

Scenarios for the European Insurance and Occupational Pensions Authority's EU-wide pension fund stress test in 2015

Introduction

In accordance with its mandate, EIOPA, in cooperation with the ESRB, initiates and coordinates EU-wide stress tests to assess the resilience of financial institutions to adverse market developments. It plans to conduct a stress test this year for pension funds, formally called institutions for occupational retirement provision (IORPs). EIOPA requested the ESRB to provide adverse macro-financial scenarios for this stress test.

This document sets out the macro-financial scenarios for the EU-wide stress test for defined benefit pension funds. These scenarios include risks and vulnerabilities that have been identified, the underlying economic narrative and calibrated shocks to key financial market variables. These shocks should be interpreted as one-off, instantaneous and permanent shifts in asset prices relative to their end-2014 levels.

The scenarios are intended to inform the harmonised valuation of defined benefit pension funds under the so-called holistic balance sheet approach (Box 1). Guidance on applying the stress test to defined benefit pension funds under national regulations or to defined contribution funds will be provided separately by EIOPA and is not part of this document.

Box 1: Elements of the EIOPA pension fund stress test

Pension funds in the European Union broadly consist of defined benefit schemes and defined contribution schemes. In the first type of scheme, the pension fund bears the financial market and longevity risks while, in the second type, pension fund members bear these risks. Both schemes are regulated by the Institutions for Occupational Retirement Provision Directive (IORP),¹ which lays down minimum rules at the EU level with regard to the valuation of liabilities and funding requirements. These are often supplemented at the national level. As a result, pension funds are subject to different national prudential standards.

EIOPA has developed proposals for market-based and risk-sensitive balance sheets, the so-called holistic balance sheet. The holistic balance sheet is an essential part of EIOPA's work on advising the European Commission on EU solvency rules for pension funds². EIOPA has decided to run its 2015 stress test exercise both on the basis of current national prudential standards and the common holistic balance sheet approach. The latter allows for EU-wide comparisons.

Applying a stress test to defined benefit schemes on the basis of the holistic balance sheet approach only requires instantaneous shocks to their balance sheets. An instantaneous shock that leads to a fall in asset prices reduces the value of defined benefit schemes' assets, while an instantaneous shock that results in a fall in the risk-free rate increases the discounted value of defined benefit schemes' liabilities. This is similar to the stress test applied to insurers on the basis of Solvency II during 2014. EIOPA requested the ESRB to design adverse financial market scenarios comprising such instantaneous shocks.

Applying a stress test to defined benefit schemes on the basis of national prudential standards requires information in addition to these instantaneous shocks. This includes assumptions on long-term returns, as these affect the value of the liabilities in some countries. EIOPA will therefore provide pension funds with country-specific guidance for implementing the shocks under the national prudential frameworks. These are therefore not reported in this document.

In turn, assessing the impact of instantaneous shocks on a market-consistent balance sheet would not be meaningful for defined contribution pension funds, since their balance sheets are always in equilibrium. Therefore, the test for defined contribution pension funds will analyse the effects of instantaneous shocks to asset prices and different assumptions for the long-term yields on the expected retirement income of different representative pension fund members. These assumptions for the long-term risk premiums are specified by EIOPA and are not part of the adverse scenarios described in this document.

¹ Directive 2003/41/EC on the Activities and Supervision of Institutions for Occupational Retirement Provision (IORPs).

² EIOPA consultation paper on further work on solvency of IORPs, EIOPA-CP-14/040, 13 October 2014.

Systemic risks and vulnerabilities addressed by the scenarios

A global financial market repricing, a continuing weak macroeconomic outlook in the European Union and re-emerging sovereign debt sustainability concerns are deemed to be the top systemic risks in the EU financial system.

Economic growth in the European Union remained weak in 2014, while inflation continued to decline, partly due to the fall in commodity prices. Information derived from financial market prices indicates that central bank policy rates are expected to remain low for a long time and that medium-term inflation expectations have declined. While low interest rates support economic growth, a prolonged period of low interest rates carries financial stability risks. In particular, it could lead to excessive risk-taking, which could in turn, amid low secondary market liquidity, lead to a sharp and disorderly adjustment of asset prices if risk sentiment were to suddenly change. Such sudden changes in risk sentiment are most likely to occur in markets with compressed risk premia such as some equity, property and lower rated corporate bond markets. In addition, and against the backdrop of a weak economy, the risk of a re-aggravation of the sovereign debt crisis in the EU has increased, reflecting heightened political uncertainty.

Given their large investment portfolios and long-term liabilities, a key vulnerability of European defined benefit pension funds is the combination of an abrupt fall in asset prices and prolonged low risk-free interest rate levels: the so-called double hit. In addition, the pension fund sector is exposed to inflation risk, as the majority of pension funds provide pensions that are linked to inflation and/or wage growth. This also makes pension funds vulnerable to high inflation, in particular in an environment where nominal returns are low.

Based on these systemic risks in the EU financial system and vulnerabilities of European defined benefit pension funds, two adverse scenarios for the EIOPA 2015 pension fund stress test are provided below. These scenarios consist of instantaneous shocks to asset prices and have been calibrated using the ECB's financial shock simulator (Box 2) on the basis of historical data covering the years 2007-14. Based on this modelling set-up, the probability that the instantaneous shocks would materialise, over a one-quarter horizon, is estimated to be less than 0.5%. In terms of severity, the shocks in both scenarios are broadly consistent with the ones applied in the EIOPA 2014 stress test for insurance companies, taking into account the different reference years (end 2014 versus end 2013) and differences between economic narratives of the two stress test exercises.

Box 2: The ECB's financial shock simulator

The financial shock simulator tool is part of the suite of stress test models used by the ECB's Directorate General Macro-Prudential Policy and Financial Stability³. The shock simulator is regularly employed for scenario design purposes for ESRB-related products and the ECB's Financial Stability Review. It was also used in the design of the EBA's stress test scenario in 2011 and 2014. The simulator builds on well-known risk measurement techniques that are widely used in the banking industry and is well suited to the design of conditional shock scenarios. The simulation method is based on a non-parametric approach to capturing dependence structures across markets, i.e. it does not impose any parametric model structure. Refraining from parametric assumptions is particularly desirable when aiming to capture dependence structures under stress (tail dependence).

Along with the technical infrastructure that has been developed to conduct the shock simulations, a large-scale database (500+ indicators) is in place and maintained to operate the tool in a flexible manner on a regular basis. The database includes, inter alia, credit spreads for banks and sovereigns, interest rates for various maturities for sovereign, corporate and bank bonds, interbank money market interest rates, equity market prices, currencies, private equity and hedge fund performance indicators, as well as other indicators, for a large cross-section of countries in Europe and the rest of the world. For the purpose of this exercise, the scope of the simulator was extended to cover inflation swap markets.

The shock simulator tool is characterised by two key features: first, it is a non-parametric technique in the sense that neither the distributions of the individual risk factors nor the joint dependence between them (the "copula") are constrained by functional assumptions. High-frequency financial market indicators are characterised by non-normal features (e.g. excess kurtosis, volatility clustering), so a normal assumption for their marginal distributions is inappropriate in many cases. For the joint dependence between markets, a joint normal distribution does not allow for changing dependence in its tails. The non-parametric approach overcomes this restriction, as well as having the advantage of not imposing a specific parametric function on the data, which would add to model risks.

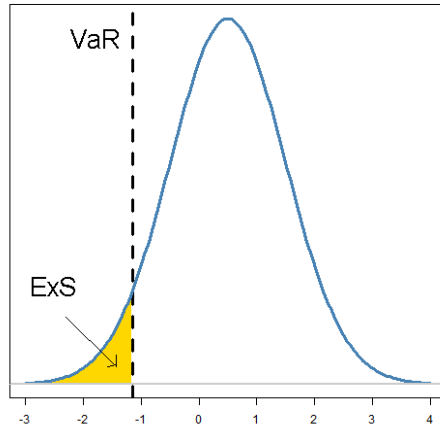
The second feature of the tool is that it is based on an expected shortfall (ExS) concept instead of value at risk (VaR). The latter is known to have several conceptual deficiencies, being related first and foremost to the fact that it would neglect losses that can be expected beyond the VaR – i.e. the actual tail risk. ExS, on the other hand, is a coherent risk measure that takes the expected losses beyond the VaR into account (see Chart 1 for a conceptual visualisation of VaR and ExS in a univariate case).

The ExS is estimated using a Monte Carlo simulation method, which produces a large number of multivariate future paths for all financial market variables included in the simulation. These simulations

³ This tool is a non-parametric variant of the conditional expected shortfall approach discussed by Adrian and Brunnermeier (2014), extended to multiple shocks to several markets or geographical areas. See Adrian, T. and Brunnermeier, M., "CoVaR", *Federal Reserve Bank of New York Staff Reports*, No 348, 2014.

are conditioned on a specific shock origin and project the response of all variables to that shock, taking into account the dependence between individual markets (via the aforementioned “non-parametric copula”).

Chart 1: Value at risk (VaR) versus expected shortfall (ExS)



For the defined benefit pension fund stress test scenarios, the equity markets of all EU countries were jointly chosen to be the shock origin for both scenarios. Additionally, for scenario 2, where upward risks to inflation expectations play a key role, an additional constraint was imposed to retain only those simulated forward paths where expected inflation rates are rising.

The scenarios, based on an EU-wide aggregate shock to equity markets, can be considered consistent, in the sense of taking the joint dependence between equity markets over particular stress periods for the European Union as a whole into account. The intuition behind this simulation scheme is that a specific period of market-wide distress for the EU aggregate is deemed more robust and representative of future distress than country-specific distress, which may be idiosyncratic.

The economic narrative of scenario 1: negative demand shock

The narrative of this adverse scenario takes as its starting point an abrupt broad-based reversal in asset prices emanating from the developed economies and affecting all major asset classes. This would trigger further vulnerabilities, in particular those related to the condition of the EU sovereigns and to bank funding conditions. The initial shock is assumed to take place in equity markets in the European Union. It would subsequently propagate to other asset classes: emerging market equities, corporate and sovereign debt, real estate and commodities. Corporate and financial credit spreads would increase, with the most pronounced impact being expected in the high-yield segments where market liquidity would become impaired. Sovereigns which benefited from a “safe haven” status during recent episodes of market stress would no longer be assumed to do so. In particular, the yield on German government bonds is assumed to remain unchanged. This implies a widening of spreads relative to the swap rates. The yield spreads of other EU sovereigns relative to the

German sovereign would widen, reflecting country-specific vulnerabilities and past sensitivities of sovereign funding conditions to financial market stress.

In this environment of tightening financing conditions, consumption and investment in the European Union would weaken and unemployment would increase, while real wages would remain sticky, with nominal wages growing in line with expected inflation. This, combined with general stress on financial asset prices, would result in a steep fall in real estate prices and would depress markets for private equity, hedge funds and unlisted infrastructure projects. The expected fall in global demand would also push commodity prices down. In turn, market-based inflation expectations over the short to medium term would continue to fall, while the expected timing of the return of inflation to central bank targets would remain unchanged. In the United States, market expectations of increasing short-term interest rates would dissipate. This would make carry trades less attractive, leading to an appreciation of the euro against the US dollar. Financial turmoil, weakened macroeconomic conditions and an accommodative monetary policy are assumed to push risk-free interest rates in the European Union, as proxied by interest rate swap rates, further below the current low levels.

The economic narrative of scenario 2: negative demand and a negative supply shock

This scenario similarly entails an abrupt decline of prices across a broad spectrum of asset classes. However, unlike the first scenario, it also assumes a materialisation of geopolitical risks which lead to a negative supply shock to the oil market and other commodities.

The effects of such supply shocks on the oil price and other commodity prices are assumed to more than make up for the opposite effects of the decreased demand for oil and commodities on their prices due to low economic activity in the European Union. The US economy, as an oil producer and being in a stronger cyclical position than the EU economy, is assumed to be less affected by global financial turmoil and an oil price shock. This leads the euro to depreciate against the US dollar. Higher oil prices and import prices would lead to a sharp increase in inflation in the short term. Simultaneously, market expectations that the current non-standard central bank policies would be effective in bringing inflation back to target levels over the medium run would strengthen, and market-implied medium and long-term inflation rates would increase. As in the first scenario, real wages would remain sticky, with nominal wages growing in line with inflation.

Calibrated shocks of scenario 1

Tables 1 to 4 present the calibration of scenario 1. EU stock prices would fall by 45% under this scenario, while the impact on the US stock market would be somewhat less severe, with prices falling by 30%. Emerging market equities, affected by spillovers from developed markets, would fall by 18%. In response to these shocks, euro area swap rates would decrease by about 45 basis points at the ten-year maturity. The slope of the euro swap curve would become steeper, as two-year swap rates would become negative after falling by about 70 basis points. Long-term sovereign yields would nevertheless remain positive and increase, on average in the European Union, by 65 basis points. Spreads on corporate bonds would also widen by between 14 and 560 basis points, depending on the credit standing and sector of the issuer. The exchange rate of the euro vis-à-vis the US dollar would appreciate by 20%.

Table 1: Equity and fund indices, commodity prices and exchange rate – scenario 1

Variable	Shock (%)
EUR-USD exchange rate	20
EU equities	-45
US equities	-30
EM equities	-18
Commodity prices	-35
Private equity	-42
Hedge funds	-12
EU REITs	-46
Global REITs	-35

Source: ECB calculations.

Note: a positive EUR-USD exchange rate shock means that the euro appreciates vis-à-vis the US dollar. All shocks refer to the last business day of 2014 and are expressed as a percentage of the index value on that day.

Table 2: Interest rate and inflation swap rates – scenario 1

	1Y	2Y	3Y	5Y	7Y	10Y	20Y	30Y
Swap rates - shocks (bps)	-65	-70	-64	-58	-53	-45	-40	-42
Inflation swap rates - shocks (bps)	-28	-56	-57	-59	-47	-23	-15	-14
Swap rates - end-2014 level (%)	0.2	0.2	0.2	0.4	0.5	0.8	1.3	1.5
Inflation swap rates - end-2014 level (%)	-0.5	0.0	0.2	0.6	0.8	1.2	1.6	1.8
Swap rates - stressed level (%)	-0.5	-0.5	-0.4	-0.2	0.0	0.4	0.9	1.0
Inflation swap rates - stressed level (%)	-0.7	-0.5	-0.3	0.0	0.4	0.9	1.5	1.6

Source: ECB calculations.

Note: shocks refer to the last business day of 2014 and are expressed in basis points. All shocks are calibrated for the euro swap rates and inflation swap rates.

Table 3: Corporate credit spreads – scenario 1

Credit rating	Non-financial corporate - shocks (bps)	Financials (unsecured) - shocks (bps)	Financials (covered bonds) - shocks (bps)
AAA	14	17	33
AA	29	36	41
A	51	82	72
BBB	90	251	91
BB	121	359	116
B<	156	498	139
Unrated	173	560	150

Source: ECB calculations.

Note: shocks with respect to the last business day of 2014. All spreads are measured in basis points over a two-year swap rate.

Table 4: Sovereign bond yield shocks – scenario 1

Sovereign	Two-year yield: shock (bps)	Two-year yield (end-2014; %)	Two-year yield (stressed level; %)	Ten-year yield: shock (bps)	Ten-year yield (end-2014; %)	Ten-year yield (stressed level; %)
Belgium	3	0.0	0.0	87	0.8	1.7
Bulgaria	62	1.7	2.4	110	3.1	4.2
Czech Rep.	32	0.1	0.5	121	0.7	1.9
Denmark	3	0.0	0.0	44	0.8	1.3
Germany	0	-0.1	-0.1	0	0.5	0.5
Ireland	39	0.3	0.7	131	1.2	2.6
Greece	N/A	N/A	N/A	466	9.5	14.2
Spain	37	0.5	0.8	118	1.6	2.8
France	3	0.0	0.0	50	0.8	1.3
Croatia	91	2.9	3.8	119	3.8	5.0
Italy	145	1.9	3.3	146	1.9	3.3
Cyprus	N/A	N/A	N/A	109	5.0	6.1
Latvia	63	0.7	1.3	155	1.8	3.3
Lithuania	106	0.7	1.8	248	1.8	4.3
Luxembourg	6	0.0	0.1	56	0.6	1.1
Hungary	177	2.8	4.6	231	3.7	6.0
Malta	37	0.6	0.9	113	1.9	3.0
Netherlands	1	0.0	0.0	14	0.7	0.8
Austria	3	0.0	0.0	48	0.7	1.2
Poland	150	1.8	3.3	211	2.5	4.6
Portugal	29	0.4	0.7	155	2.7	4.2
Romania	114	2.0	3.1	206	3.7	5.7
Slovenia	30	0.5	0.8	121	2.1	3.4
Slovakia	17	0.1	0.3	94	1.1	2.1
Finland	0	-0.1	-0.1	18	0.7	0.8
Sweden	2	0.1	0.1	16	0.9	1.1
United Kingdom	1	0.5	0.5	3	1.8	1.8
EU average	31	0.4	0.8	65	1.4	2.0

Source: ECB calculations.

Note: all shocks refer to the last business day of 2014 and are expressed in basis points.

Calibrated shocks of scenario 2

Tables 5 to 8 present the calibration of scenario 2. EU stock prices would fall by 33% under this scenario, while the impact on the US stock market would be more muted. Emerging market equity prices would also decrease by 33%. Commodity prices, including the oil price, would increase by 53%, triggering an increase in one-year inflation expectations by over 1.6 percentage points. Long-term (ten-year) inflation expectations would increase by about 0.4 percentage point on an annual basis. The exchange rate of the euro vis-à-vis the US dollar would depreciate by 2%. The euro area swap curve would shift downwards in a nearly parallel fashion by about 60 basis points. Long-term sovereign yields in the European Union would nevertheless increase on average by 14 basis points. Spreads on corporate bonds would also widen by between 91 and 639 basis points, depending on the credit standing and sector of the issuer.

Table 5: Equity and fund indices, commodity prices and exchange rate – scenario 2

Variable	Shock (%)
EUR-USD exchange rate	-2
EU equities	-33
US equities	-4
EM equities	-33
Commodity prices	53
Private equity	-38
Hedge funds	-10
EU REITs	-37
Global REITs	-63

Source: ECB calculations.

Note: a negative EUR-USD exchange rate shock means that the euro depreciates vis-à-vis the US dollar. All shocks refer to the last business day of 2014 and are expressed as a percentage of the index value on that day.

Table 6: Interest rate and inflation swap rates – scenario 2

	1Y	2Y	3Y	5Y	7Y	10Y	20Y	30Y
Swap rates - shocks (bps)	-54	-58	-59	-56	-60	-55	-70	-73
Inflation swap rates - shocks (bps)	164	101	85	85	64	41	21	14
Swap rates - end-2014 level (%)	0.2	0.2	0.2	0.4	0.5	0.8	1.3	1.5
Inflation swap rates - end-2014 level (%)	-0.5	0.0	0.2	0.6	0.8	1.2	1.6	1.8
Swap rates - stressed level (%)	-0.4	-0.4	-0.4	-0.2	-0.1	0.3	0.6	0.7
Inflation swap rates - stressed level (%)	1.2	1.0	1.1	1.4	1.5	1.6	1.8	1.9

Source: ECB calculations.

Note: shocks refer to the last business day of 2014 and are expressed in basis points. All shocks are calibrated for the euro swap rates and inflation swap rates.

Table 7: Corporate credit spreads – scenario 2

Credit rating	Non-financial corporate - shocks (bps)	Financials (unsecured) - shocks (bps)	Financials (covered bonds) - shocks (bps)
AAA	91	134	123
AA	124	130	142
A	127	166	249
BBB	135	337	313
BB	141	441	398
B<	147	579	472
Unrated	150	639	512

Source: ECB calculations.

Note: shocks refer to the last business day of 2014. All spreads are measured in basis points over a two-year swap rate.

Table 8: Sovereign bond yield shocks – scenario 2

Sovereign	Two-year yield: shock (bps)	Two-year yield (end-2014; %)	Two-year yield (stressed level; %)	Ten-year yield: shock (bps)	Ten-year yield (end-2014; %)	Ten-year yield (stressed level; %)
Belgium	8	0.0	0.0	24	0.8	1.1
Bulgaria	118	1.7	2.9	57	3.1	3.7
Czech Rep.	32	0.1	0.5	26	0.7	1.0
Denmark	0	0.0	0.0	0	0.8	0.8
Germany	0	-0.1	-0.1	0	0.5	0.5
Ireland	1	0.3	0.3	2	1.2	1.3
Greece	N/A	N/A	N/A	0	9.5	9.5
Spain	12	0.5	0.6	25	1.6	1.9
France	9	0.0	0.1	37	0.8	1.2
Croatia	0	2.9	2.9	58	3.8	4.4
Italy	3	1.9	1.9	0	1.9	1.9
Cyprus	N/A	N/A	N/A	0	5.0	5.0
Latvia	0	0.7	0.7	1	1.8	1.8
Lithuania	0	0.7	0.7	2	1.8	1.9
Luxembourg	0	0.0	0.0	29	0.6	0.9
Hungary	98	2.8	3.8	22	3.7	3.9
Malta	3	0.6	0.6	11	1.9	2.0
Netherlands	0	0.0	0.0	0	0.7	0.7
Austria	21	0.0	0.2	61	0.7	1.3
Poland	28	1.8	2.1	0	2.5	2.5
Portugal	0	0.4	0.4	1	2.7	2.7
Romania	1	2.0	2.0	0	3.7	3.7
Slovenia	0	0.5	0.5	0	2.1	2.1
Slovakia	24	0.1	0.4	71	1.1	1.8
Finland	0	-0.1	-0.1	0	0.7	0.7
Sweden	0	0.1	0.1	0	0.9	0.9
United Kingdom	0	0.5	0.5	0	1.8	1.8
EU average	10	0.4	0.6	14	1.4	1.5

Source: ECB calculations.

Note: all shocks refer to the last business day of 2014 and are expressed in basis points.