

Information and methodology of sigma explorer data

How to use sigma-explorer.com

Watch this [short video](#) explaining the main functionalities.

Data sets

The web application <https://www.sigma-explorer.com/> contains data from the annual sigma reports on natural catastrophes (catastrophe database), the world insurance markets (world insurance database ; see www.swissre.com/institute/research/sigma-research/World-insurance-series.html) and macroeconomic resilience indicators. In the case of the catastrophe database, only a subset of the individual catastrophes is shown, ie the twenty largest events for each year by the number of victims, by insured losses or by total losses (excluding events from the US).

Catastrophe database: terms and sources

A natural catastrophe is caused by natural forces.

Natural catastrophes

The term "natural catastrophe" refers to an event caused by natural forces. Such an event generally results in a large number of individual losses involving many insurance policies. The scale of the losses resulting from a catastrophe depends not only on the severity of the natural forces concerned, but also on man-made factors, such as building design or the efficiency of disaster control in the afflicted region. In this *sigma* study, natural catastrophes are subdivided into the following categories: floods, storms, earthquakes, droughts/forest fires/heat waves, cold waves/frost, hail, tsunamis, and other natural catastrophes.

A man-made or technical disaster is triggered by human activities.

Man-made disasters

Major events associated with human activities are categorised as "man-made" or "technical" disasters. Generally, a large object in a very limited space is affected, which is covered by a small number of insurance policies. War, civil war, and war-like events are excluded. *sigma* subdivides man-made disasters into the following categories: major fires and explosions, aviation and space disasters, shipping disasters, rail disasters, mining accidents, collapse of buildings/bridges, and miscellaneous (including terrorism). In Tables 8 and 9 (pages 26– 44), all major natural catastrophes and man-made disasters and the associated losses are listed chronologically.

Losses due to property damage and business interruption that are directly attributable to major events are included in this study.

Total losses

For the purposes of the present *sigma* study, total losses are all the financial losses directly attributable to a major event, ie damage to buildings, infrastructure, vehicles etc. The term also includes losses due to business interruption as a direct consequence of the property damage. Insured losses are gross of any reinsurance, be it provided by commercial or government schemes. A figure identified as "total damage" or "economic loss" includes all damage, insured and uninsured. Total loss figures do not include indirect financial losses – ie loss of earnings by suppliers due to disabled businesses, estimated shortfalls in GDP and non-economic losses, such as loss of reputation or impaired quality of life.

The amount of the economic losses is a general indication only.

Generally, total losses are estimated and communicated in very different ways. As a result, they are not directly comparable and should be seen only as an indication of the general order of magnitude.

The term "losses" refer to insured losses, but do not include liability.

Insured losses

"Losses" refer to all insured losses except liability. Leaving aside liability losses, on one hand, allows a relatively swift assessment of the insurance year; on the other hand, however, it tends to understate the cost of man-made disasters. Life insurance losses are also not included.

Newspapers, direct insurance and reinsurance periodicals, specialist publications and other reports are used to compile this study.

Sources

Information is collected from newspapers, direct insurance and reinsurance periodicals, specialist publications (in printed or electronic form) and reports from insurers and reinsurers. In no event shall Swiss Re be liable for any loss or damage arising in connection with the use of this information.

Figures are converted into US dollars at running annual average market exchange rates.

World insurance: Methodology and Data

Using the average exchange rate for the financial year, premium volumes are converted into US dollars to facilitate comparisons between markets and regions.¹ Where no premium data is available (indicated by “na.” for the local currency value in the tables), the premium income in US dollars is estimated assuming a constant ratio of insurance premiums to GDP. Regional growth rates are calculated using a weighted average of the real growth rates of the individual countries. The weighting is based on the relevant premiums of the previous year in USD.

Country classifications generally follow IMF conventions.

The designation of the economies in this *sigma* as “advanced” or “emerging” is generally in keeping with the conventions of the International Monetary Fund (IMF). Advanced economies include the US, Canada, Western Europe (excluding Turkey), Israel, Oceania, Japan and the other advanced Asian economies (Hong Kong, Singapore, South Korea and Taiwan). All other countries are classified as “emerging” and generally correspond to the IMF’s “emerging and developing” economies.²

Data sources

The insurance data and estimates contained in the study originate primarily from national supervisory authorities and, in some cases, from insurance associations. Macroeconomic data was sourced from the International Financial Statistics of the IMF, Oxford Economics and IHS Markit.

Definition of premium income

This report is based on information concerning the premiums written for direct business by all registered insurers. This means:

1. Direct insurance premiums, including commissions and other charges, are considered prior to cession to a reinsurance company.
2. Domestic insurers – regardless of their ownership – and domestic branches of foreign insurers are regarded as domestically domiciled business units. By contrast, business undertaken by the foreign branches of domestic insurers is not regarded as domestic business.
3. Business that has been written in the domestic market includes premiums for cover of domestic risks as well as those covering foreign risks, as long as they are written by domestic insurers (cross-border business).

Health insurance is allocated to non-life business.

Life and non-life business areas in this *sigma* study are categorised according to standard EU and OECD conventions: health insurance is allocated to non-life insurance, even if it is classified differently in the individual countries.

Density and penetration do not include cross-border business.

Only premium income from domestic risks is used to calculate insurance penetration and density. Cross-border business is not included. This has a significant effect in Belgium, France, Liechtenstein, Luxembourg, Ireland, Malta, Norway, Singapore or the UK.

Macroeconomic Resilience Index: methodology

Our index includes a sample of 31 countries that make up about 75% of world GDP.

E-RI methodology overview

To construct the Macroeconomic Resilience Index (E-RI), we use annual data from 2007 to 2021 for 31 advanced and emerging economies. For the current year resilience (ie, 2021 this year), the E-RI score is tentative for the fiscal and monetary policy space while the structural elements remain at their last actual/realised level available given their slow-moving nature. The countries in our sample are of systemic importance to the world economy, together making up

¹ In Egypt, India, Iran, Japan, South Korea and Malaysia, the financial year is not the same as the calendar year. Precise details about the differences in dates are given in the notes to the statistical appendix.

² The only exceptions are the Czech Republic, Estonia, Latvia, Lithuania, Slovenia and Slovakia.

roughly 75% of world GDP. Importantly, these countries have complete, robust and reliable data series. The lack of data is the main reason for exclusion of other larger economies such as Argentina and Indonesia. The index methodology is reviewed in a three-year cycle.

The E-RI consists of macro buffers and structural elements.

Table 1 below outlines the 10 components that constitute the E-RI, and the rationale for their inclusion.³ The E-RI comprises two overarching dimensions: buffers and structural components.

- **Macro buffer** components include an economy's room to use monetary and fiscal policy. Broadly speaking, fiscal space measures how likely a country is to face fiscal distress, that is a time of extreme funding difficulty/loss of market access. The less likely a country is to face fiscal distress, the more fiscal space it has. The monetary policy space component measures the ability to ease or tighten policy. Among others, this includes the distance of short and long-term interest rates to the zero lower bound. This de facto captures the ability and effectiveness of interest rate cuts and quantitative easing.⁴ See *E-RI methodology deep-dive* below for a more detailed overview of how the fiscal space and monetary policy space are computed.
- **Structural** components are variables that define the fundamental framework of an economy and which evolve/develop slowly, such as access to talent and the challenges that banks face in a prevailing operating environment. To a large extent, a country's economic structure defines how dynamic a society's shock absorbing mechanisms are. All structural indicators are indices themselves, or components of other already-available indices.⁵

Each component of the index is scored from 0 (minimal resilience) to 1 (maximum).

All component indicators have scores ranging between zero and one⁶ and are weighted according to the weights in Table 1. One represents the highest score across time and sample countries, and zero is the lowest. A value of one means that a country is the most resilient in that particular category and year, while a value of zero infers minimal resilience. By averaging the scores of each of the nine components, we derive overall E-RI scores of each of our sample countries and regions, between 2007 and 2021.

Cross-border spill-overs in macro resilience are captured in the E-RI.

In addition to the 10 indicators that drive a country's economic resilience (see Table 1), the index aims to also capture cross-border impacts. The goal is to account for the notion that resilience is ultimately global and that countries stand to benefit from each other's shock absorbing capacity.⁷ See *E-RI methodology deep-dive* below for a more detailed overview of the spill-overs.

³ While very important for different analysis such as recession likelihood estimation, indicators of economic imbalances are disregarded, as our index focuses on the shock absorption capacity of economies.

⁴ Given vastly different economic and policy environments, the approaches for advanced and emerging economies in our index are different. The standardization approach is also slightly different versus the rest of the variables. See appendix for more details.

⁵ Components that are indexes include the low-carbon economy index, for example. The soundness of banks is a component of the WEF's competitiveness index. More details are available in the appendix.

⁶ The zero to one scores are created using a "min-max" approach. It is a technique that transform data with different scales into values between zero to one.

⁷ The cross-border spill-overs in macroeconomic resilience are included as an additional layer. Country A's resilience is therefore computed based on the 10 indicators in a first stage and in a second stage, the spill-overs are computed. 80% of an economy's final macroeconomic resilience stems from its "internal" resilience which is driven by the 10 indicators and the remainder 20% is driven by the resilience of the economies to which that economy is most exposed through trade and USD dependency (the latter is only applied for emerging economies).

Table 1 – Components of the SRI Macroeconomic Resilience Index

Indicator	Weight	Source	Definition of indicator	Rationale
Macro buffers				
Fiscal space	35%	Swiss Re, based on data from World Bank (WB)/IMF and Swiss Re forecasts	An empirical estimate of an economy's room to use fiscal policy without risking a fiscal distress situation. This includes the level of government debt and external debt as a percent of GDP, government effectiveness, the current account balance, actual real GDP growth rates over a three-year period and potential growth rates. ⁸ For emerging markets, we include FX pressures.	We consider fiscal policy the most important policy tool to mitigate the length and depth of an economic shock.
Monetary policy space	15%	Swiss Re, based on World Bank data	Measures the ability of a central bank to ease or tighten monetary policy. This includes the distance of short and long-term rates to the zero lower bound or to "fair-value" yield estimates. For emerging markets, a proxy of central bank independence and the policy differential against the US Federal Reserve are also included.	Monetary policy is a key policy instrument to absorb economic shocks.
Macro structural elements				
Banking industry backdrop	18%	World Economic Forum (WEF)	The findings of a WEF survey of executives, indicating how sound a country's banks are generally considered to be. The measure is not based on economic or accounting measures, but popular perceptions around dimensions influencing the health of the banking sector (eg, capital buffers, sustainability of business models, regulatory developments and the macro environment). ⁹	A fragile banking industry backdrop propagates shocks given the sector's interconnectedness with the economy.
Labour market efficiency	10%	WEF	Includes flexibility of wage determination, hiring and firing practices, capacity to retain talent, female participation in the labour force, etc.	More efficient and dynamic labour markets allow for easier reallocation of workers during times of stress.
Financial market development	8%	IMF	This component is a summary of how developed financial markets are in terms of depth, access and efficiency.	Developed financial markets diversify the funding sources available for the real economy.
Economic complexity	4%	The Observatory of Economic Complexity	A holistic measure of the sophistication and variety of goods produced by and exported from an economy. It shows the breadth and depth of an economy's production capacity.	An economy producing sophisticated and a variety of goods will be less affected by shocks in specific sectors.
Income inequality (new)	4%	World Inequality Database	This indicator is measured as the ratio between the top 10 percentile of the income distribution to the bottom 50. It shows the distribution of income across a population between the poorest and the wealthiest. A higher ratio indicates higher inequality.	Low income inequality supports the purchasing power of lower-income households thus translating into stronger overall demand within an economy. This also ensures society can fare better in difficult times as households should be able to secure higher cash buffers.
Insurance penetration	2%	Swiss Re	Ratio of total (life and non-life) direct insurance premiums to GDP.	Insurance acts as a shock absorber and smoothens financial volatility.
Human capital	2%	WB	Assesses how health and education levels shape the productivity and social mobility.	High social mobility and skill levels make a country more dynamic, such that it can better withstand and adjust to shocks.
Low-carbon economy	2%	Maplecroft	Measures the extent to which a country already is a low-carbon economy (low fossil fuel or de-carbonized in terms of output/emissions).	Climate change has disruptive effects on global supply chains and infrastructure. This negatively impacts government finances, firms' capital, and household wealth. ¹⁰

Notes (1) Robustness tests showed that changing the weights slightly does not meaningfully alter country rankings; (2) The fiscal space does not include market prices such as Credit Default Swaps, because prices are not available for all countries, and they do not allow for a further fundamental macro analysis of what increases a fiscal distress likelihood. (3) Insurance penetration has a low weight since its value proposition of financial volatility smoothing occurs mostly at the "micro" level (for households and corporates). (4) Due to licensing, the Maplecroft data can no longer be shown on a standalone basis on Sigma Explorer but is captured in the overall index. Source: Swiss Re Institute

⁸ The measure of FX pressure relates the PPP-implied exchange rate to the nominal exchange rate against the US dollar. An overvalued currency implies an economy is less competitive which increases the fiscal default probability. We include FX pressure in the fiscal space indicator instead of the monetary policy space measure. This is because the euro area sovereign debt crisis showed that a country's inability to devalue quickly has severe repercussions for its fiscal position. In a currency union like the euro area, overvaluation can only be restored by devaluing the real economy, for example by lowering wages and prices, which is very costly in terms of GDP and employment levels. In any case, large economies with a free-floating exchange rate can also experience severe fiscal distress and adjustment, as was the case in the UK in 1976.

⁹ Regulatory filings such as banks capital positions are not available for all countries and for a sufficient amount of time.

¹⁰ *Climate change: a core financial stability risk*, IIF, 2019.

Data curation

E-RI methodology deep-dive

Adjustment for outliers and missing values were computed. We imputed missing values using either lagged values or averages for highly time-invariant indicators such as the low carbon economy, economic complexity and the human capital index. We excluded observations above the 90th and below the 10th percentile and forced these observations to be equal to the 90th and 10th percentile, respectively, for the majority of the indicators to avoid distorting the 0-1 scores through the "min-max" standardization approach.

Fiscal space methodology

Fiscal space measures the room a country has to implement policy without risking a sovereign distress situation.¹¹ We estimate the fiscal space in two steps. (1) Using annual data from 1995 to 2021 (where 2021 are forecasts), we estimate distress probabilities through a panel-probit estimation following previous works.¹² Our novel approach uses traditional economic variables such as public debt and current account imbalances, but also explicitly takes into account the under/overvaluation of currencies for emerging economies as this is a key adjustment valve for these economies.¹³ (2) We construct the fiscal space by taking the inverse of the fiscal distress probabilities. Following our analysis of previous fiscal distress episodes, we consider that countries with probabilities of around 30% or higher have *de facto* no fiscal space. At these levels, distress likelihoods become highly non-linear and exposed to shifts in economic growth momentum and sentiment, as evidenced during the euro area sovereign debt crisis. For the fiscal space indicator, this means that countries with a fiscal distress likelihood of 30% or higher get a zero score for fiscal space, while countries with likelihoods of 0% get a score of 1.

Monetary policy space methodology

The monetary policy space indicator is a completely novel approach which measures the ability to ease or tighten monetary policy, depending on whether the central bank policy rate is below (ease) or above (tighten) the estimated neutral policy rate.¹⁴ This symmetry is important for resilience, because a very high policy rate does not mean more resilience: it could also mean destabilisation as is often witnessed in emerging markets. Given the vast differences in economic and political environment of advanced and emerging economies, we take different approaches for the two segments (see Table 2).

Broadly speaking, the ability to ease in advanced economies is the distance of short and long-term interest rates to the zero lower bound, as well as the US policy stance given its global relevance. This *de facto* captures the ability and effectiveness of rate cuts and quantitative easing.¹⁵ The closer interest rates are to zero, the lower the resilience score. For emerging markets, the ability to ease is also determined by the distance to the zero lower bound, but also by the interest rate differential versus the US and, most importantly, central bank independence.¹⁶ We believe these are key determinants for emerging markets' central banks to conduct monetary policy effectively. The ability to tighten in advanced economies would be to measure how far away the short and long-term interest rates are from the neutral rate and fair value, respectively, though no country falls into this category currently. For emerging markets, it is again most dependent on central bank independence, the policy differential versus the Fed, and the discrepancy of the central bank rate vs neutral. Since the sub-components of the monetary policy space indicator are already standardized to a 0-1 value range, we do not standardize the ultimate index again to a 0-1 range. Hence, the final score is only 1 if all subcomponents are at 1. Since this has never been the case, the highest value in the panel is 0.72. In any case,

¹¹ Fiscal distress is defined as a period of extreme government funding difficulty, incl. credit events associated with sovereign debt, recourse to large-scale multilateral financial support, implicit domestic default (e.g. via high inflation rates) and/or loss of market confidence in the sovereign.

¹² Gerling et al. (2017), "Fiscal Crisis" and Goldman Sachs (2019), "Fiscal Space Across the Euro Area".

¹³ Our approach uses public debt to GDP and external debt to GDP, the current account balance, GDP growth rates over a three-year period, potential GDP growth rates, and a measure of govt effectiveness. In addition, for emerging economies, foreign exchange (FX) pressures are also included. We exclude CDS prices in our analysis since we use a fundamental macroeconomic approach.

¹⁴ The domestic neutral policy rate is the central bank interest rate at which it is neither expansionary, nor contractionary for the economy and inflation. We estimate this rate as the long-term real GDP trend growth rate plus the domestic central bank inflation target.

¹⁵ Quantitative easing aims to decrease the term premium and lower long-term funding costs. When long-term rates are close to zero, the effectiveness of QE decreases as funding costs are already very low.

¹⁶ Central bank independence is proxied by the World Bank's Worldwide Governance measure of government effectiveness, which considers among other elements how free public institutions are from political interference.

robustness checks show that applying this approach would only very slightly change the overall macro resilience score of a country, for example well below 0.01 pts in 2018 for most countries.

Table 2 – Methodology for monetary policy space for advanced and emerging markets

Methodology for advanced economies	Methodology for emerging markets
<p>The ability to ease consists of three sub-components:</p> <ul style="list-style-type: none"> • The CB policy rate buffer: this is the domestic policy rate at a given point in time – 0% as lower bound (50% weight) • The 10-year yield buffer: this is the domestic 10-year yield at a given point in time – 0% as the lower bound (10% weight) • US policy space: this is a 50%/50% average of the US CB policy rate buffer and the US 10-year yield buffer (40% weight) 	<p>The ability to ease consists of three sub-components:</p> <ul style="list-style-type: none"> • The CB policy rate buffer: this is the domestic policy rate at a given point in time – 0% as lower bound (20% weight) • Policy rate differential versus Fed: this is the z-score of the current policy differential of the domestic central bank vs its historical policy differential versus the Fed (30% weight) • Government effectiveness: This is a proxy for central bank independence. (50% weight)
<p>The ability to tighten consists of two sub-components:</p> <ul style="list-style-type: none"> • Central bank rate versus neutral: this is the domestic central bank rate versus a neutral estimate (potential growth rate plus inflation target); (60% weight) • Domestic 10-year yield versus fair value: this is the domestic 10-year yield versus a measure of its fair value (potential growth rate plus inflation plus historical domestic term premium); (40% weight) 	<p>The ability to tighten consists of three sub-components:</p> <ul style="list-style-type: none"> • Central bank rate versus neutral: this is the domestic central bank rate versus a neutral estimate (potential growth rate plus inflation target); (20% weight) • Policy rate differential versus Fed: this is the z-score of the current policy differential of the domestic CB vs its historical policy differential versus the Fed (30% weight) • Government effectiveness: This is a proxy for central bank independence. (50% weight)

Index weights and empirical relevance

The weights and relevance of the index¹⁷ were tested for robustness through various econometric analysis.¹⁸ The methodology consists of two parts. (1) We identify shocks on GDP growth experienced by a majority of countries at the same time and independent of shock origin (eg, external shocks, credit burst, etc). (2) Empirically testing whether higher resilience levels are statistically significant in explaining higher shock absorption capacity. Given the data restrictions, the only major common shock across the global sample was the global financial crisis. This tilts the weights of the index that ensure statistical significance disproportionately towards financial indicators, such as the soundness of banks.¹⁹ We corrected for this bias by adjusting the weights because we intended our approach to measure an economy's resilience against a broader variety of shocks that are not necessarily financial in nature. Adjusting weights slightly does not change the overall country ranking dynamics substantially, although it can lead to marginally better or worse rankings for individual countries.

Cross-border spillovers

The cross-border spill-overs in macroeconomic resilience are included as an additional layer once country-level resilience is obtained. In other words, country A's resilience is computed based on the 10 indicators in a first stage and in a second stage, the spill-overs are added. 80% of an economy's final macroeconomic resilience stems from its "internal" resilience which is driven by the 10 indicators and the remainder 20% is driven by the resilience of the economies to which that economy is most exposed through trade and USD dependency (the latter is only applied for emerging economies). For advanced economies, spill-overs onto a country's resilience are determined by the resilience of that country's main export

¹⁷ The weights of the index were proposed and vetted by more than a dozen economists at the Swiss Re Institute and the London School of Economics and Political Sciences. The weights are supported by academic literature.

¹⁸ We follow Sondermann (2016) "Towards more resilient economies: the role of well-functioning economic structures." and Blanchard and Wolfers (2000) "The Role of Shocks and Institutions in the Rise of European Unemployment: The Aggregate Evidence", to identify common shocks across a panel of countries and to test whether higher scores in the SRI-LSE Macroeconomic Resilience Index are associated with higher shock absorption capacities.

¹⁹ We increase by 12 p.p. the soundness of banks, by 2 p.p. labour market efficiency and the financial markets development. We decrease by 10 p.p. fiscal space, by 5 p.p. monetary policy score, and the human capital score by 1 p.p..

trading partners. Spill-overs into emerging economies also account for the high dependency of these economies on USD financing conditions, which in turn are heavily influenced by macroeconomic resilience in the US itself.²⁰

Acknowledgements

The *sigma* editorial team would like to thank the supervisory authorities, associations and companies that helped with data compilation.

For additional queries please contact sigma@swissre.com

²⁰ For emerging economies, two-thirds of the spill-over layer is driven by USD dependency and a third by the largest export trading partners.