items’ within the liabilities category are only updated if total assets exceed total liabilities and equities in the period in question. If so, a user-supplied absorbing ratio is employed.

    BS_DueToBanks[t+1]=BS_DueToBanks[t+1]+CustomMethods.Max(0,BS_TotalAssets[t+1]-BS_TotalLiaAndEquity[t+1])*GapAbsorb_Liability_DueToBanks[0];

49. Customer accounts

    As above

    BS_Deposits[t+1]=BS_Deposits[t+1]+CustomMethods.Max(0,BS_TotalAssets[t+1]-BS_TotalLiaAndEquity[t+1])*GapAbsorb_Liability_CustomerAccount[0];

50. Debt securities in issue

    As above

    BS_DebtIssue[t+1]=BS_DebtIssue[t+1]+CustomMethods.Max(0,BS_TotalAssets[t+1]-BS_TotalLiaAndEquity[t+1])*GapAbsorb_Liability_DebtIssue[0];

51. Other liabilities

    As above

    BS_OtherLiabilities[t+1]=BS_OtherLiabilities[t+1]+CustomMethods.Max(0,BS_TotalAssets[t+1]-BS_TotalLiaAndEquity[t+1])*GapAbsorb_Liability_Other[0];

52. Total assets

    This is a dependent item.

    BS_TotalAssets[t+1]=BS_Cash[t+1]+BS_TradingAssets[t+1]+BS_FVAssets[t+1]+BS_DerivativeAssets[t+1]+BS_ForSaleAssets[t+1]+BS_NetLoanToBanks[t+1]+BS_NetLoanToCustomers[t+1]+BS_RepoAssets[t+1]+BS_OtherAssets[t+1];

53. Total liabilities

    This is a dependent item.

    BS_TotalLiabilities[t+1]=BS_DueToBanks[t+1]+BS_DueToBanks[t+1]+BS_Deposits[t+1]+BS_RepoLiabilities[t+1]+BS_TradingLiabilities[t+1]+BS_FVLiabilities[t+1]+BS_DerivativeLiabilities[t+1]+BS_DebtIssue[t+1]+BS_SubDebt[t+1]+BS_OtherLiabilities[t+1];

54. Total liabilities and shareholders' equity

    This is a dependent item.

    BS_TotalLiaAndEquity[t+1]=BS_TotalLiabilities[t+1]+BS_TotalEquity[t+1];

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