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**MACRO STRESS TESTS:  
WHAT DO THEY MEAN FOR  
THE MARKETS AND FOR  
THE ASSET MANAGEMENT  
INDUSTRY?**

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**Risk and Trend  
Mapping**

AUTORITÉ  
DES MARCHÉS FINANCIERS

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## SUMMARY

In this document, macro stress tests are understood to mean tests carried out by competent authorities as opposed to those carried out by market intermediaries for their own risk management purposes. Their objectives include the assessment of risks across/spanning a sector, a market, or the entire financial system, for the purposes of financial stability. They are in the process of being developed, and they naturally fall within the remit of **markets authorities**, particularly in the field of market infrastructures (clearing houses, etc.) but also in the sector more specifically addressed here, namely that of asset management. The ability of this sector to alleviate or amplify shocks affecting the whole financial sector is still up for debate.

At this stage, **approaches and practices vary significantly** from one authority to another, whether they are international (FSB, IMF), European (ESRB, ESMA) or national (French Financial Stability Board, etc.). Methodologies are not yet fully developed, and initiatives are more often than not experimental. Some useful **typologies** for classifying these tests are based on their institutional governance, their technical specifications (scenario(s), types of risk, data, models) and the use of their results (publication, recommendations, etc.). **Two major types of test** stand out, however. In this document we will differentiate between: i) **bottom-up** tests, carried out systematically across the entities under review, by the entities themselves or by authorities that have access to relevant data at a micro level; the results of these tests, once aggregated, provide macroprudential insights; and ii) **top-down** tests, in which the comprehensive approach taken at the outset aims to take account of interactions between market participants as well as market dynamics (fire sales, contagion) that are likely to lead to their failure. An analysis of market (dis)equilibria should therefore, ideally, take account of all participants in the financial system that operate on the market under test. Recent tests have been carried out by researchers at central banks, most notably the Federal Reserve in New York and the Bank of England. These tests are, as yet, to a degree theoretical and exploratory.

In fact, macro stress tests outside the banking universe that contribute effectively to macroprudential decision-making are still largely to be developed, independently of the scale of the shocks tested (this document does not cover these aspects of the tests, which would require separate analysis). On the one hand, such tests are subject to availability, accessibility and various other factors (standards, classifications) related to **data**. On the other hand, they are limited by the ability to model interactions and dynamics, for example to estimate the risks of lack of market liquidity. The necessary development of such tests is still often based on academic research: grounded in in-depth empirical observation of agents' incentives and behaviour, market structures, and characteristics of liquidity. The current top-down tests also frequently suffer from **a lack of full macroeconomic scope/balance** (incomplete coverage of market participants contributing to market equilibrium, too much focus on certain types of agent) or insufficient specification of **time periods** (effective duration of the impact of the shocks and stabilisation of the system). The integration of relevant analysis tools (models of general equilibrium, agent-based models, networks, behavioural analysis, etc.) also needs to be perfected.

Given these limitations, this document underlines how important it is to interpret the current results of top-down stress tests with a degree of caution. In the short term, bottom-up tests seem more relevant and better suited to providing, for the purposes of an overall analysis of market risks, macroprudential insights on the observation of individual behaviour patterns. Work on macro stress tests could be further developed in the light of the following proposals.

For all macro stress tests

- Clarify **terminology** to obtain a common classification of macro stress tests that reflects their ability to meet the statutory objectives of authorities;
- Specify **governance** of macro stress tests to reinforce the mandates and powers of concerned authorities as well as coordination between institutions (a top-down stress test therefore generally has, from the outset, an inter-sectoral and international dimension);
- Increase capacity for use of **data**, and add to these if/where needed by specific interactions with supervised entities or new data (for example on liabilities of investment funds, market making);
- Ensure that models reflect **real** situations (for example, integrate liquidity management tools with which fund managers are now equipped);
- Mobilise these tools for impact studies linked to certain prudential regulations, particularly watching out for any possible **undesired effects**. For example, too normative a recourse to cash buffers could lead funds to sell simultaneously in order to comply with their risk limits, causing a harmful effect overall.

For top-down macro stress tests

- **Develop academic research** on the improvement of relevant methodologies and models, particularly with descriptions of interactions and dynamics (return to equilibrium after a shock, time needed);
- Given their limitations, rather than drawing absolute macroprudential conclusions from top-down macro stress tests at the current juncture, assess them in relative terms and monitor the **evolution over time** of vulnerability indicators and determine corresponding explanatory factors (variation of risk taken by the market participants, or change in the interactions between participants, etc.) which is of interest in itself;
- Use these/such top-down macro stress tests in **reverse stress tests** to specify scenarios that could lead to instability in the financial system and assess these scenarios'plausibility (as well as assumptions of models used).

For bottom-up macro stress tests

- **In an environment where questions have been raised on the financial stability of certain bond markets**, carry out bottom-up stress tests on the most vulnerable market segments via the financial entities concerned (banks, insurance companies, asset management companies, etc.) capitalising on, for example, the experience gained by the HCSF (French Financial Stability Board) when testing commercial real estate in 2016:
  - In the field of asset management, targeting investment funds whose vulnerability is established according to their characteristics: transformation of liquidity, leverage, strategies, etc.;
  - Accounting for effective practices, in the different/various sectors, of supervised entities in terms of risk management. In the case of asset management, for example, and also for unit-linked contracts, it would be necessary to consider their liquidation strategies, use of liquidity management tools, etc.;
  - Liaising with entities concerned in order to encourage the emergence of best practices and to raise awareness of issues at stake.

## 1. EXTENDING MACRO STRESS TEST PRACTICE BEYOND THE BANKING SECTOR

### 1.1. PROPOSED DEFINITION

Given the lack/absence of a specific regulatory definition, in this document macro stress tests are defined as tests carried out on the initiative of the competent authorities, which are not intended primarily to assess individual risks of the entities under review - that is the objective of the regulatory UCITS, AIFMD and MMFR stress tests - but rather to assess the risks spanning the entities (markets or market segments) that are exposed to them, in order to consider their impacts on financial stability from the outset.

The development of these stress tests is in line with a process of extending initial banking supervision practices to all financial sectors, and with the adoption of a cross-functional perspective of market risks (lack of liquidity, contagion). Note here that, in this regard, competent authorities can coordinate tests carried out by, or in collaboration with, supervised entities.

### 1.2. EXTENSION OF BANKING PRACTICES

#### 1.2.1. Initial banking practices

**Since the financial crisis, the use of stress tests by the authorities<sup>1</sup> has been institutionalised in the banking sector<sup>2</sup>.** Practices in this sector are now standardised - regular implementation, governance (schedule of interaction between the authorities and supervised entities), systematic collection and analyses of data, integration of results in the supervision and risk management frameworks<sup>3</sup>. In the biennial EBA stress tests, the competent authorities submit scenarios, developed jointly by the ECB, the ESRB and the European Commission, to the banks concerned. The “stress” (adverse) scenario is assessed by difference to a “core” (benchmark) scenario.

**Banking stress tests primarily assess solvency.** Based on macroeconomic and financial scenarios, the EBA stress tests in 2016 assessed four main risks: a rapid increase in the cost of risk; low future profits for banks and insurance companies; concerns about the sustainability of public and private sector debt; significant stress in the *shadow banking* sector<sup>4</sup>. The banks are required to report, on these bases, within the specified time frames (five months), internal projections for the stress period (2015-2018) and to document their development. At the end of a verification period (quality assurance), the results are

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<sup>1</sup> This practice has been promoted by the IMF in particular. In the US, the banking stress tests are annual (Dodd-Frank Act §165(i), 12 U.S.C. §5365(i)). The Federal Reserve requires banks with more than USD 50bn in assets to conduct a coordinated test. In the EU, tests are biannual (Art. 97 and 100 of CRD IV). Certain banks carry out a biennial test coordinated by the EBA, under the aegis of the ECB and the ESRB, in collaboration with the national banking supervisors. Integration in supervision processes (Comprehensive Capital Analysis and Review (CCAR) in the US, and Supervisory Review and Evaluation Process (SREP) in the EU) resulted in abandoning tests that generally designated publicly the entities that did not comply with regulatory requirements (pass/fail).

<sup>2</sup> At the end of 2017, the BCBS submitted “Stress Testing Principles” for public consultation, for the attention of credit institutions and authorities responsible for banking stress tests. Their significance for non-banking sectors has yet to be evaluated. Normative aspects, such as the prescription of annual tests, could for example make less sense in areas where methodologies are not stabilised, so tests would rather be led on a case-by-case basis.

<sup>3</sup> See specific description of the methodology by Borie-Tessier (2016).

<sup>4</sup> The ESRB’s specification of the “*Adverse macro-financial scenario for the EBA 2016 EU-wide bank stress testing exercise*” dated 29/01/16 provides more detail on this point. In the banking sector, the initiatives aim notably to integrate the effects of interactions with, on the one hand, the real economy and on the other, the financial sphere. Regarding shock scenarios to be tested, a topic not covered in this document, we note that the approaches differ. Some authors prefer to multiply the scenarios (Pritsker (2017)), while others steer clear of scenarios altogether by using reverse stress tests. The dependence of the results of the stress test on the shock scenarios and the effective calibration of the scenarios is a subject that still needs to be explored.

published and integrated into micro- and macroprudential supervision frameworks. For each bank under review, they give a measure of the specific impact of the adverse scenario on the regulatory capital ratios and thus on the bank's solvency<sup>5</sup>.

**The integration of interactions (*contagion*) and market dynamics (*feedback loops*) in banking stress tests is still being perfected.** There are multiple projects under way, particularly under the initiative of the BIS and the IMF<sup>6</sup>, which aim to improve the integration of dynamics and interactions between the banking sector and the real economy, and also within the financial sector between banking and non-banking entities. Following a number of research initiatives, the ECB has proposed extensions to the models used<sup>7</sup>. Stress tests on the **resilience of the banks' financing** in the face of liquidity spirals and drops in asset prices – as in Brunnermeier, Pedersen (2009) - are proposed<sup>8</sup>. At the same time, an estimation of the sensitivity of stocks of securities held by banks for the purposes of **market making** (*bid/offer reserves*) is provided<sup>9</sup>. For major banks, it shows that less liquid asset classes are vulnerable to shocks. In addition, a detailed analysis of the **effects of contagion** in full counterparty networks is proposed<sup>10</sup>. The goal is thus to integrate stress tests **in the financial system**<sup>11</sup>, in particular to take account of the risk of indirect contagion due to the joint exposures of the asset portfolios of banks and of asset managers (*portfolio overlaps* with the **shadow banking sector**<sup>12</sup>). The Bank of England notes the relevance of liquidity macro stress tests for the bond markets, and in this regard focuses its analysis in particular on the **vulnerabilities of investment funds**<sup>13</sup>.

Coordination of these research initiatives, which aim to integrate market dynamics (second round effects, contagion) in the banking supervision stress tests, has yet to be determined. In fact, since they assume an interaction between the supervisory bodies and the supervised entities to assess the impact of the scenarios under consideration, these scenarios are effectively limited in their ability to fully integrate the dynamics under review (this would necessitate the submission of a second test to evaluate the second-round effects, etc.). The modelling of market dynamics - as well as that of the interactions with the real economy - is therefore largely performed, by internal models of the central banks.

<sup>5</sup> See, for example, "EBA launches 2016 EU wide stress test exercise" dated 24/02/16, and the results of the French banking groups involved in the 2016 EBA stress test, published on 29/07/16. EBA launched a new stress test on 31 January 2018.

<sup>6</sup> See BIS (2015); Krznar, Matheson (2017).

<sup>7</sup> See Dees, Henry, Martin (2017). By virtue of the law establishing the ESAs, the ECB, via the ESRB, supports analytically the ESRB: cooperating with the ESAs within a pan-European stress test framework, it provides mainly adverse macroeconomic scenarios and methodological content, such as calculations of credit risk benchmarks.

<sup>8</sup> Chapter 14: "A top-down liquidity stress test framework".

<sup>9</sup> Chapter 6 "Market liquidity", section 5 "Top-down modelling for market risk".

<sup>10</sup> Chapter 13: "Cross-sector contagion". See also recommendation in Ch. 16 for modelling multi-layer networks.

<sup>11</sup> Chapter 16: "Prospects for further developments of STAMP€": "a macroprudential stress test framework should ideally integrate all elements of the wider financial sector (banks, shadow banks, insurers and pension funds, and central counterparties (CCPs), as well as the real economy".

<sup>12</sup> Cont, Schaanning (2015), Calimani, Hałaj, Żochowski (2017). The use of the term *shadow banking* to describe asset management is debatable and does not correspond to the definitions of the FSB and the ESRB, which particularly exclude institutional management of insurance and pension funds from their scope but, on the other hand, include other categories of financial intermediary (securitisations, dealers, financing companies, etc.) (see ESRB (2017b), Grillet-Aubert et al. (2016)).

<sup>13</sup> Baranova, Coen, Lowe, Noss, Silvestri (2017), see section 1.4.1 below and discussion in 2.

### 1.2.2. Extension to non-banking sectors

**For a number of years, the use of stress tests has been extended to non-banking sectors.** In the European **insurance**<sup>14</sup> sector, the main entities have been subject to prudential (solvency) stress tests since 2011<sup>15</sup>. Since 2015, pension funds, namely **institutions for occupational retirement provision (IORPs)** supervised by EIOPA, are also subject to stress tests. Defined contribution funds (DC), which are similar to collective management funds - and which invest significant amounts in mutual funds<sup>16</sup> - are also covered by these tests<sup>17</sup>. As they do not offer their beneficiaries a guarantee of performance, but rather an investment service backed by a guarantee of restitution of assets, their solvency risk reflects a "liability constraint" linked to their ability to liquidate and return the assets of open-ended funds within the statutory time frames. Therefore, rather than evaluating the solvency of DC funds in its strictest sense, the EIOPA stress tests evaluate the impact of scenarios on the rates of replacement of expected redemptions by three types of beneficiary and thus extrapolate the effects on household income and the economy. The measurement of risk is therefore dependent on the thresholds of tolerance to these impacts<sup>18</sup>.

**ESMA, like the other ESAs, has a mandate** with regard to stress tests, that it is required to implement jointly<sup>19</sup> with the ESRB<sup>20</sup>. This **generic** mandate gives it a certain amount of discretion in terms of the scope and methods of implementation. Its first stress tests, in 2015, involved **central counterparties (CCPs)**<sup>21</sup>. These tests have been repeated since then, and have inspired similar tests in the United States<sup>22</sup> and an international framework has been developed by CPMI-IOSCO, highlighting best practices in this field<sup>23</sup>. If the diversity of CCPs and their methods of risk management were taken into account, this could likely contribute to the development of stress test methodologies for other types of non-banking institution, where applicable<sup>24</sup>.

<sup>14</sup> Europe was a forerunner in this area. A stress test on the insurance sector was carried out in the US by the NAIC across the sector in 2014, and by the IMF on 43 groups in the framework of an FSAP published in 2015.

<sup>15</sup> Its statutes (Regulation (EU) 1094/2010) require EIOPA to conduct EU insurance sector stress tests in consultation and cooperation with the ESRB, the ECB, and the EBA. EIOPA carried out such tests in 2011, 2014, and 2016, whereby the latter included in particular a satellite scenario of "protracted period of low interest rates".

<sup>16</sup> EIOPA (2017) specifies: "IORPs have to value their (...) assets at the reference date on a market-consistent basis and by applying a look-through approach to investment funds and other indirect exposures".

<sup>17</sup> See <https://eiopa.europa.eu/financial-stability-crisis-prevention/financial-stability/occupational-pensions-stress-test>

<sup>18</sup> NB. these thresholds can be interpreted as legitimising public intervention (Claessens, Ratnovski (2014)).

<sup>19</sup> The regulation instituting this provides that the ESMA, in collaboration with the ESRB, must conduct stress tests including an analysis of systemic risk - see in particular Art. 21(2)b on colleges of supervisors, 23(2) on the identification and measurement of systemic risk, and 32(2) on the analysis of market fluctuations. In its propositions for the reform of the European Supervisory Authorities dated 20/09/17, the European Commission proposes increasing the role and powers of the ESAs, and in particular ESMA, with regard to stress tests.

<sup>20</sup> The ESRB has also been conducting work on investment fund stress testing. Recommendations were issued on asset managers' stress tests (ESRB (2018)). Work on the relevance of macroprudential stress tests led by the authorities may translate into an upcoming publication.

<sup>21</sup> NB. EMIR article 21(6) provides for the organisation and coordination "at least once every year, at EU-level, of assessments of the resilience of central counterparties in the face of negative market fluctuations".

<sup>22</sup> Since 2016, the US CFTC has also been conducting stress tests on CCPs; see Powell (2017).

<sup>23</sup> See public consultation dated June 2017 on a "Framework for supervisory stress testing of CCPs".

<sup>24</sup> This is likely to lead to an increase in the number of stress scenarios (Pritsker (2017)). The CFTC stress test in 2016 included 11 scenarios. The second ESMA stress test (initiated in February 2017) provides for three types of scenario (*Credit Stress*, *Liquidity Stress*, and *Reverse Credit Stress*) accompanied by additional requests for analysis of interactions and contagion (*clearing member knock-on*, *concentration analysis*, *interconnectedness*).

**Macro stress tests** on the one hand reflect an increasingly systematic use of stress testing by supervised entities for the purposes of their own risk management<sup>25</sup>, and on the other, they raise questions on the vulnerabilities of the financial system to **liquidity crises** and the role that non-banking entities – aside from CCPs - are likely to play. The importance here lies in the vulnerability of secondary market financial instruments (especially bonds) to shocks that are likely to lead to imbalances between the supply of liquidity (especially by *dealers* and market makers) and the demand for liquidity that is likely to originate from investment funds, and in some cases other institutional managers possibly subject to liability constraints. Therefore, on the one hand, the emphasis is on the **resilience of the liquidity supply** in an environment where banking reforms and/or structural market changes could have reduced the ability of the banks to stand as counterparty in unstable markets<sup>26</sup>; on the other, the continued long-term growth of **investment funds that are exposed to possible redemption orders in the short term** (typically open-ended funds) raises questions at an international level about their collective resistance to liquidity shocks<sup>27</sup>.

It is against this backdrop that the question of the relevance of extending the so-called “macro” stress tests to the asset management sector has been debated for several years now. The FSB (2017a) thus recommends: giving “*consideration to system-wide stress testing that could potentially capture effects of collective selling by funds and other investors on the resilience of financial markets and the financial system more generally*”<sup>28</sup>. Similar recommendations have been developed by the IMF, some of which are intended more specifically for the supervisory authorities<sup>29</sup>. From an economic point of view, the emphasis is on the vulnerabilities of bond markets liquidity in particular, especially less liquid corporate bonds<sup>30</sup>.

### 1.3. MACRO STRESS TEST CHARACTERISTICS

The macro stress tests can usefully be described, as illustrated by the diagram below, by the specifications related to their method of organisation (governance), the specifications for their implementation, and the degree of insertion of their results in the framework of micro- and macroprudential supervision. Three characteristics are particularly important in this regard:

<sup>25</sup> A regulatory framework has been established by UCITS, AIFMD and MMFR (in rising order of the degree of prescription of the texts). With regard to UCITS, the AMF is promoting the adoption of good practices (see AMF (2017a)). The German financial services authority (BaFin) has also proposed similar guidelines since then. Upon recommendation of the ESRB (2018), the ESMA will put together EU guidelines ensuring that best practices are harmonised. Reminder: conducted by the supervised entities for their own purposes, these stress tests are distinct from the macro stress tests conducted by the authorities across supervised entities.

<sup>26</sup> Per CPMI-IOSCO (2017): “*Liquidity risk may also crystallise in the event of a default or the failure to perform of a participant, obligor, liquidity provider, or other relevant service provider (...) authorities could also examine the implications of the failure of service providers such as liquidity providers*”. CGFS (2015) examines the role of market makers and own-account dealers.

<sup>27</sup> More generally, the FSB (2017a) identifies: “*four important structural vulnerabilities (...) which (...) should be addressed through policy responses: (i) liquidity mismatch between fund investments and redemption terms and conditions for open-ended fund units; (ii) leverage within investment funds; (iii) operational risk and challenges at asset managers in stressed conditions; and (iv) securities lending activities of asset managers and funds*”.

<sup>28</sup> See Recommendation 9 in section “2.4.4 Additional market liquidity considerations” from the FSB (2017a).

<sup>29</sup> Recommendations from the US FSAP (2015) were general: “*The exercise suggests scope for enhancement in the authorities’ stress tests. While the authorities’ solvency stress tests for BHCs are state-of-the art in many respects, enhancements are needed, especially in non-bank stress tests. Improvements include addressing data gaps (...); implementing both solvency and liquidity stress tests not only for banks but also for non-banks (such as insurance companies, mutual funds, and pension funds); linking liquidity, solvency, and network analysis in a systemic risk stress testing framework; and examining the spillover risks between non-banks and banks*”. Those of Luxembourg FSAP (2017) are intended for the market supervisor: “*the CSSF should issue industry guidance on liquidity management tools and liquidity stress testing modalities, and develop internal stress testing capacity*”.

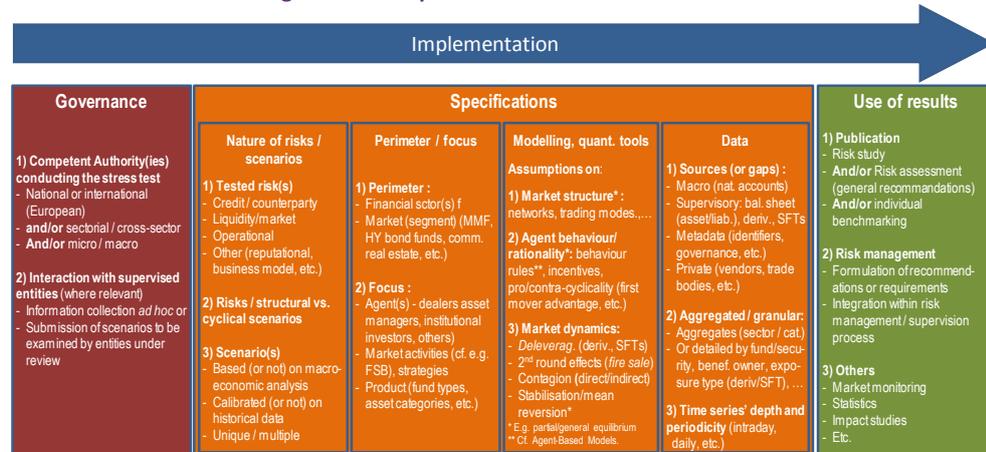
<sup>30</sup> See discussions on bond liquidity by the ESRB (2016a, 2016c) et AMF (2015, 2017c).

- **The type of authority carrying out the test** and, where applicable, **the nature of the interactions with the supervised entities**. The supervision and financial stability mandates of national, European and international competent authorities seem to provide a basis that is adapted to the implementation of relevant tests, which benefit from specific contributions from supervised entities if necessary<sup>31</sup>. Different examples attest an effective ability to implement such stress tests, if necessary by bringing into play institutional coordination between authorities, at a domestic or international level, or across the financial sectors.
- **The type(s) of risk in question, and the specification of the scope** (type of product, market) and methodology resulting from this. Risks consist primarily of the usual major risk categories - operational risk, counterparty/credit risk, market risk (shocks on asset prices) or liquidity risk (mass redemption by shareholders) - but are not necessarily limited to these. Other relevant factors and risk criteria (reputation, business model, market dysfunction) may also be taken into consideration. An important distinction, however, lies between entity-level risks (solvency, resilience) and market-level risks (market or liquidity risk), which are assessed by taking into account the dynamics of the interactions between the entities in question.
- **The purpose of the test and the use that will be made of the results**. The intention behind the use of stress tests is usually to integrate the results into supervision and risk management. The desired objective can change depending on the sector and consequently, authorities may read the results differently. It is therefore worth making a distinction between two principal types of tests (see 2.1 below). On the one hand, analytical exercises (research initiatives) that are primarily intended to develop the methods of evaluating risks for financial stability; on the other, tests that are intended to develop diagnostics and, if necessary, operational risk management recommendations.

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<sup>31</sup> In the absence of specific legal foundation, the authorities base their actions in the area of financial stability on their mandate. In particular: *"In carrying out its duties, the AMF takes account of the objectives of financial stability throughout the EU (...) It cooperates with the competent authorities of the other States. (...)"* (Art. L. 621-1 of the Monetary and Financial Code). In addition, the AMF has powers to collect any relevant information from supervised entities in this context, in accordance with Art. L. 621-8-4 of the French Monetary and Financial Code (*"The AMF may request, by the persons or entities mentioned in II of Art. L. 621-9, any documents or information, whatever the medium, useful for the exercise of its mission of monitoring and surveillance"*).

Diagram 1: Principal characteristics of macro stress tests



Source: Autorité des Marchés Financiers (French Financial Markets Authority).

#### 1.4. FOCUS ON ASSET MANAGEMENT: PRACTICES VARY AND EVOLVE

In the absence of any specific requirement for macro stress tests in the asset management sector, but with the FSB and the IMF offering incentives to develop capacities in this field, the practices adopted by different authorities are the result of diverse and spontaneous initiatives. In this regard, we make a distinction primarily between bottom-up supervision tests, whose specifications may vary considerably, and the more analytical top-down tests, which aim to take systemic liquidity risks into account by modelling market dynamics. The cases under study, are conducted under the aegis of central banks.

##### 1.4.1. Bottom-up supervision tests: multiple objectives

At this stage, the **supervision exercises** are primarily bottom-up stress tests. They are often exploratory and not standardised, and are rarely published.

**Practices are still being developed, however, mainly on the initiative of the IMF** (see box 1). After a pilot test<sup>32</sup> that covered the entire mutual funds sector in the United States in 2015, a number of the IMF's Financial Sector Assessment Programs (FSAP) implemented stress tests, particularly in jurisdictions that specialise in the domiciliation of investment funds<sup>33</sup>, to evaluate the risks linked to asset management. They are being integrated into the more general assessments of resilience of the financial system and **tend, in collaboration with supervisors, to focus on specific market segments** (money market funds, high yield bond funds), using very simple and robust risk indicators (statistics) (see section 2.3). They thus enable the development of credible and detailed **risk management requirements** and provide good reasons for developing further macro stress test methodologies and their use.

From among the one-off national initiatives, whose results have been published in recent years, an **exercise carried out by the Romanian Financial Supervisory Authority's (FSA) is worthy of note**. This tested the market, counterparty and liquidity<sup>34</sup> risks across a sample

<sup>32</sup> Focusing on 9,000 mutual funds, the FSAP evaluated the impact of a redemption shock calibrated on 1% of the tail of distribution, in line with the liquidity providers' capacity to absorb demand.

<sup>33</sup> See Ireland (IMF (2016a)), Luxembourg (IMF (2017)) and Sweden (IMF (2016b)) FSAPs.

<sup>34</sup> 29 open-ended funds and 73 closed-end funds. Market risks: fall in share prices, increase in interest rates, currency fluctuations. Counterparty risks: collapse of the three principal counterparties to the fund's assets. Liquidity risk: redemptions of the holdings of the two principal investors. For more detail, see ASF (2016).

of **open and closed-end funds**. Based on contributions from portfolio managers, a number of results were published at the beginning of 2017<sup>35</sup>. They shed light on the resilience of exposures in the equity markets and counterparty risk<sup>36</sup>, and highlight the hedging of exchange risk (by derivatives) as well as **sensitivity to fluctuations in interest rates**<sup>37</sup>. The impact of liquidity risk seems however limited by the **low probability of mass redemptions on the funds**<sup>38</sup>. **The test was extended by targeted interactions** with industry aiming to develop mechanisms for risk management and internal stress testing (best practices). It is planned to repeat the test on a regular basis.

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<sup>35</sup> The scenarios were evaluated by the portfolio managers between 01/08/16 and 23/09/16, and a summary of the results was published in January 2017 (ASF (2017)).

<sup>36</sup> Judging by the ratings of the principal counterparties (primarily authorities and credit institutions) relating to bond holdings and bank deposits.

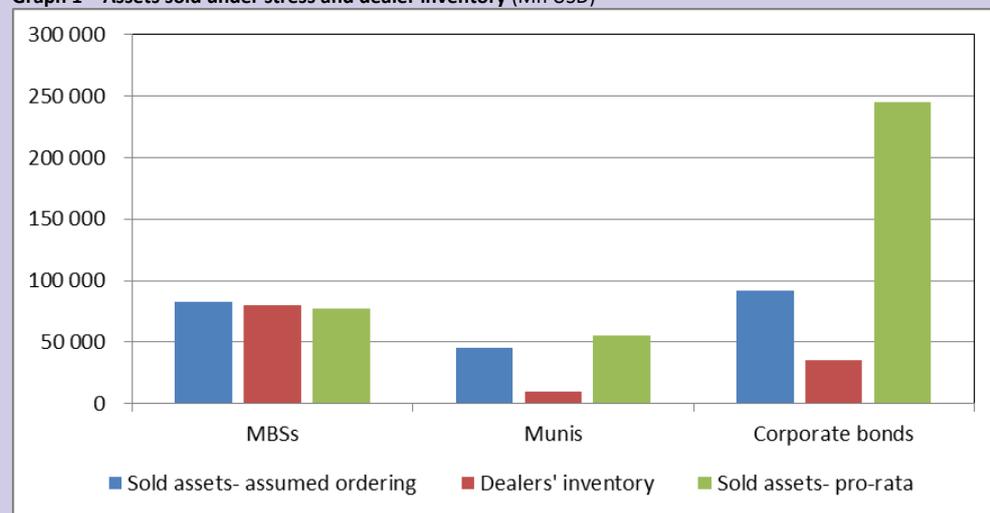
<sup>37</sup> This investigation would require specification of the impact of the valuation (in market value or by models).

<sup>38</sup> Measured by an analysis of net flows over the last five years. NB: for some small or medium-sized funds, the high weighting of the major shareholders can sometimes create a vulnerability on the fund's liabilities.

**Box 1: Examples of asset management stress tests carried out under IMF FSAPs.**

The **United States FSAP** published in July 2015<sup>39</sup> evaluates the resilience of the entire asset management sector based on a *top-down stress test* of 9,000 American *mutual funds*. As such, it evaluates the impact of a single redemption shock corresponding to 1% of the tail of distribution, and compares these redemptions to the *dealer inventory*. The test envisages two scenarios whereby the portfolio managers sell their assets either in proportion to their weighting in the portfolio, or in decreasing order of liquidity (*waterfall*), and concludes that the redemptions of units in an investment fund can “lead to significant market stress”, creating significant liquidity constraints that force sales at rock-bottom prices in the municipal and corporate bonds segments (see graph). Against this background, the “authorities are encouraged to start conducting regular top-down analysis to provide a more holistic picture of the industry’s contribution to systemic risk”. “The exercise suggests scope for enhancement in the authorities’ stress tests. While the authorities’ solvency stress tests for BHCs are state-of-the-art in many respects, enhancements are needed, especially in non-bank stress tests. Improvements include addressing data gaps (...); implementing both solvency and liquidity stress tests not only for banks but also for non-banks (such as insurance companies, mutual funds, and pension funds); linking liquidity, solvency, and network analysis in a systemic risk stress testing framework; and examining the spillover risks between non-banks and banks”.

**Graph 1 – Assets sold under stress and dealer inventory (Mn USD)**



Source: IMF (2015b)

**The Ireland FSAP stress test** in 2016 (similar to the one carried out in Luxembourg in 2017) focused more on the **individual resilience of samples of MMFs and Emerging Markets and High Yield bond funds**.

For example, the test assessed the individual capacity of the funds to stand up to the liquidity requirements following redemption shocks **over one day and over one week**. Secondly, resistance to **consecutive liquidity and credit shocks** was assessed for *prime MMFs and government MMFs*: “A full portfolio revaluation was performed utilizing **security level holding data** (yield, coupon, maturity, and duration information) for the 20 largest Irish-domiciled MMF portfolios. The stress test was **calibrated to various combinations of credit spread and risk free interest rate shocks**, in increments of 15bps, 30bps, 60bps and 120bps respectively. The results suggest that prime MMFs, which are broadly equally sensitive to credit and duration risk, would need to be subjected to a simultaneous 60bps shock to both credit spreads and risk free interest rates in order to experience a marked-to-market decline in excess of 0.2 % (...). As expected, government MMFs are mostly exposed to duration risk, and would need to encounter a very large risk-free rate shock to produce a shadow NAV decline requiring immediate remedial action from the portfolio manager”<sup>40</sup>.

The stress test on bond funds is based on an estimate of the **time to liquidation** following redemption shocks of 5%, 10% and 20% of the NAV. Here, it uses “an advanced pricing algorithm developed by a third party vendor (...) to estimate the expected number of days it would take to liquidate each individual security holding (dependent on the position size). The algorithm takes into account market depth, and takes as inputs recent (3-month) information on traded volume, turnover, price volatility, and bid-ask spreads). Three caveats apply with respect to the estimates for ‘time to liquidation’ metric: they are based on historical rather than forward looking data, thus

<sup>39</sup> See US FSAP, IMF (2015b).

<sup>40</sup> The details of some test scenarios, particularly the decision not to specify shocks for each class of rating on the portfolio, and the impact of shocks on *floating rate notes*, are also discussed in the IMF report.

*the ability of market makers to continue offering liquidity in times of stress may be different from those recorded in the realized sample; the uncertainty associated with the ability to transact seamlessly is an increasing function of transaction sizes; and the time to liquidation is estimated on an individual security basis and does not explicitly model portfolio correlations". Furthermore, it is considered that assets are sold in proportion to their weighting in the portfolio.*

Based on these, the IMF recommends that the authorities should increase their capacity to carry out liquidity risk and market risk stress tests, as follows (see box):

- **"Liquidity risk** — the Central Bank of Ireland should: monitor liquidity risk in MMFs and IFs with reference to (i) a minimum weekly liquid asset ratio, and (ii) characteristics and concentration of the investor base. More frequent liquidity stress tests should be informed by security level fund holdings.
- **Market risk** — the Central Bank of Ireland should: build internal capacity that would allow for more frequent stress testing with respect to market shocks for MMFs, and IFs that avail of significant leverage".

The stress test conducted under the Ireland and Luxembourg FSAPs can therefore be understood to be a supervisory test intended to add value to the tests carried out by the fund managers themselves via a cross analysis (*benchmarking*) of the universe of funds (or samples thereof). The method of presentation of the detailed results for MMFs offers the benefit of assessing, as in a *reverse stress test*, the size of shocks that may have destabilising effects. A review of the methodologies for the recent asset management stress tests carried out under the IMF FSAPs is proposed by Bouveret (2017). This is discussed in 2.4 below.

**In France, an initiative** (see box) by the **national macroprudential authority (HCSF)** focuses on testing for the risk of a sudden drop in **commercial real estate (CRE)** prices and the impact on the financial system (banks, insurance companies, and investment funds). Based on the scenarios defined by the Banque de France, the HCSF coordinated the tests carried out by banking, insurance and market supervisors (see box 2). In this regard, the AMF was responsible for the organisation of a stress test on investment funds.

The characteristics of this test relate in particular to:

- Its **multi-sector governance**, adapting the test to the sectors covered but analysing the impact of the shocks on all financial institutions (banks, insurance companies, open-ended real estate funds), i.e. throughout the entire financial system;
- **The anchoring of the three scenarios** in a macrofinancial analysis establishing their plausibility (calibration on a fundamental overvaluation of market prices);
- **Shocks affecting a delineated market scope**, and the entity-by-entity risk assessment depending on their specific characteristics (liquidity management, risks to the assets of the portfolio (line by line), use of leverage and external funding, liability constraints);
- **Limited use<sup>41</sup> of modelling** of market interactions. The reliability of the methodology is based on the limited number of scenarios used to estimate the impact on the entities under review. However, it also includes a significant limitation: only the direct effects of the shocks are explicitly taken into account, not market interactions (second round, interactions between financial agents). These limitations are, however, partially offset by conservative assumptions on shocks and the "realism" of the integration of conditions of execution (asset

<sup>41</sup> The linearity of the fund performance-redemption flow relationship is an implicit assumption.

liquidation strategies, risk management<sup>42</sup>, use of liquidity management tools (LMTs)).

This test could in many respects provide inspiration for future tests<sup>43</sup>:

- **Reliability** of the methodology - which uses a very limited market (closed system adapted for stress tests), limits strong assumptions (traditional models of equilibrium), and puts forward plausible scenarios (a “narrative” “endogenises” the shocks) - ensures the **credibility** of the test.
- **Degree of specification** of the tests (entity by entity, taking into account the precise features of the products and incentives) enables the **effective use** of the results by the supervisor for macroprudential purposes (targeted recommendations).
- Coverage of **all financial sectors** could allow a macroeconomic “**closure**”, namely balancing the flows (asset sales, reallocations), particularly intersectoral or international flows, resulting from shocks, thus ensuring the true macroprudential nature of the test.

#### 1.4.1. Systemic top-down analyses, focused on liquidity risk

In an environment of economic and structural change in bond markets<sup>44</sup>, concerns have been raised about their systemic vulnerabilities. The fact that investment funds, mostly open-ended, may not have the capacity to manage the risk of forced asset sales (collective, sudden and self-sustaining) has been indicated in this context<sup>45</sup>. Macro stress tests can be useful to the authorities in their efforts to understand and measure these risks.

Recent studies<sup>46</sup> led by, or co-written by, economists from central banks constitute *top-down* macro stress tests, insofar as they integrate market dynamics<sup>47</sup>. Based on estimates of the relationship between performance and inflow to/outflow from investment funds, they analyse the systemic vulnerability of the markets to shocks on the bond rates in the portfolio and/or redemption of shares in the investment funds. Extending a text on “flow-

<sup>42</sup> For example, the IMF distinguishes two liquidation strategies, namely between waterfall strategies (where fund assets are sold in decreasing order of liquidity (cash, sovereign debts, etc.) and pro rata strategies (which maintain the initial asset class structure of the portfolio).

<sup>43</sup> Limitations of the indicators and data are discussed in 2.3 and 2.4. Initial guidelines have been put forward to remedy these. The most fundamental limitation related to the analysis of market interactions (dynamics). It was the subject of separate stress tests (top-down) whose scope and limitations are discussed in 2.2.

<sup>44</sup> In particular, the implementation of monetary policies that facilitate credit, the structural evolution of the capital markets (electronic trading, central clearing, etc.) and the increasing use of certain market instruments (*market-based finance*). Some of these (MMFs, repos) are qualified as “shadow banking”; here, the transformation of liquidity combined with substitutability for bank credit (Pozsar (2014, 2015)) comes with implicit government guarantees (Claessens, Ratnovski (2015)). The FSB and the ESRB have developed methodologies to specify the systemic risks of the market activities of some non-banking entities (dealers, securitisation funds, investment funds). In Europe, as banks continue to divest, investment funds have become the main holders of corporate bond debt and have brought the debate on this point to a head.

<sup>45</sup> See review of the initiatives in 2.1. The Governor of the Banque de France noted (12/07/17) that after the Basel III reforms, “the main issue now is no longer the solvency of banks, but the liquidity of non-banks” and that it is “thus of key importance that authorities develop and use system-wide liquidity stress-testing tools, in order to address the risks of a “funds-run” in adverse market conditions”. Similar views have been put forward by the Vice-Chairman of the ECB (26/09/17) and Alex Brazier, Director of Financial Stability, Strategy and Risks of the Bank of England (01/02/18).

<sup>46</sup> The views expressed are those of the authors.

<sup>47</sup> See discussion on the concept of *top-down* and *bottom-up* stress tests in 3.1 below.

performance” relationship (see 2.2.3 below), these models transpose the Greenwood, Landier, Thesmar (2015) model, which underlines the vulnerability of banks to the market impacts of forced sales (*fire sales*) and the contagion effects of deleveraging. They thus describe the potentially systemic effects of procyclicality (spiralling asset sales and falling prices) and indirect contagion

**Box 2: Macroprudential stress test on French commercial real estate carried out by the Financial Stability Board (HCSF) in 2016\***

- **Scenarios:** designed by the Banque de France, approved by the HCSF, and specified by sector authorities. Scenario where commercial real estate prices fall for one month and then remain unchanged for two years
  - Scenario 1: prices fall by 30% (Paris area) and 15% (elsewhere in France)
  - Scenario 2: 30% (Paris area only)
  - Scenario 3: 60 % (Paris area only)
- **Simultaneous implementation** by the ACPR, AMF and Banque de France (July 2016 – December 2016)
- **Banking sector:** Autorité de contrôle prudentiel et de résolution (ACPR) - *Bottom-up* approach\*\*
  - Scope: Five major banks
  - Indicators tested: *Risk Weighted Assets (RWA)*; *Core Equity Tier 1 (CET1)* ratio
  - Results:
    - Weak impact on RWA and CET1
    - Banks are weakly exposed to commercial real estate
- **Insurance sector:** ACPR - *Bottom-up* and *top-down* approaches\*\*
  - Scope: 19 insurance companies
  - Indicators tested (*bottom-up* and *top-down*): capital; *Solvency Capital Requirement (SCR)*
  - Results:
    - Consistency between *bottom-up* and *top-down*
    - Weak impact on average
    - Among a limited number of insurers, the stressed SCR falls below 100%
- **Investment funds sector:** Autorité des marchés financiers (AMF) - *Bottom-up* approach
  - Scope: Eight main companies managing retail OPCIs
  - Additional assumptions concerning:
    - Redemption orders of 40% (scenarios 1 and 2) or 50% (scenario 3) over two months
    - Prices of listed assets (equities and debt of real estate companies)
    - Focus on open-end funds distributed to retail investors
  - Results:
    - Decline of 6% to 21% in fund NAV
    - Resilience in terms of ability to honour redemption orders
    - (Minimum) liquidity ratio temporarily restrictive for some funds; diversification ratio (max. physical real estate/unlisted assets) restrictive.

Price drop scenario	Drop in NAV
15% overall/30% in Paris region	12% to 25%
30% (Paris area only)	6% to 21%
60% (Paris area only)	12% to 42%

- **Risk monitoring:**
  - The limited exposure of market participants reveals no evidence of systemic risk at this stage.
  - However, warnings were issued by:
    - the ACPR and the AMF in terms of the distribution of funds invested in real estate (not only commercial) to individual investors
    - the ANC and the AMF concerning the valuation of real estate assets
- **Communication** of the results by the HCSF: March 2017  
See the updated analysis and results of stress tests for the commercial real estate segment

\* See more at: [https://www.economie.gouv.fr/files/files/directions\\_services/hcsf/HCSF-170331-Note\\_publique\\_CRE.pdf](https://www.economie.gouv.fr/files/files/directions_services/hcsf/HCSF-170331-Note_publique_CRE.pdf).

\*\* Under the bottom-up approach, supervised entities are provided with the stress scenarios and their contributions are consolidated. “Top-down” scenarios use the data (from regulatory and market inflows) held by the competent authorities. The definitions proposed in 2.1 are based more generally on the use of the data without prejudice to their source.

(by virtue of market impacts on stocks held jointly by different funds or types of agent). These studies vary in terms of detail. Two - Cetorelli et al. (2017), Fricke et al. (2017) - analyse the US market at the individual investment fund level, with the first considering bond funds and the second evaluating, security-by-security, the impact of sales of equity funds on the share prices. The third (Baranova et al. (2017)) considers categories of corporate bond funds at a European level and describes more extensively the interventions of dealers and alternative funds (assumptions are made for institutional investors) as counterparty to transactions on investment funds.

These studies draw multiple conclusions: the detailed analysis by Fricke et al. (2017) underlines the importance of *deleveraging* (which is, in fact, quite limited for mutual funds) to determine the systemic nature of the procyclicality loops, and the resulting low impact, in absolute terms, of sales of funds on the securities prices. Large or interconnected funds are rarely vulnerable with regard to their individual contribution to the aggregated risk. Cetorelli et al. (2017) shows a relative increase over time, abstracting from their absolute level, in the “run” risks on bond funds - including due to an increase in the sensitivity of their inflows to variations in bond yields and the concentration of the risk of lack of liquidity by some funds (large and sensitive to variations in share prices)<sup>48</sup>. Finally, Baranova, Coen et al. (2017) concludes primarily that there is a benefit in the models of interaction between bank and non-bank agents - but also highlights, based on the scenarios used, the unlikely but plausible nature of the systemic risks. The model calls for institutional investors’ behaviour to be taken more precisely into account. We can see here that these are likely to have potentially procyclical effects (under the influence of liability constraints) but also ultimately having a stabilising effect (“corrective force” of share purchases by *contrarian* investors) on the market<sup>49</sup>.

Generally, the top-down liquidity stress tests focused on investment funds’ call for prudent interpretations insofar as they make implicit assumptions on the functioning (“otherwise”) of the capital markets. Section 3 below therefore recommends analyses that look in more detail at market (dis)equilibria, explaining on these bases the specific role of the different types of market participant. Reinforcing the credibility of these *stress tests*’ uses could, in fact, be seen as a positive factor, especially where a number of representatives of the industry have expressed a degree of scepticism<sup>50</sup>.

#### 1.4.2. Institutional framework

Notwithstanding the benefits of top-down and bottom-up tests, authorities’ ability to conduct prudential asset management macro stress tests is steadily developing. Initiatives reflect a degree of willingness to develop, in Europe, the institutional framework in this field, whereas the United States could delay the adoption of a specific regime.

**In the United States**, the provisions of the Dodd Frank Act<sup>51</sup> require that some non-bank financial companies, especially portfolio managers with more than 10 billion in

<sup>48</sup> NB. like Fricke et al. (2017), this study does not model the non-linearity of the impact of asset sales.

<sup>49</sup> Closing the system (moving from a partial to general equilibrium) contributes to identify the counterparties of fund asset sales, but also to specify the temporality of liquidity spirals.

<sup>50</sup> According to BlackRock (2017), for example, “System-wide stress testing cannot be used for macroprudential purposes unless it can (i) distinguish market and liquidity risk from systemic risk and (ii) obtain sufficient data on at least the majority of asset owners. We strongly discourage [its] use (...) to justify policies that hinder natural price adjustment processes. (...) Stress testing across mutual funds is not a starting point for system-wide stress testing. (...) Mutual funds do not operate in markets in isolation nor do they represent a homogeneous sector. (...) Stress tests of asset managers will not inform systemic risk efforts (...) Applying macroprudential policies to asset management will increase systemic risk by encouraging the pro-cyclical behavior such policies aim to counteract”.

<sup>51</sup> See the requirements of the Dodd Frank Act relating to the obligation for certain non-bank financial companies to conduct annual stress tests provided for in DFA §165(i)(2) (codified by 12 U.S.C. §5365).

consolidated assets, carry out annual stress tests. To this end, the SEC has to establish a methodology that is “consistent and comparable” to the other macroprudential stress test methodologies and the results of the tests must be reported to the SEC and the US Federal Reserve. However, the SEC has not so far proposed any regulations in this area. In a report from October 2017 (US Treasury 2017), the US Treasury highlighted the difficulties with implementing these prudential stress tests. Considering that the regulations adopted over time covering MMFs (regulation 2a-7) and the liquidity of *mutual funds* (regulation 22e-4) deal appropriately with the risks that would be likely to arise under stressed market conditions, it recommended amending the Dodd Frank Act to remove the obligation to carry out prudential stress tests on funds and fund managers.

Conversely, **in Europe**, recommendations have been made by the European Commission<sup>52</sup> with regard to stress tests, with a view to increasing powers (aligning those of EIOPA and ESMA with those of EBA) and their use by ESMA. In this regard, the Commission proposes establishing an Executive Board that would have authority over stress tests. The vulnerabilities identified by the stress tests would therefore be taken into account in the development of its strategic plan, and the assessment of ESMA's ability to achieve its objectives would specifically involve the implementation of stress tests.

## 2. MACRO STRESS TESTS: FIELDS FOR DEVELOPMENT

### 2.1. TYPOLOGY AND REVIEW OF TESTS CARRIED OUT

#### *Top-down macro stress tests centred on market dynamics and externalities*

Macro stress tests can, in principle, assess different types of risk, especially<sup>53</sup> operational, counterparty/credit, and market/liquidity risks. In the current market context, there is keen interest in tests targeting market dynamics/lack of liquidity<sup>54</sup> that are detrimental to financial stability. The objective is therefore to identify the circumstances that are favourable to the occurrence of these destabilising market effects: structural or economic vulnerabilities, collective market behaviour that would be likely to transmit or amplify the effects. The intervention by the authorities is therefore all the more legitimate as there are negative externalities and systemic impacts<sup>55</sup> in play. Claessens (2014) identifies three types of externality here:

- i) **Excessive risk taking**<sup>56</sup>, for example under the influence of badly managed competition (*race-to-the-bottom*), incentives or reputational effects, information or behavioural biases (under estimation of extreme risks, imitation, *search for yield/return chasing*<sup>57</sup>, etc.), or because of moral hazards (anticipations of intervention, *backstops*)<sup>58</sup>;

<sup>52</sup> Regulation 2017/0230 dated 20/09/17 of the European Commission.

<sup>53</sup> An exhaustive list has yet to be established, which would include other types of, e.g. reputational, risks.

<sup>54</sup> When assessing risks of “*fire sales*”, i.e. sequences of asset price drops and redemptions of fund units, market (simulating asset price/interest rates shocks) and liquidity stress tests (redemption shocks) are quite close.

<sup>55</sup> The externalities are characterised by the fact that market participants do not internalise the costs for financial stability. In terms of well-being, financial instability is thus akin to a pollution effect.

<sup>56</sup> Claessens (2014) highlights the strategic complementarities of market interactions that characterise financial cycles. For example, the return on investment strategies may increase with the number of agents implementing them, or reputational factors or factors linked to the structure of agents' incentives may lead them to favour short-term gains over the price of risk-taking in the longer term.

<sup>57</sup> On search-for-yield in a low interest rate environment, see Annex D of ESRB (2016c) and Ammer, Claessens, Tabova, Wroblewski (2018).

<sup>58</sup> Pozsar (2014), Claessens, Ratnovski (2014) propose defining *shadow banking* on the basis of public and private *backstops*, considering in particular the quasi-monetary nature of non-bank assets.

- ii) **Forced sale mechanisms** (*fire sales*) amplify the turnarounds in the market, particularly under the influence of constraints on the use of external financing and/or debt leverage (physical or synthetic);
- iii) **Contagion effects**, particularly where interconnections are likely to favour the propagation of initial shocks. Vulnerabilities are more structural here and are subjected primarily to cross-sectional analysis.

When market dynamics (e.g. *fire sales*) and direct contagion (due to the unwinding of counterparties' positions) or indirect contagion (due to joint market exposures) are likely to affect various parts of the financial system (*system-wide*), macro stress tests require that these effects be modelled in a **top-down approach**. They are therefore intended to analyse - without restriction to a single type of agent - the interactions between all the different market participants engaged in the market intermediation activities under review, and account for the dynamics of market (dis)equilibria.

*Bottom-up tests: primarily a benchmarking of individual resilience capacities.*

**Bottom-up** stress tests are primarily intended for tangible and practical purposes, and are therefore more limited in their ambitions with a view to improving their reliability; they are used less for modelling market dynamics and externalities, and focus more on the vulnerabilities of certain types of entity in order to meet the needs, in the first place, of the micro- and macroprudential supervision of the markets. They add/lend, to the risk assessments of the supervised entities carried out for their own purposes, a capacity for cross analysis based on the use of common scenarios and for benchmarking across the entities under review. This therefore shows the effects (at least the direct ones) of the shocks tested, and offers views on the overall risk exposures, including where market participants lack information on other market participants' positions<sup>59</sup>. However, the reliability of the resilience indicators of the entities under review thus ensures their credibility and usefulness for risk management. Further, they may, as a first approximation, subsume the effects of market interactions by relying on conservative assumptions and test scenarios<sup>60</sup>. Supervisory stress tests (of banks by the EBA, CCPs by ESMA, investment funds by the IMF FSAPs, the French HCSF or the Romanian FSA, etc. – see Table 1) belong to this type of stress test<sup>61</sup>.

Based on assumptions on market structure, macro stress test methodologies currently aim to schematically model the synchronic dimensions (across considered market entities, at a given moment) and diachronic ones (dynamics) of observed effects. The following table shows the progress of the tests under review in these two areas.

<sup>59</sup> V. Acharya (2015) underlines the possible benefit to the regulator of playing the transparency role on the market for some exposures (while preserving the anonymity of the market participants).

<sup>60</sup> Cont, Schaanning (2017) stress the need for alternatives to making up for the lack of modelling of asset price contagion effects by scaling up the intensity of the shocks tested. Such approaches measure the increase in the banks' average losses caused by the shock, but not the distribution of the impacts and therefore not the aggregated effect, in a cross-sectional analysis, that is relevant for financial stability.

<sup>61</sup> NB : current changes in methodology, notably in bank stress tests, aim to better integrate market dynamics (see 1.1).

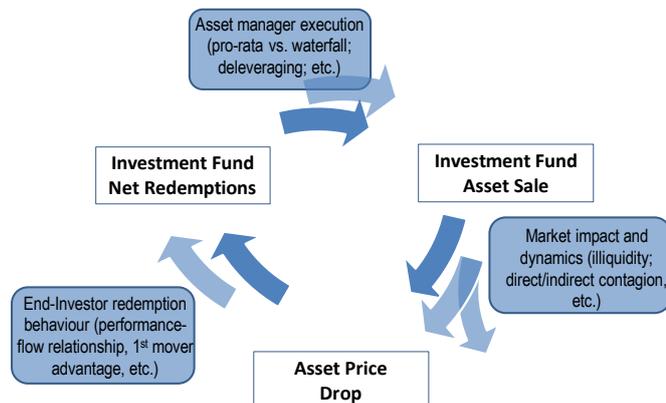
**Table 1 - Development areas for macro stress tests**

	One sector	Multiple sectors	
		Without intersectoral or partial interactions	All sectors interconnected
<b>Indicator</b>	- Banks (EBA, US Federal Reserve); insurance companies, pension funds (IORP) (EIOPA); CCP (ESMA) - MMFs (Ireland, Luxembourg FSAPs (IMF (2016a, 2017)) - Open or closed-ended investment funds (Romanian FSA)	- Stress test on French commercial real estate (HCSF)/Application by the IMF to open-ended <i>retail</i> real estate funds (by the ACPR to banks and insurance companies)	∅
<b>Dynamic (2<sup>nd</sup> round)</b>	- Cetorelli et al. (2016) "How vulnerable are mutual funds to fire sales? (NY Fed) - Fricke et al. (2017) "Vulnerable Asset Management: The Case of Mutual Funds" (Bundesbank)	- Baranova et al. (2017) "Simulating stress across the financial system. Resilience of corporate bond markets and the role of investment funds" (Bank of England)	"Ideal" or "complete" stress test  ∅

Source: AMF

**The modelling and endogenous integration of market dynamics**, subject to the simulated shocks, are in general intended to analyse the risk of occurrence of liquidity crises characterised by *fire sales*<sup>62</sup> that can lead to market dysfunction. The systemic nature of the risks is therefore due to the amplification of the initial shock by the concomitant behaviour of market participants. Schematically (see diagram below) this mechanism consists of successive actions from three types of agent (possibly in iterative steps, beginning with the first type of agent subject to the initial shock): investor redemptions (due to price drops), asset sales by managers (amplified or not by *deleveraging*, *cash hoarding*<sup>63</sup>) and actions of potential market counterparties (market makers or others - *hedge funds*, own-account dealers, institutional investors, etc.). The significance of the test therefore firstly reflects its capacity to anchor the modelling of procyclicality in the specific, empirical observation of behaviours, and to consider the relevant incentives.

**Diagram 2 - Fire sales by investment funds**



Source: AMF

**Another field for development aims to increase the relevant market scope taken into consideration and model the interconnections.** This is of particular importance for stress tests intended to be *system-wide*, typically in markets where liquidity cannot be considered as exogenous (such as markets that are structurally less liquid<sup>64</sup>). Evaluating

<sup>62</sup> Cycles of share purchases can also have a destabilising effect, especially if they go market expectations. See for example "flash rally", analysed by Bouveret, Breuer, Chen, Jones, Sasaki (2015).

<sup>63</sup> Morris, Shim, Shin (2017) demonstrates that bond managers, in the face of liquidity shocks, firstly tend to increase their cash reserves in anticipation of future redemptions; this is known as *hoarding* and is likely to encourage the occurrence of fire sales.

<sup>64</sup> Such as markets in physical assets, like real estate assets or certain unlisted assets.

the resilience of the liquidity of some entities (such as investment funds) therefore requires consideration of strategic behaviour of potential counterparties in terms of asset sales, and other market participants<sup>65</sup> that make a material contribution to the (dis)equilibria that characterise the formation of liquidity and market prices.

## 2.2. TOP-DOWN STRESS TESTS: FIELDS FOR DEVELOPMENT

Five development areas appear to be relevant in terms of the development of methodologies for macro stress tests, in particular top-down tests. They aim in particular to improve the integration of market scopes and interconnections, the use of leverage and financing/hedging of transactions, the anchoring of market equilibria in the observation of behaviours, agents' incentives and market structures, and the integration of different analysis tools in unified models that enable the simulation of the system's reaction to the shocks tested.

Given the object of this study, the following part pays particular attention to asset management. These specific observations are, however, intended to be integrated in a more general view **covering all market participants** that influence the formation of liquidity and market prices in the event of stress, particularly market counterparties that are likely to provide liquidity in this context.

Finally, it stands out that both top-down and bottom-up stress tests, despite their limitations (detailed below), offer direct and indirect benefits for the macroprudential supervision of the markets. For example, they allow the development of indicators used to track the activity and vulnerabilities of the entities under review. These can, for example (see Fricke, Fricke (2017)), measure aggregate exposures at risk, or evaluate the direct effect of a shock on the assets of the entities under review and its possible amplifying factors (leverage, lack of liquidity, etc.) or even, based on additional assumptions (models), measure the indirect impacts including the diffusion effects (contagion, second round). They can symmetrically evaluate the resistance capacity of the entities to shocks (*buffers*, etc.). Indicators on the market structure of exposures (cross, joint, concentration, etc.), which are in some cases unavailable to market participants, can be particularly useful in this regard.

### 2.2.1. Modeling market interconnections

Two levels of analysis are, in practice, often envisaged with regard to modelling of interconnections. Market equilibria can often be modelled based on **aggregate agent categories** (or investment funds). The Bank of England (see table 1) describes, for example, the risks of *fire sales* on a European market level, via interactions between investment funds, *dealers* and *hedge funds*<sup>66</sup>. More systematic inclusion of other market participants involved in the formation of market (dis)equilibria would complete the relevant network of market counterparties, i.e. overcome the limitations of a partial equilibrium model. In so doing, it could also strengthen the empirical base of this type of model<sup>67</sup> i.e. anchor it in more precise (microeconomic) representations of market structures and strategies of market participants (see 2.2.3 and 2.2.4 below).

<sup>65</sup> Clerc, Giovannini, Langfield, Peltonen, Portes, Scheicher (2016) and Dees, Henry, Martin (2017) underline the importance of considering the "indirect contagion" due to similar market exposures of market participants that do not have, in some cases, bilateral exposure among themselves.

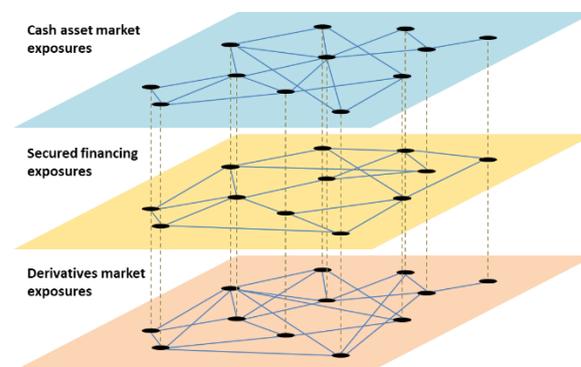
<sup>66</sup> On the modelling of the behaviour of dealers and hedge funds, see point 2) of 2.2.3 and footnote on page 94.

<sup>67</sup> The representation of institutional investors has been simplified. In a shock scenario, they are assumed to reduce, in a linear fashion, the daily asset purchases from dealers down to half of their normal level of

Other analyses demonstrate the possibility of **fine-tuned modelling of the networks of counterparties**<sup>68</sup> and the sensitivity of risks to the structure of these networks (Acemoglu, Ozdaglar, Tahbaz-Salehi (2013), Battiston et al. (2012), Cont (2013)). The development of these techniques, based on the modelling of bilateral exposures (to the assets and liabilities of the balance sheets of the entities concerned), is primarily confirmed at the moment by the empirical work in progress on the stability of interbank networks (Lelyveld, in't Veldt (2012), Halaj, Kok (2014)). Their usefulness, in a multi-layer network model (multiplex), for market stress tests is, however, pointed out by Crisóstomo, Peralta (2016). In this regard, it matters to:

- Cover all the relevant types of exposure, e.g. in multiplex networks (see diagram 2 and 2.2.2 below);
- Reflect the specific features of the structure of the networks of investment funds compared to that of the banks<sup>69</sup>;
- Modéliser les dynamiques de la liquidité au niveau des entités ou nœuds du réseau (incitations, gestion actif-passif, voir 2.2.3), au-delà de la seule solvabilité (cf. cascades de défauts d'Eisenberg, Noe (2001) et Acemoglu et al. (2013)) ;
- Model the dynamics of liquidity of the entities or network nodes (incentives, asset-liability risk management, see 2.2.3) beyond solvability (e.g. default cascades of Eisenberg, Noe (2001), Acemoglu et al. (2013));
- Use granular and structured data available at the level of the markets in question for the purposes of the test (see Cont (2013, 2016), Farmer (2016)).

**Diagram 3 - Simplified representation of a multiplex network**



Source: AMF.

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purchasing. These long-term investors - as well as other types of agent (see 2.2.3 on own-account investors) - are, however, likely to end up acquiring depreciated assets sold off by the fund.

<sup>68</sup> Inspired by these, pioneers, of Allen, Gale (2000) and the analysis of complex systems by the pure sciences (Battiston, et al. (2016)).

<sup>69</sup> Unlike the banks, the funds do not have permanent equity, and their clients exhibit more mixed behaviours. Where the banks have exposures among themselves on the interbank market, the funds have systematically fewer crossed exposures (investing in other funds is not the general rule). FSB (2018) assesses bilateral sectoral exposures of banks and non-banks at an aggregate level. Benhami, Le Moign (2018) provides a granular analysis of the investment fund network within the French domestic financial sector.

### 2.2.2. Taking leverage into account

**The use of leverage, including derivatives and securities financing transactions<sup>70</sup>, has a significant effect on the impact of liquidity shocks.** *Deleveraging* events can be seen in most episodes of financial instability observed, particularly when it comes to asset management<sup>71</sup>. In fact, they are an essential component of the banking model of Greenwood, Landier, Thesmar (2015), which is the theoretical basis for the *top-down* macro stress tests on investment funds under review<sup>72</sup>, and they generally constitute an essential mechanism in the reference literature on *fire sales*<sup>73</sup>. Models integrating leverage are liable to specify the risks linked to its tendency to amplify the situation. However, note that the use of derivatives, which generally characterises the leverage of investment funds (synthetic leverage) can also in some cases have a stabilising effect (hedging).

Financing and derivative transactions are generally secured by collateral. One issue associated with this concerns the liquidity of the markets in safe assets posted as **collateral** in this regard and for the purposes of clearing of orders. It is therefore especially important to consider the impact of the simulated shocks on the availability (*scarcity*) and re-use of posted safe assets (Ferrari, Guagliano, Mazzacurati (2017), ESRB (2017a)). Note in this regard that secured transactions – e.g. the use of cash reserves or "*buffers*" - to address liquidity demands is likely to introduce **non-linearities** in the impact on the market of the shocks tested - reducing the probability of extreme events but increasing procyclicality and correlation between asset classes when the coverage thresholds (margin calls, depletion of liquidity buffers) are reached.

### 2.2.3. Observing agents' behaviour and incentives

The following section looks primarily at certain types of behaviour in the asset management sector (managers, unitholders) and at liquidity provision. However, it is important in this regard to consider more generally **all market participants** that have a material influence on the formation of liquidity and market prices under stress.

**1) Asset management:** stress test models describe in general the systemic risks primarily as procyclical loop *fire sales* (diagram 1). The "**flow-performance**" relationship, i.e. the sensitivity of redemptions of units to the performances of the funds, plays a key role in this regard<sup>74</sup>. Its form<sup>75</sup>, specification and stability<sup>76</sup> have yet to be reliably established and

<sup>70</sup> For reasons associated with the regulatory limits on the use of credit ("physical" leverage) by UCITS, and to market practices and alternative fund management techniques, leverage on investment funds is largely driven by the use of derivatives ("synthetic" leverage or *secured financing transactions*). Note here that other types of transaction, e.g. those corresponding to short selling strategies, or linked to corporate actions (payment of coupons or dividends, etc.) can also have an effect on liquidity.

<sup>71</sup> Episodes linked to *deleveraging* of alternative investment funds (LTCM, Amaranth, etc.) and money funds during the *subprimes* crisis are highlighted here. Khandani, Lo (2008) demonstrates the risk of transmission of shocks across the markets due to certain alternative investment strategies. The *deleveraging* of a *long-short* fund positioned on the buy and sell sides leads to the simultaneous buying and selling of stocks to reduce the position. The risk is therefore more related to a dislocation of the market structure than to a single-direction movement of market prices. Assessment of the impact of *deleveraging* (or of *cash management* in the symmetrical case of leverage of less than one year) is an area for development.

<sup>72</sup> Their low leverage leads Fricke, Fricke (2017) to conclude precisely that the systemic risks for the liquidity of the market induced by US equity mutual funds are limited.

<sup>73</sup> The reference literature (Brunnermeier, Pedersen (2009), Gromb, Vayanos (2009), Geanakoplos (2010), Adrian, Shin (2008)) is primarily related to banks and therefore paints an incomplete picture of the use of derivatives (synthetic leverage).

<sup>74</sup> Cetorelli, Duarte, Eisenbach (2016) assumes as an initial approximation the linearity of this relationship. Baranova, Coen, Lowe, Noss Silvestri (2017) favours a relationship between VIX and buy flows.

specified<sup>77</sup>. In particular, it is important to analyse underlying behaviours of unitholders<sup>78</sup> and portfolio managers, in an environment where the funds' exposures to liquidity risk are actively managed<sup>79</sup>. Finally, in a stress test model, investors' procyclical return chasing (in the cross-section and over time) should be consistent with a model for valuation of financial assets<sup>80</sup>.

**With regard to unitholders**, investment and (net) redemption behaviours - particularly the sensitivity of individual and institutional investors to variations in share prices - are as yet not fully assessed. Progress has been made in terms of analysis, at an aggregate level, of the pro- or countercyclicality of institutional investors with regard to market liquidity (see end of section, below). However, the microeconomic analysis has yet to be more precisely grounded. Research into behaviours<sup>81</sup> highlights multiple biases (psychological, cognitive, etc.) among investors, particularly individuals<sup>82</sup>, so it is difficult to base models on assumptions assuming their rationality. The lack of data on fund unitholders (incomplete identification details) limits the analyses significantly<sup>83</sup> (see 2.4) that would specifically assign any procyclicality to unitholders' behaviours<sup>84</sup>. The measurement of fire sales risks must accordingly also reflect fund managers' knowledge of unitholders' behaviours (on the liabilities of their funds), thus their ability to manage liquidity risk.

**With regard to portfolio managers, the observation of risk-taking incentives** is in keeping with an economic environment of accommodative monetary policies that favour the search for yield by the funds, and more generally, increasing levels of investment in some markets in bonds and illiquid assets<sup>85</sup>. Therefore, it is necessary to model the behaviour involved in managing liquidity risk-taking<sup>86</sup> and then determine, on these bases, whether there are any conflicts of interest, incidental to the statutory objectives of the

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<sup>75</sup> The top-down stress tests often make significant assumptions about its form (continuity, linearity, convexity) to extrapolate observations made on average from extreme market situations.

<sup>76</sup> Darolles (2017b) notes that the estimate of the "flow-performance" relationship depends on the stability of the liabilities structure (it must take into account changes, over the period of estimation, in clients and unitholders).

<sup>77</sup> The analysis of detailed categories of European mutual funds by Grillet-Aubert, Sow (2009) does not confirm the perception of procyclicality.

<sup>78</sup> Procyclicality is generally attributed by the top-down tests to the first-mover advantage. This is a characteristic of the transformation of liquidity by the funds; it refers to the desire of investors, in the event of stress, to be first to redeem the liquid assets held in their funds (*run on liquid assets*) at the expense of other unitholders. In practice, this advantage is primarily a feature of CNAV MMFs (see IOSCO (2012)).

<sup>79</sup> See Darolles (2018). Looking at a side view, the profitability of *hedge funds* is linked to the liquidity of the market (Sadka (2010); Teo (2011), Agarwal, Aragon, Shi (2015)). Agarwal, Aragon, Shi (2015), and then Dudley, Nimalendran (2010), Aragon, Strahan (2012), show that it is also linked to the liquidity of secured funding. This demonstrates that arbitrages are realised systematically between expected return and the risk of a liquidity crisis.

<sup>80</sup> Karcecki (2002) does not manage to establish empirically a consistent relationship between such procyclicality and the CAPM.

<sup>81</sup> Séjourné (2007), Shefrin (2017) propose reviews of a Nobel prize-winning text (Kahneman, Tversky 2002, Thaler 2017) on behavioural biases affecting individual investors and savers in particular.

<sup>82</sup> According to Christophersen, Xu (2015), for example, "attrition" after bad performances reduced the sensitivity of the flows of individual investors (not institutional) to the performances of active management funds.

<sup>83</sup> Especially taking into account their diversity (Christophersen, Xu (2015)).

<sup>84</sup> With the help of new data from the US SEC, Kruttli, Monin, Watugala (2017) shows, for example, that the subscription-redemption volatility of hedge funds increases with the concentration of investors.

<sup>85</sup> In Europe, during the last decade, the institutional sector of investment funds has become a major holder of corporate bonds (favouring divestment by the banks) and investment in some markets in illiquid assets (particularly real estate assets) has increased. Jotikasthira, Lundblad, Ramadorai (2012) highlights the procyclicality of international funds invested in the emerging markets.

<sup>86</sup> Darolles, Rousselet (2017), for example, models the optimal allocation of the manager in the presence of market liquidity and financing risks in a simplified model that includes liquid and illiquid assets.

management mandates, leading to excessive risk-taking that could affect financial stability, and especially the occurrence of *fire sales*.

Two observations are made here:

- Academic literature on US investment funds underlines the importance of the **flow-performance relationship**. When its curve is convex, it indicates a manager's conflicts of interest leading to excessive risk-taking<sup>87</sup>. When concave, it indicates the materiality of a (final investor's) first-mover advantage<sup>88</sup>. However, alternative interpretations of the empirical regularities observed are also put forward, with less impact on financial stability<sup>89</sup>. Failing to firmly establish the convexity of the relationship, the analysis of French equity funds by Bellando, Ringuedé (2009) adopts such alternative assumptions. Ferreira, Keswani, Miguel, Ramos (2012) confirms that the US observations related to the convexity of the flow-performance relationship are not universal, and less pronounced for institutional investors and in developed countries.

- The evaluation of the potential effects of managers' risk-taking incentives must account for the **effectiveness of their risk management**: firstly, their strategic trade-off between liquidity risk management and performance<sup>90</sup>. On these bases, it is necessary to understand their **behaviour with regard to liquidation** under stress, i.e. whether they tend to liquidate portfolio assets in decreasing order of their respective liquidity (*waterfall*) rather than in proportion to assets' weight in the portfolio (*pro rata*), to honour net redemption orders. In theory, while the second behaviour pattern maintains the continuity of the management strategy, the former is of more benefit to first movers (first-mover advantage)<sup>91</sup> and could foster procyclical redemptions in a stress event. Morris, Shim, Shin (2017), like Girardi, Stahel, Wu (2017), demonstrates *cash hoarding* in stress periods by US and emerging markets bond funds, which would increase procyclicality of redemptions even further, compared with waterfall liquidation<sup>92</sup>. Conversely, Nanda, Wei (2018) shows that the mutual funds **actively manage their overlap** by systematically reducing their holdings in assets shared with other funds, and therefore reduce their vulnerability to correlated sales.

On these two points, sensitivity-based approaches such as *reverse stress tests*, which specify the scenarios (flow-performance relationship, risk management) that are likely to generate risks, may also be useful (see Baranova, Coen et al. (2017)).

Ultimately, **in order to gain a better view on the prevalence of these effects in Europe**, there is a need to broaden the observation of empirical regularities, and to ground it more deeply considering multiple criteria: type of fund (MMF, AIF, UCITS), strategy (asset class, leverage, index-referencing, etc.), manager's ability to hedge or internalise the risks (e.g.

<sup>87</sup> Chevalier, Ellison (1997), Sirri, Tufano (1998) demonstrate the convexity of the flow-performance relationship for US equity funds. Good performances lead to inflow on the funds, but unitholders are less sensitive to bad performances. This "optional" form of the relationship is interpreted as a hidden incentive to take risks for the manager (remunerated based on assets under management).

<sup>88</sup> IMF (2015a) (Figure 3.9) establishes the convexity of the flow-performance relationship for US bond funds; Goldstein, Jiang, Ng (2016) establishes a concave relationship for corporate bond funds. Chen, Goldstein, Jiang (2010) goes deeper, showing a reduced sensitivity to performances of institutional flows (a high proportion of institutional flows could therefore indicate less procyclicality).

<sup>89</sup> According to Brown, Harlow, Starks (1996), seasonal competitive effects incite managers to take more risks.

<sup>90</sup> Hombert, Thesmar (2014) makes the first attempt at "endogenisation" of the behaviour of liquidity management based on redemption risk. Darolles, Rousselet (2009) optimises the objective of the manager based on the arbitrage between the earnings from liquidity risk hedges and their cost (impact on performance).

<sup>91</sup> The implications of this advantage in terms of equal treatment, and thus protection, of investors, result in possible trade-offs between investor protection and financial stability.

<sup>92</sup> The analysis of global bond funds (EPFR database) is more conclusive when the assets in the fund are illiquid.

in a family of funds<sup>93</sup>), the precise regulatory<sup>94</sup> and supervisory frameworks governing trade-offs between asset management objectives and liquidity risk management<sup>95</sup>, etc.

**2) Liquidity providers:** statutory **market makers** are the natural counterparties for the sales of assets in “stressed” investment funds<sup>96</sup>. To reach an aggregate measure of their liquidity provision is beset with practical problems, notably due to the lack of a single, consistent definition on which to base the quantifications<sup>97</sup>. Where banking or official market makers are affected by factors limiting their provision of liquidity in “stressed” markets, it is necessary to reconsider the incentives of the different types of market participant in this regard<sup>98</sup> to understand the impact of the transactions on the market. Barbon, Di Maggio, Franzoni, Landier (2017) highlights certain predatory strategies common among dealers that can affect “stressed” investment funds<sup>99</sup>. More generally, the electronic secondary financial markets have, for example, in recent decades, seen rapid growth in **proprietary algorithmic trading**. It is necessary to take the effects of such activity on market stability into account. For example, Biais, Declerck, Moinas (2017) shows that, on the French equity market, own-account trading helps to absorb shocks, including during periods of crisis<sup>100</sup>. In the United States, Choi, Huh (2017) demonstrates a switch of liquidity provision from the buy side to the dealers, with mixed results for financial stability.

**3) Arbitrageurs**<sup>101</sup> aim to take advantage of “abnormal” variations or deviations in asset prices, with the deviation from the norm generally being considered on the basis of a probability of mean reversion (temporary inconsistency or of correlations between asset categories). By nature, they tend to correct the transitory impacts on market prices of investment fund liquidations<sup>102</sup>. Stress test assumptions on the capacity to implement

<sup>93</sup> Bergstresser, Chalmers, Tufano (2009), Christoffersen, Evans, Musto (2013) demonstrate the conflicts of interest of the distributors of US funds but also the benefit of being able to internalise redemptions within a family of funds.

<sup>94</sup> IOSCO (2018) and ESRB (2018) systematise the use of liquidity management tools on the fund (swing pricing, suspension of redemptions, gates, etc.). IOSCO (2018) provides a comprehensive description of these tools.

<sup>95</sup> The introduction of risk management tools, including macro stress tests, is not neutral with regard to these arbitrages. It is therefore important to minimise the undesired effects (see 2.3).

<sup>96</sup> The Bank of England (Baranova, Coen et al. (2017)) models the provision of liquidity (purchases against sales of funds), including the market impact of endogenous asset sales from funds: the *dealers*, once *hedge funds* have seized (subject to financing constraints) arbitrage opportunities, balance out the market subject to regulatory capital requirements (see Baranova, Liu, Shakir (2017)). Assumptions on capital requirements applicable to *dealers* - and conditioning *hedge funds'* financing - thus bear significant impacts on stress test results.

<sup>97</sup> Upon reviewing available market making and own-account trading data, the BIS (2014) concludes: “*industry bodies and relevant authorities could consider collecting and disseminating more detailed information on market-makers' inventories and risk taking to monitor risks and support other market participants in assessing liquidity*”. In Europe, the ESRB’s analysis “Market liquidity and market-making” (2016) concludes: “*There is a significant information gap in terms of financial reporting in the EU that hampers a full assessment of the level of market liquidity and any related systemic risks*”. Quantification would require primarily a significant effort to specify an economically relevant concept based on multiple existing statutory definitions: regulatory (MiFID, short selling regulation, national banking laws, etc.) and private (Euronext *Supplemental Liquidity Provider* programme, etc.).

<sup>98</sup> Anand, Venkataraman (2015), Bessembinder, Hao, Zheng (2015) emphasise the benefit of raising incentives and even obligations of market makers to provide liquidity. Bessembinder et al. (2016) notes the withdrawal of traditional liquidity providers (bank-affiliated dealers) – from which Bao, Jack, O’Hara (2017) identifies a vulnerability of US bonds in periods of stress – but also highlights a switch to non-bank dealers. According to Korajczyk, Murphy (2014), however, “*HFTs reduce liquidity provision for “stressful” [institutional] trades (...) while DMM liquidity provision remains mostly unchanged*”.

<sup>99</sup> Of a few percent of asset prices, *fire sales* are, in principle, not systemic here.

<sup>100</sup> “*We find that proprietary traders, be they fast or slow, provide liquidity with contrarian marketable orders, thus helping the market absorb shocks, even during crisis, and earn profits doing so*”.

<sup>101</sup> Sometimes known as *hedge funds* in texts (Baranova, Coen et al. (2017)), they implement statistical strategies; they also include dealers who engage in own-account trading, typically algorithmic.

<sup>102</sup> In principle, arbitrage is neutral as regards liquidity provision, as one leg of the strategy (initiation or unwinding) may consume market liquidity while the other provides it. However it generally operates a transfer of liquidity between correlated assets. It may thus play a stabilising role when it transfers liquidity to stressed

arbitrage strategies and thus contribute to maintain market equilibria are therefore important<sup>103</sup>. After Mitchell, Pulvino (2012), Hombert, Thesmar (2014) demonstrates here the unduly simplistic nature of the assumptions of financing constraints weighing on arbitrageurs<sup>104</sup>, and recommends a more detailed analysis of their strategies.

Furthermore, arbitrage strategies (e.g. between derivatives and index-linked products, and underlying assets<sup>105</sup>) make liquidity, particularly on algorithmic markets, “fungible” or transferable in some respects, across markets in correlated assets (Hasbrouck (2003), Khandari, Lo (2008), SEC-CFTC (2010)). Considering liquidity uniform within an asset class, and independent of that of correlated assets thus makes a strong assumption, particularly for index constituents or derivative products’ underlying references, macro stress tests must therefore consider as far as possible complete markets and possible liquidity transfers (shocks) across asset classes. Conversely, this assumption seems more reasonable for less liquid assets (real estate, *commodities*, *off-the-run* bond issues, etc.)<sup>106</sup>.

**4) Institutional investors are subject to diverse liability constraints.** The liability constraints of guarantee provider insurance companies can be procyclical. Ellul, Jotikasthira, Lundblad (2009) lists forced sales of downgraded corporate bonds by insurance companies in the United States, as a result of applicable regulatory requirements. Timmer (2017) analyses granular data from Germany (stock-by-stock) and demonstrates the procyclicality of banks and investment funds, but the countercyclicality of insurance companies, which buy stocks following asset price depreciation. In the Netherlands, Duijm, Steins Bisschop (2015) demonstrates the procyclicality of sales of shares and government bonds by insurance companies during the “*taper tantrum*”, but the more generally countercyclical nature of insurance companies and pension funds. Kojen, Yogo (2016) highlights the benefits of taking into consideration the endogeneity of demand and the diversity of the preferences, beliefs, information and constraints of institutional investors in a model of asset price equilibrium. Top-down macro stress tests, in particular on bond markets, should therefore examine the impact of different types of institutional investors’ interventions (including, for example, sovereign funds) on the formation of market equilibria.

#### 2.2.4. Integrating market structure

The realism of top-down macro stress test models also depends on the representation of organisational and functional market characteristics<sup>107</sup>. Research in market

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markets and also contributes to shock propagation in the markets. For a theory of interconnected liquidity see Cespa, Foucault (2014).

<sup>103</sup> Baranova, et al. (2017) considers, for example, that hedge funds are distinct from other investment funds, and assumes constraints on their leverage in the event of stress.

<sup>104</sup> According to Hombert, Thesmar (2014), “*theories of limits to arbitrage make the critical assumption that arbitrageurs cannot design their capital structure ex ante to avoid value-destroying liquidation in case of underpricing. In practice, however, some arbitrageurs do adjust their ex ante capital structure to avoid liquidating positions when their trades go against them temporarily. In the hedge fund industry, investors often accept constraints on withdrawals. For instance, hedge funds may have lockup periods of typically one year during which investors cannot recover their funds*”.

<sup>105</sup> The flash crash of 6 May 2010, for example, highlighted the fungibility of the liquidity of S&P 500 index futures (E-mini), S&P 500 ETFs (SPDR) and underlying stocks, the initial shock on futures markets being rapidly absorbed but transmitted to the underlying market. See SEC-CFTC (2010) and Kirilenko, Kyle, Samadi, Tuzun (2011). Foucault, Cespa (2015) highlights the increasing complementarity between liquidity provision and arbitrage.

<sup>106</sup> A “bifurcation” of liquidity is noted here (BIS (2014)), which benefits more liquid stocks at the expense of less liquid ones.

<sup>107</sup> Biais, Glosten, Spatt (2015) “*market microstructure offers a unique opportunity to directly confront microeconomic theory to the actual workings of markets. This facilitates both tests of economic models and the development of policy prescriptions*”.

microstructure<sup>108</sup> precisely assesses sensitivities to assumptions in this area, and analyses - according to the degree of intermediation, centralisation, automation, etc. - the trading modes, and the impact on market equilibria of observed frictions and strategic behaviour. In particular, it emphasises the importance of trading modes for the formation of liquidity (platforms centralising orders, internal search for liquidity, or for blocks with other institutional investors)<sup>109</sup>. The analysis is fundamentally empirical and centred on liquidity and price formation<sup>110</sup>. Here it is worth taking the points put forward by this literature into consideration<sup>111</sup>, particularly because they form the conceptual basis for measuring liquidity, and ensure the consistency of the macro stress test scenarios with the precise empirical observation of the markets.

The **concept of liquidity** is noted here to be **multidimensional** and useful in the specification of relevant **indicators** (instant, quoted and effective, spreads and depth; intertemporal impact and resilience measures<sup>112</sup>). However, the analysis fails to establish a synthetic indicator of aggregate liquidity covering all of these dimensions<sup>113</sup>.

**The costs of impact** are particularly important for asset managers, who are structurally initiators of large-size orders<sup>114</sup>. They include two components: one informational, on the fundamental, non-observable, value of market prices; the other strategic, on the exploitation by the market of information asymmetries against order initiators. To manage the risks of this type of strategic interaction with their market counterparties (risk of adverse selection), funds tend to spread their executions over the continuous trading sessions and to fragment their orders<sup>115</sup>. It is therefore important to specify, particularly in Europe, the **effective conditions for order execution** - impact measures, prevalence of informational effects (counterparties ability to spot funds' liability constraints), execution and risk management strategies - and their effects on market equilibrium - sensitivity to intraday market variations<sup>116</sup>, order flow correlation, etc. This could contribute especially

<sup>108</sup> Grillet-Aubert (2010) proposes a review of the contribution to the regulatory debate and supervision of the markets of microstructural analysis of technological and organisational developments in the markets.

<sup>109</sup> See, for example, conferences on "Market Microstructure : confronting many viewpoints".

<sup>110</sup> Here we consider the market liquidity of assets held by the funds. In the first instance, financing liquidity, which may affect the financing of funds, for example if they have recourse to the lending and borrowing of securities or secured financing, is a separate issue (dealt with in 2.2.2 in a market making perspective).

<sup>111</sup> In fact, the conclusions from this literature are often specific to the observed market structures and are therefore difficult to integrate in macroeconomic models.

<sup>112</sup> Liquidity is a multidimensional concept. Schematically (Bessembinder, Venkataraman (2010), Goyenko et al. (2009)), three types of indicator: quoted and effective indicators of instant cost (bid-ask spreads), of depth, and intertemporal metrics (impact costs, Amihud, viscosity, etc.), which are particularly sensitive to strategic behaviours (information asymmetries).

<sup>113</sup> See discussion by Idier, Jardet, Le Fol (2009).

<sup>114</sup> Whether they trade large quantities in liquid markets or in less liquid markets, order fragmentation aimed to reduce individual trade impacts induces order flow autocorrelation. Metrics are proposed by Darolles, Le Fol, Mero (2015) to assess liquidity distinguish short-term (intraday) frictions from the effects of positive autocorrelation of daily returns. Lehalle (2014) reviews useful indicators for analysing institutional orders by making considering execution phases of large meta-orders (transient, temporary, relaxation, permanent), and using "propagation models" (positive autocorrelation of trade signs, and small scale negative returns).

<sup>115</sup> Impact cost measurements limit the macro stress tests under review (see 1.3.2). For example, considering that the "Reliable point estimates for the price impact of liquidation are not available in the literature for most of the assets we consider", Cetorelli, Eisenbach (2017) uses approximations. Bouchaud, Farmer, Lillo (2016), for example, demonstrates that aggregation over time periods of several days does not take into consideration the concavity (according to volumes traded) of the impact measures over shorter time periods. The impact measure is therefore heavily dependent upon the time period. Kyle, Obizhaeva (2016) observes that "price impact in large markets [is greater] than in small markets".

<sup>116</sup> The vulnerability of investment funds to market events – the "flash crash" of 6 May 2010 (Kirilenko et al. (2011)) or the "flash rally" on the bond market of 15 Oct. 2014 (Bouveret et al. (2015)) – has yet to be measured, and its systemic nature needs to be discussed. Some managers integrate concerns of this type into their risk management or investment strategies (see Risk.net; Berkeley researchers build flash crash early warning tool; 28/09/17; Risk.net; Quants stymied by lack of alternative risk premia flows data; 16/10/17; Risk.net; University of California's Bookstaber urges use of agent-based models; 04/09/17).

to the specification of relevant time scales and frequencies<sup>117</sup>, where those of “second round” effects (*fire sales*) of the top-down stress test models under review<sup>118</sup> reveal an insufficient appraisal of market trading dynamics.

The requirement outlined in the previous point, of analysing the dynamics **of liquidity provision** in a stress situation, also falls within a market microstructure analysis.

Finally, some tools that are relevant to macroprudential analysis<sup>119</sup> help to increase market resilience, specifying in some respects *trading halts*, *circuit breaker* mechanisms<sup>120</sup> in addition to managers’ liquidity management tools (suspension of redemptions).

### 2.2.5. Relevance and limits of general equilibrium models

The major benefit, and challenge, of macro stress tests is to integrate relevant analyses **in a unified framework**, while taking into account progress being achieved. Multiple limitations of general equilibrium models are highlighted by the literature on behavioural finance (limited rationality), or on the microstructure of the markets (frictions). For example, the high degree of persistence of the order flow reveals, according to Bouchaud, Farmer, Lillo (2016), a lack of market efficiency<sup>121</sup>. A critical approach to these models should increase the “realism” (for example, ensure the consistency of beliefs, the convergence of strategic dynamics) and consider also additional tools, e.g. simulation tools to alleviate certain assumptions on the behaviour of agents. Battiston, Farmer, Haldane et al. (2016)<sup>122</sup> propose, for example, implementing advanced simulation techniques integrating analysis in networks and Agent-Based Models (ABM)<sup>123</sup>, which would fine-tune the representation of market interactions based on simplified but effectively observed rules of behaviour of agents (that could reflect a limited rationality).

The specification of the models is therefore based on significant compromises between, on the one hand, granularity, or the degree of realism of the representation of agents and markets (which therefore makes the models less tractable) and, on the other, the typical objective of a general equilibrium framework, that models schematically the potentially destabilising interactions (*fire sales*, contagion) at system-wide level. Developing macro stress tests should be a long-term objective, dependent in particular on: i) the availability, granularity and quality of data needed (see 2.4 below); ii) computing capacities; iii) the ability to integrate multiple relevant theoretical and empirical contributions; iv) and,

<sup>117</sup> According to Bouchaud, Farmer, Lillo (2016) “*revealed market liquidity is extremely low, large orders to buy or sell can only be traded incrementally, over periods of time as long as months. As a result order flow is a highly persistent long-memory process*”.

<sup>118</sup> In the models under review, redemption cycles are arbitrarily interrupted - at the end of a “round” (Cetorelli, Duarte, Eisenbach (2016) or two (Baranova, Coen, Lowe, Noss, Silvestri (2017) - when the impacts are assessed. A brief period (of a few days at most) would justify integrating subsequent “rounds” until a new equilibrium is reached, therefore integrating to the model the corrective forces that ultimately stabilise the system. Failing that, the uninterrupted cycles of redemptions result in asset prices or fund AuMs that are null.

<sup>119</sup> Farhi, Tirole (2017) separates the macroprudential and market analyses. By including the market analysis in a model of the bank and non-bank financial system, it underlines the need to increase the resilience of its structure (concentration of liquidity, use of offsetting) and to separate market and banking activities. Stress tests in the two sectors are recommended to reduce the risk of regulatory arbitrage.

<sup>120</sup> The specification of mechanisms for interruption of trading/volatility gives rise to a rich literature (Draus, van Acher (2012), Subrahmanyam (2013), Clapham, Gomber, Haferkorn, Panz (2017), Brugler, Linton (2017)).

<sup>121</sup> The agents are: “*at best weakly informed and all have a similar and extremely noisy impact on prices*” and the formation of prices depends primarily on the endogenous observation of the market process by its participants (“*rather than from external news*”).

<sup>122</sup> Such tests are still very dependent on the availability of granular data (on the bilateral exposures to the assets and liabilities of all the entities under consideration, etc.).

<sup>123</sup> A benefit of ABMs is based on their ability to increase the flexibility of the assumptions on agents’ rationality. Bookstaber, Foley, Tivnan (2015), Thurner, Farmer, Geanakoplos (2012), Fischer, Riedler (2014), Aymanns, Farmer (2015) underline the importance of the choices relating to leverage and risk management.

incidentally, the ability to coordinate institutionally the initiatives of the authorities concerned.

As such, multiple specifications are relevant. The realism of general equilibrium models must be increased both by extending the scope of the financial system (types of agents/products) covered, in order to consider it as both comprehensive and closed, and by anchoring the analysis in the granular observation of market participants' behaviours and market structures<sup>124</sup>. Alternatives that increase the flexibility of the less-plausible assumptions of these models must also be considered. To increase credibility of the tests carried out, it appears appropriate to consider their complementarity with the **bottom-up, modular and decentralised tests**, which build upon current sectoral supervisory tests and may rely on interaction with supervised entities<sup>125</sup>. Such tests would effectively, in a common framework, define analytical modules to be taken into consideration according to the specific agent's features - particularly those of "non-banks" (diversity, lack of explicit guarantee, etc.) - but in fact such tests have a limited capacity to integrate market dynamics.

Regardless of choices made, the development of methodologies and the credibility of the tests require a degree of transparency on the way they are carried out, in order to:

- highlight the level of dependence of the results on the specifications used (diversity of approaches is useful, in principle);
- increase, upstream, the reliability of assumptions and scenarios tested;
- improve, downstream, the understanding of the systemic nature of the risks.

### 2.3. BOTTOM-UP STRESS TESTS: FIELDS FOR DEVELOPMENT

Bottom-up stress tests are initiated by the authorities, who typically mandate or coordinate them with supervised entities, and are based from the outset on **individual, entity level examination** of risks. Within the limits indicated, regarding their ability to take into account market interactions, they integrate certain objectives of financial stability, however. When not applied to inherently systemic entities<sup>126</sup>, they effectively **enable analysis and/or aggregation of measures of impact across the entities** in a market, and therefore evaluate the direct collective effects of the simulated shocks<sup>127</sup>, thus providing relevant information for the purpose of financial stability analysis, as well as for supervision<sup>128</sup>.

**With regard to asset management**, this perspective is **already reflected in European fund regulation**. Requirements for individual stress testing of funds apply to all types of fund (UCITS, MMFs, AIFs) but/nevertheless regulatory reporting requirements are on the increase,: while AIFMD stress test reports are not specifically subject to a requirement in terms of format<sup>129</sup>, those covered by MMFR are based on standardised parameters for scenarios of liquidity stress on the assets held (with regard to credit, interest rate and exchange risk; redemption orders; *spread* against underlying indices; and macroeconomic

<sup>124</sup> Some compromises are necessary: a model of general equilibrium (rather than partial equilibrium) ensures a consistent representation of the financial system, but can result in less granularity or "realism".

<sup>125</sup> The analysis of the scenarios by the supervised entities accounts for "real" market conditions and factors that are difficult to quantify: multiplicity of exposure types (use of derivatives and external financing, service provision, etc.), identification of liability constraints, liquidation behaviours, etc.

<sup>126</sup> Regarding the process to identify globally systemic entities, see FSB (2017). Systemic entities are also likely to be identified at regional (e.g. credit institutions under CRD-IV in Europe) or national level (e.g. under US FSOC).

<sup>127</sup> The stress test can also be used here to detect not only the aggregate exposures but also the correlations between strategies and other liquidation or deleveraging behaviours.

<sup>128</sup> See aforementioned supervision activities.

<sup>129</sup> UCITS are not subject to any formal obligation to report or provide information to unitholders, but best practices have been developed in this area (see AMF (2017a)).

shocks<sup>130</sup>). This level of standardisation means that the regulator can carry out its assessments transversally, and independently of the stress tests carried out by the funds to their own ends, hence such stress tests can be qualified as "bottom-up".

**Risk indicators** have been developed in connection with the supervisors' stress tests and IMF FSAPs (see 1.3.1), for which Bouveret (2017) provides a relevant summary. The study is based on stress tests carried out on money market funds, and in some cases also on other types of fund, particularly those exposed to the risk of bond illiquidity (High Yield, EME, etc.); it proposes, based on the data available, methods for calibration of redemption shocks, indicators of resilience to shocks (reserves of liquid assets dampening shocks), and estimated times to asset liquidation (see table 2<sup>131</sup>) as well as, incidentally, risk indicators of interconnection with the banking sector.

**Table 2. Methods used for liquidity stress tests for funds in recent FSAPs**

Country & reference	Redemption shock				Liquidity buffers		Liquidation method	Measure of resilience
	Threshold	Method	Scope	Freq.	Method	Scope		
U.S. (IMF (2015b))	1%	Historical distribution	Fund style	M	TTL	Agg	Prorata and waterfall	Selling pressure/ Dealer inventories
Sweden (IMF (2016b))	1%	Historical distribution	Fund style	Q	TTL	Agg	Prorata and waterfall	Selling pressure/ Turnover
Luxembourg (IMF (2017))	1% and model	i) Historical distrib. ii) macro approach	Indiv. funds fund style	M	Tiered approach (HQLA and short-term assets)	Agg and sec	Prorata and waterfall	Redemption coverage ratio
Ireland (IMF (2106a))	5/10/20%	Ad hoc	Indiv. funds	D	TTL	sec	Prorata	Time to Liquid.

Source: IMF. Legend: Freq.: frequency; Q: quarterly; M: monthly; D: daily; TTL: Time-to-Liquidation (estimated time for liquidation of assets); Agg: aggregated; sec.: security-by-security data

These stress tests, within the framework of a general analysis of the resilience of the financial sector (FSAP)<sup>132</sup>, are used primarily for the analysis of certain vulnerabilities of money market funds and bond funds to contagion linked to bilateral exposures to banks<sup>133</sup> (*spillovers*) and fire sales, and for the development of risk management policies. Current recommendations highlight above all the need for authorities to develop tools for risk measurement and macro stress testing.

The IMF puts the results of the stress tests into context and interprets them with a degree of caution. The use of stress tests **could, however, have undesired effects**. In fact, it is important to consider the **incentives provided to managers by the authorities' risk assessment models**. In other words, the risks are not independent of the risk assessment. Certain undesired normative effects can for example result from the overly exclusive use of certain resilience indicators (*cash buffers*); these may draw too much attention to the scarcity of liquid assets and may negatively affect the incentives provided to managers

<sup>130</sup> Article 28 of the MMFR provides that ESMA shall develop guidelines on this point.

<sup>131</sup> We must emphasise the need to take into account the exact (by type of client) structure of liabilities and its changes over time in order to predict extreme flows and contagion, as we are only considering here past averages (see 2.2.3 on the behaviour of managers, and 2.4 on needed data collections).

<sup>132</sup> Luxembourg FSAP (IMF (2017)): "The banking sector and investment fund sector stress tests were integrated in a number of ways. These included (i) a common macro and financial scenario, (ii) the transmission of a fund redemption shock to bank deposits, (iii) market data-based analysis of spillovers and distress dependence, and (iv) network analysis of balance sheet exposures."

<sup>133</sup> Luxembourg FSAP (IMF (2017)): "(...) the investment fund industry gives rise to three main vulnerabilities with implications for global financial market and domestic financial stability. First, funds that have (...) concentrated exposures might find it difficult to liquidate (...) a large share of individual bonds (...). In the case of common exposures, the distress of a fund can spillover to other funds through fire sales. Second, since most investment funds in Luxembourg (...) can be exposed to liquidity mismatches in asset classes such as EM debt or HY bonds (...) a large redemption shock could require funds to rapidly liquidate portfolios, resulting in a large price impact and price spirals ("fire sales") (...). Third, funds can be exposed to the health of banks (...): on the asset side, exposures from (...) bank debt securities and through bank deposits, in addition to derivatives transactions (...). On the liability side, (...) investment funds have the ability to put in place overdraft facilities and credit lines with banks (...)"

and/or unitholders. The risk would therefore, for example, relate to favouring liquidation behaviours (*waterfall, hoarding*) that increase the first-mover advantage at the expense of allocations that are generally fairer and more in line with the management mandate of unitholders (*pro rata*). Preserving the diversity of fund resilience indicators would thus help to avoid certain procyclicality factors when a shock is anticipated by unitholders. More generally, it is important to consider the inherent regulatory arbitrages, where securing transactions increases the polarisation between normal market environments and stress situations (see 2.2.2)<sup>134</sup>.

The scope of the indicators still focuses on certain vulnerabilities of categories of money market fund and bond fund to a scenario involving an unexpected downturn of risk premia on bonds, leading to a redemption shock on fund units. It is necessary here to broaden the range of tools available. In fact, the risks could relate to funds that are less specifically exposed to liquidity risk (not open to daily redemptions by unitholders) but/yet are still vulnerable to downturns in asset prices (typically investing in unlisted assets). By way of illustration, this scenario is explored in box 3.

Generally, the following observations and guidelines are put forward:

- New data will be useful, particularly on fund liabilities, to identify unitholders and gain a better understanding of behaviours with regard to liquidity risk management, liquidation (*waterfall vs. pro rata*), reallocation of unitholders' redemption proceeds, and use of liquidity management<sup>135</sup> tools in the event of a crisis (LMT) (see 2.2.3). Such data will help qualify the risk factors more accurately and "positively" based on the observation of asset-liability imbalances and not only resistance to asset shocks.
- Alternative indicators improve the integration of the specific features of the fund:
  - o Indicators showing use of derivatives will help to evaluate the amplifying effects of *deleveraging* or the stabilising effects of *hedging*<sup>136</sup>;
  - o Indicators showing the use of secured financing will help to evaluate the impact of shocks on the markets in safe assets used as collateral;
  - o Alternative liquidity indicators would also be relevant. Metadger, Moloney (2017) suggests, for example, limiting the use of HQLA indicators that do not accurately integrate the liquidity properties of the fund's assets<sup>137</sup>, and proposes the use of more "*market-based*" indicators for other bond funds;
  - o A number of other characteristics of the funds must be examined as well - passive or active management strategies, alternative management strategies, etc.<sup>138</sup>.

<sup>134</sup> NB. securing liquidity risk tends to make fund risk management more similar to that of MMFs. New provisions applicable to US *mutual funds* specify risk management requirements based on self-defined classes of asset liquidity. They serve as clear supervision objectives but their effect on unitholders' incentives (first-mover advantages) in the event of stress has yet to be determined.

<sup>135</sup> Note that the existence of liquidity management tools is likely to reduce liquid asset holdings aimed to honour unitholders' redemptions, and is thus likely to have a positive effect on fund performance (see 2.2.3).

<sup>136</sup> In the Luxembourg and Ireland FSAPs, the IMF calls for deepening the analysis on this point. IOSCO is currently mandated by the FSB to carry out work on the relevant risk indicators.

<sup>137</sup> The HQLA approach is suitable for MMFs and Advanced Sovereign funds, less so for HY and EME funds: "*Liquidity indicators based on credit ratings and sector do not take into account market depth, trading volume, price impact or transaction costs (...). HQLA type classification methodology may be too blunt to capture the liquidity of complex debt security portfolios, for example excluding all securities issued by financial sector companies*".

<sup>138</sup> For example, the capacity of index funds and ETF funds to replicate ("at any cost") their underlying index could be considered, and compared in particular with the liquidity provided by the banks' index swaps (now

- The integration of market interactions and equilibria is limited for this type of test, so there is particular benefit in carrying out bottom-up tests, similar to the test by the French HCSF, across the different types of relevant market participant on the market in question (dealers, own-account traders, banks, insurance companies, etc.). A specific macroprudential benefit can, in fact, be found in comparing the results of the different bottom-up stress tests - including ensuring consistency (for example, identification of market counterparties of investment fund sales), and analysing the interactions across the different sectors (and/or jurisdictions).

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subject to regulatory disclosure requirements). Based on Marginal Expected Shortfall indicators, Dunne, Shaw (2017) demonstrates that: *“risks vary significantly depending on the investment focus (...) Equity funds contribute disproportionately (...) fund size is seldom significant (...). Open-ended funds and funds catering to Retail investors have relatively higher exposures (...). Funds with high levels of interconnectedness through holdings of foreign assets (...) have relatively high levels of exposures (...). Leverage is statistically significant (...). While holding cash and the use of derivatives have an alleviating effect”*.

**Box 3: Hypothetical example of a stress test on private equity exposures to a downturn in risk premia on leveraged debt**

**1) Narrative:** assets under management of *private equity* funds have increased significantly in recent years. These are now a significant source of financing in Europe, although to a lesser extent in the United States (see table 3). These funds fall under the following types: i) *Leveraged Buy Out* funds (LBOs), which concentrate high volumes of financing in a limited number of transactions; and ii) venture capital funds, which finance smaller projects but in greater numbers (supporting the initial growth of small companies).

In this context, a tension reflects investors' search for yield, between on the one hand funds' *dry powder* (capital raised available for investment), and on the other, the valuations of target investments (unlisted asset).

Multiple risk factors may be at play here, reflecting the specific feature of the debt generally incurred by the companies targeted for investment by these funds. On the one hand, the target companies may contract **excessive levels of debt** because of the financing facilities offered: low interest rates, weak restrictions imposed by debt clauses (covenants), etc. Furthermore, this type of risk can foster a distinct focus on high-risk (leveraged or *high yield*<sup>139</sup>) debt - which may be made up of bank credit that does not go through the markets, therefore does not fall within the exclusive remit of market authorities. Moreover, managers may be faced with conflicts of interest, in this context. For example, Driessen, Lin, Phalippou (2012) mention a risk of **overvaluation of assets** (e.g. unlisted) throughout the life of the fund. This could result in sudden revaluations of the fund's assets under management as they approach liquidation, with possible effects on financial stability. The following proposes focusing a stress test on this more specific scenario.

**Table 3 - Activity of private equity funds**

<b>• Activity at a global level (source: Preqin, USD)</b>	
Assets under management (mid-2016)	2.49 trillion (all-time high)
Dry powder (end-2016)	820 billion (755 billion end-2015)
Capital raised (collections closed, 2016)	347 billion - by 830 funds
Concentration (capital raised by 10 biggest funds 2016)	26% (vs. 19% in 2014)
Average size (2016)	471 million (previous maximum)
Capital payouts	257 billion (H1 2016, after a record 472 billion in 2015)
Annual performances	Exceeded expectations of 95% of investors (81% end-2011)
Investor expectations (surveys)	48% forecast increasing their allocations to private equity in the long term 6% forecast reducing their allocations to private equity in the long term
Valuations (source: PitchBook)	7.6x EBITDA in United States (maximum over 10 years)
<b>• Activity in Europe (source: Invest Europe*, EUR)</b>	
Capital raised	74 billion (+38%) incl. 56.3 by LBO (+71%), mainly by the biggest funds
Distribution of investors by category	Growing strongly: pension funds (1/3); stable: funds of funds (20%), insurance companies (12%), private wealth (10%), SWF (10%), banks (5%)
Distribution of investors by jurisdiction of origin	French: 2nd after American (United States). US investors finance more LBOs, and French investors finance more venture capital
Valuations (source: press)	11.6x EBITDA (Fitch) but large deals at 18x
<b>• Activity in France (sources: AMF, France Invest)</b>	
- <b>Approved vehicles</b> (end-Sep. 2017, source: AMF, EUR)	
• AIFs open to non-professional investors (FCPR, FCPI, FIP)	
- Assets under management	7.1 billion
- Number of funds	796
• Professional private equity AIFs	
- Assets under management	48 billion
- Number of funds	807
- <b>Private equity</b> (H1 2017, source: France Invest)	
Funds raised	8.1 billion (14.7 in 2016)
Funds invested	6.4 billion (12.4 in 2016)
Disinvestments	4.3 billion (9.0 in 2016)

Source: AMF

**2) Characteristics of a stress test of private equity fund valuations:**

The following section puts forward, for illustrative purposes and based on the narrative above, a *bottom-up stress test* based on the criteria identified in 1.2 (diagram 1).

**Governance:** *private equity* fund activities, particularly in the LBO segment, can be easily and frequently carried out cross-border, both in terms of assets (cross-border investment by funds) and liabilities (investment in funds by non-residents). Furthermore, the institutionalisation of investment in *private equity* would indicate possible channels for contagion within the financial sector.

This argues in favour of an implementation at European level, under the aegis of the ESMA/ESRB, or at least on a cross-sectoral basis, under the aegis of national macroprudential authorities.

**Specification:**

- **Risks/scenarios:** risk of overvaluation of assets (market/liquidity). Market participants in *private equity* rarely use stress tests during the life of the fund, given the generally closed nature of their activity. As such, a

<sup>139</sup> Appendix 7 of FSB (2016) on "Leveraged finance and institutional investment: recent trends and risks" proposes an initial review of the risks associated with *leveraged loans* and *high yield bonds* at a global level.

*reverse stress test* would accurately identify the fundamental and technical factors that are likely to lead to a significant revaluation of assets under management (AuM). Furthermore the impact of a hypothetical shock<sup>140</sup> on the AuM could be evaluated. This could be expressed directly as a differential between the NAV and the stressed NAV as a percentage of NAV, or indirectly by the impact of an increase in interest rates (revaluation of risk premia) on the principal risk exposures in the portfolio. It would occur if the funds were only partially redeemable, and would also have to be assessed in the scenario of a liquidation of the fund over a fixed period<sup>141</sup>. Different estimates of possible valuation biases could help to calibrate the shocks tested<sup>142,143</sup>.

- **Scope/focus:** the supervised entities could be considered as a priority:
  - o **Private equity funds**<sup>144</sup>: based on “positive” identification of the qualified legal *private equity* structures among AIFs, a sample of funds could be established taking into consideration several vulnerability criteria on the assets (AuM, credit risk structure of the portfolio, etc.) and the liabilities (types of liquidity and liquidity constraints of unitholders, concentrations of holdings, etc.);
  - o An intersectoral test would also provide a view of vulnerabilities of:
    - **institutional investors:** insurance companies, pension funds (IORPs), investment funds (funds of funds) most exposed to the risks of *private equity* funds. It would also be necessary here to evaluate the liability constraints of the funds, i.e. the sensitivity - according to the characteristics that are specific to their contractual and regulatory commitments - of the different types of investor to asset valuation shocks (flow-performance relationship, etc.);
    - **credit institutions** financing *private equity* transactions (by bank credit) - currently, it would seem that few banks hold *private equity* fund units. It would therefore be necessary to assess the vulnerability of the banks to a deterioration in the credit quality of the loans concerned.
- **Data:** AIFMD data collection covers *private equity* funds. It does not, however, positively identify *private equity* vehicles<sup>145</sup> and primarily relates to risks linked to the leverage of the funds; generally, *private equity* funds have limited leverage, as their leverage is obtained indirectly by the indebtedness of the target companies they invest in. It would therefore seem necessary for market supervisors to collect *ad hoc* data, or let stress scenarios be assessed by the asset management companies themselves.
- **Models and quantification:**
  - o **Private equity funds:** focus is on asset valuation methods (rather than on their liquidity). The primary objective is therefore to characterise the information, assumptions, techniques employed by their asset management and risk management by the supervised entities (reverse stress test).
  - o **Institutional investors:** focus is on the appropriate nature of risk management of *private equity* exposures where search for yield could lead to excessive risk-taking. Thus, there is need to evaluate the capacity of market participants to meet their regulatory requirements (solvency) and their contractual commitments, as well as, if applicable, potential disruptive or systemic effects where implicit guarantees are likely to be given (e.g. on pension replacement rates - see EIOPA stress tests in 1.2.2).
  - o **The systemic dimension** of the test could be linked to interactions between sectors, in particular if downturns in asset prices lead to significant levels of redemptions by institutional investors. The modelling of these interactions could therefore constitute a top-down element of the test.
- **Use of the results:** risk management by supervised entities; monitoring of risks by authorities.

#### 2.4. DEVELOPMENT OF RELEVANT DATA

The observed development of macro stress tests is based on the extension of the data collection as part of the reforms to the financial system implemented after the financial crisis, particularly in the fields of the financial markets and collective management. On a global scale, common data standards (LEI, UPI, UTI) have been established. In Europe, different requirements for the collection and reporting of market data (EMIR, SFTR, MiFID,

<sup>140</sup> Insofar as fund assets are rated, the simulation could consist in proposing transition matrices to simulate credit shocks (*rating*) for each type of security. Less automatic alternatives could be proposed.

<sup>141</sup> On this point, stress tests match best practices recommended by the AMF to fund managers (see AMF (2017)).

<sup>142</sup> An alternative fundamental valuation of fund assets would give a theoretical basis to the test. Driessen et al. (2012) values fund assets using an econometric discounted dividend model. Other approaches may be considered, for example based on analysis of the changes in asset valuation multiples - which are at unprecedentedly high levels according to various sources (e.g. Pitchbook (2017) and various press articles).

<sup>143</sup> NB: calibration on historical data is not necessary in itself; theoretical shocks can be used to assess new risks.

<sup>144</sup> Private equity funds indicate different types of vehicle, with their legal frameworks primarily reflecting national specificities (see IOSCO (2010), CACEIS (2016)).

<sup>145</sup> The European labels EuVECA, EuCVA, EuSEF and ELTIF, introduced in the framework of the promotion of the Union of Capital Markets, do not currently capture the universe of relevant funds.

etc.) and asset management data (AIFMD, MMFR, RIAD, SHSDB, etc.) have been put in place. These initiatives have been extended at an international and European level, aiming in particular to improve the usability<sup>146</sup> and integrity of the data collected (for example under EMIR) and to establish new data collection processes and requirements<sup>147</sup>.

Based on the fields for development identified in 2.2, the macro stress tests would seem to be able to obtain significant benefits from the increased capacity to:

- Analyse liquidity at more granular levels. A significant benefit may be found in considering the specific features of securities traded (e.g. security-by-security)<sup>148</sup>, behaviour of the different types of agent, individual characteristics of funds (strategy, target investors, (risk) management tools);
- Integrate use of multiple relevant databases (on different types of agent, exposures, etc.), in some cases in detailed representations of (multilayer) networks of counterparties;
- Specify factors that have an impact on use or interpretation of data (chains of intermediaries, end-investor unit holdings, market structures, incentives (fees, governance, etc.) affecting market participants strategies).

The development of macro stress tests is concomitant to that of relevant data. It also contributes to the specification of the data requirements. For example, information on redemptions (liabilities) of the funds is particularly important<sup>149</sup> in basing an analysis of liquidity risk on an accurate evaluation of asset-liability mismatches - and the ability of fund managers to anticipate and/or manage these<sup>150</sup>. Here it will be important to evaluate the extent to which the private initiatives in progress can provide relevant data<sup>151</sup>. More generally, macro stress tests aim to articulate macrofinancial data (and data on national accounting) and microeconomic data (particularly related to supervision). In this regard, Goksu, Heath (2017), in connection with the extension of data collection to the non-bank financial sector and going beyond the G-20 Data Gaps Initiative, call for holistic approaches to data collection, including for the needs for stress testing.

<sup>146</sup> In particular, work carried out by IOSCO at the FSB's initiative, and in the EU as part of AIFMD's review, to specify relevant indicators to measure investment fund leverage (see FSB (2017d)).

<sup>147</sup> At an international level, the progress of data collections was reviewed by IMF-FSB (2017). CPMI-IOSCO (2017) reports on the harmonisation of data collected on OTC derivatives. In asset management, the main data gaps identified by IOSCO (2016) relate to open-ended collective investment funds, Separately Managed Accounts, and alternative investment funds. On top of collecting money market and financial account data, the ECB has developed the RIAD (Register of Institutions and Affiliates Database) and SHS (Securities Holdings Statistics).

<sup>148</sup> This point is underlined by Fricke, Fricke (2017).

<sup>149</sup> The IMF reiterates this need for data: the Ireland FSAP suggests "*on the liability side, [to] step up monitoring of the characteristics and concentration of the investor base. [footnote: While concentration risk pertains to CIV assets and liabilities, and from the perspective of run risk is even more important for the latter (...), regulators have historically tended to focus more on the former]*". The Luxembourg FSAP: "*The authorities are also encouraged to continue recent efforts to deepen their analysis of investment fund liquidity risk, (...), and the concentration and categorization of beneficial investors*".

<sup>150</sup> The nature and the management of the client relationship can play an important role here.

<sup>151</sup> The French Asset Management Association (AFG (2017)) notes "*Blockchain platform projects that are already very advanced and ambitious (...) dedicated to the management of subscription/redemption transactions on UCIs and the maintenance of issuer registers in order to reduce administration costs and other processes in the distribution of funds*". A use for risk management purposes is envisaged, and according to Darolles (2017a): "*The results obtained (...) optimise the duration of the investments on the assets side (...) The model used enables the prediction by major Client categories of the number of subscriptions and redemptions*". The AFG also highlights, however, the "*differences in operation between record-keeping (...) in Luxembourg (...) and the model involving a central securities depository as used in France*".

### 3. CONCLUSION AND PROPOSALS

#### 3.1. MACRO STRESS TESTS: A NEED FOR CLARIFICATION OF TERMINOLOGY

Refining the definition of macro stress tests contributes to their operational usefulness and prompts, in the first instance, to distinguish between “top-down” and “bottom-up” stress tests.

Definition: tests initiated by the competent authorities...

...favouring the supervision and management of risks at a micro level (bottom-up) or taking into account in a more exploratory fashion the market dynamics between micro segments and the trend (top-down).

- **Definition:** macro stress tests are tests carried out on the initiative of competent authorities for the purposes of risk management, of which the primary and single objective is not to evaluate risks at an individual level of the entities under review, but to measure the risks to financial stability spanning entities (across markets or market segments) in the entire financial system.
- **“Top-down” and “bottom-up” macro stress tests:** Top-down tests are primarily intended, over and above the analysis of direct effects of shocks, to pick up systemic risks arising from market interactions and to bring various approaches of different competent authorities into line with one another. The relevant analysis tools (models) still need to be more firmly/directly anchored in microeconomic analysis (behaviours, market structures), however, depending on the data available, and integrated with a unified approach. These tests are still largely exploratory. Bottom-up tests, which are more robust and directly linked to markets supervision, calibrate and aggregate risk measures at the level of entities under review, primarily in order to evaluate the risks to the financial system. As long as they prompt authorities to request specific contributions from supervised entities, they are limited in their capacity to account for market interactions and dynamics (particularly liquidity spirals and contagion).

#### 3.2. DEVELOPMENT OF METHODOLOGIES FOR TOP-DOWN STRESS TESTS

Top-down tests would represent an **“ideal” test** in so far that they lend the ability to model risks at an entire financial system level, notably by: i) simultaneously taking into account all **relevant market participants** that contribute to the formation of the macrofinancial (dis)equilibria tested; ii) integrating, on a specific empirical basis, other than solvency risk, the **market interactions** (fire sales, contagion).

Several recent initiatives underpin the desire to include **asset management** in these analyses. The macro stress tests under review model all the risks as a vicious circle on the basis of a flow-performance relationship: 1) a redemption shock on fund units leads to sales of assets by portfolio managers; 2) these sales drive asset prices down; 3) the price drop causes funds’ performance to deteriorate and in turn, leads to more redemptions<sup>152</sup>. These tests are primarily centred on the asset management sector, and are subject to significant limitations, particularly related, on the one hand to their anchoring in the accurate observation of procyclical factors and mechanisms, and on the other, to the fact that there is no “closed loop” system: who buys the assets from the sales of the investment funds? How and at which speed does the market (the system) balance out at the end of the day?

<sup>152</sup> The initial shock can also be applied in 3) - to the asset prices or the interest rate risk premia. These models explicitly transpose that of Greenwood, Landier, Thesmar (2015) applicable to the banking sector.

Construction of the relevant models therefore requires **an extension and deepening of research**. The scope of current initiatives is still limited as regards the operational purposes of macroprudential policies. Even so, on the one hand, different empirical initiatives are extending and/or integrating the relevant analytical perspectives. On the other hand, within the limits mentioned, the work carried out has already contributed, albeit partially, to macroprudential policies.

**Proposed guidance to the macroprudential authorities conducting top-down macro stress tests, and to researchers in this area, aim to:**

- **Extend/deepen relevant research initiatives** carried out by competent authorities and the academic world, with a critical and “holistic” approach in the medium term that clarifies their specific contribution to the **development of methodologies** for the macro stress tests, in particular to:
  - Specify the form and reliability of the relationship between flows and fund performance, this being a major argument in favour of the procyclicality of net investment flows;
  - Ensure a true macroeconomic and temporal “closed loop” of models that characterise market equilibrium – in order to avoid too exclusive a focus on certain sectors, assess the time taken for the system to stabilise;
  - Develop, at this stage additionally, models that relax some unduly simplistic assumptions in market equilibrium models (general or partial) related to the rationality of agents or the operation (structure) of the markets<sup>153</sup>;
  - Develop and integrate relevant analytical perspectives in unified models.
  
- **Favour the most credible specifications<sup>154</sup>, hence:**
  - **anchor scenarios in “narratives”** that demonstrate plausibility of the shocks (if not modelled as exogenous) and that **qualify** the economic (financial cycles) or structural nature of market/liquidity risks, credit/counterparty risks, etc. Specifying macroeconomic causes and circumstances of shocks, typically on bond markets, effectively makes assumptions more credible and increases test consistency;
  - specify the **focus** and set boundaries for **scope** of a test. Stress tests, based in physical terms on analysis of dynamic systems, are all the more powerful if they consider **closed systems**. Tests that focus on clearly delineated market segments, particularly less liquid assets or assets that bear little correlation to the rest of the markets (real estate, high yield bonds, emerging markets), are therefore likely to make tests more powerful and meaningful;
  - **make test specifications and limitations more transparent**, primarily those related to the systemic qualification of the risks (i.e. market events), over and above direct effects, factors amplifying and transmitting shocks but also those

Top-down methodologies to be developed in the medium term according to various relevant analytical focus areas...

...for which the operational scope for risk management still largely remains to be developed...

...but that also include a range of indirect benefits.

<sup>153</sup> Analysis of incentives and conflicts of interest, and more generally of agents' behaviour, is likely to limit the supposed rationality of general equilibrium models. The microstructure of the markets analyses the liquidity indicators and the information processes of the market depending on the specific characteristics of market participants' incentives and trading characteristics: trading techniques (e.g. algorithmic); market rules; risk management; fee structures; etc. Market microstructure introduces “frictions” in the general equilibrium models.

<sup>154</sup> This point is also likely to affect the governance of the macro stress tests.

related to market stabilisation/balancing, and their temporality. The analysis of sensitivity to specifications (assumptions, models, data) and carrying out *reverse stress tests* increases the benefit of tests in this regard.

- favour specifications that are **relevant to effective macroprudential policies**, e.g. centred on the capacity to inform **arbitrages between financial and international sectors**, particularly related to the identification of entities (financial or non-financial) that are supposed to bear and/or manage risks, and materiality thresholds making public intervention necessary (*backstops*).
- **capitalise on indirect benefits of methodological initiatives**, particularly in terms of development of **market monitoring** indicators, with impact studies if required.

### 3.3. DEVELOPMENT OF BOTTOM-UP STRESS TESTS

These **macro stress tests**, being based on the analysis of risks at individual entity level, are primarily inspired by risk management practices among supervised entities. Their **robust methodologies** thus allow supervisors to **add macroprudential considerations into its management of financial markets' risks into practice**.

They extend prudential tests focusing on banks', insurance companies' and market infrastructures' (CCPs) solvency and stand out by following an objective of assessing market risks that are both less directly and easily quantifiable: they do not only measure the ability to meet capital ratio requirements, but also integrate the ability of market intermediaries to honour their contractual obligations potentially leading to systemic events - such as mutual fund requirements to honour unitholders' redemptions.

In practice, they generally benefit from the use of data from - or the analysis of scenarios by - supervised entities. In this case, their ability to take market dynamics into account is limited. However, data provided to authorities in the framework of MMFR means that to a large extent they are relieved from the need to request it specifically from supervised entities for stress testing purposes. Ultimately, data collected regularly by authorities should allow them to evaluate market dynamics, and these stress tests should therefore **converge with the top-down tests**.

More operational bottom-up stress tests...

**Proposed guidance to authorities carrying out bottom-up tests aim to:**

...but with limited capacity to integrate the market dynamics...

- **consider the specific features of market structures and rules (liquidity risk management tools) and the vulnerabilities and incentives specific to the agents** under review, to anchor analysis of procyclicality and contagion factors in an accurate observation of their behaviours.

...and where the range of risk measurement tools still needs to be enhanced over and above the resilience indicators such as cash buffers.

- **in the specific case of investment funds**, development of use of bottom-up macro stress tests should:
  - **capitalise on a critical analysis and consistency of tests carried out:**
    - **by supervised entities for their own purposes**, particularly in the framework of AIFMD, UCITS, MMFR. In particular, requirements of MMFR in the field of stress testing that integrate normative aspects specific to facilitating the calibration and aggregation of results by regulatory authorities, and thus constitute in this regard a form of macro stress test;

- **at national level, by the IMF** (e.g. as part of the FSAPs, see Bouveret (2017)) **or on an ad hoc basis in many jurisdictions** (e.g. French HCSF, Romanian FSA).
- **on these bases, continue development of relevant indicators:**
  - most operational tools currently available are focused primarily on money market funds and resilience indicators (*cash buffers*, or equivalent);
  - For other fund types, too **normative** a use of these resilience indicators could create undesired incentives and procyclical factors, i.e. risks of *runs* on safe assets. Hence it is necessary to multiply relevant resilience indicators and, further, **to accurately specify the incentives and procyclicality factors**.
  - On this matter, a number of proposals contribute to the development of relevant indicators, highlighting:
    - that liquidity risks are characterised by asset-liability imbalances, so an analysis of determining factors of **fund liability dynamics** is required (redemption behaviours, leverage, etc.) as well as impacts of risk management methods (LMTs, etc.);
    - the need to integrate **vulnerability factors specific to asset markets and types of fund under consideration**, particularly with regard to liquidity properties (cost and depth, impact and resilience, correlations, etc.) and strategies implemented (incl. use of derivatives, SFTs, etc.). It could, for example, be useful to **focus analysis on vulnerabilities due to liquidity transformation** in open-ended funds (see test carried out by the HCSF on open-ended funds with exposures in/to commercial real estate<sup>155</sup>).
  - **Analysis** of different types of entity concerned **across the financial sectors**. The French HCSF demonstrates, for example, the feasibility of a coordinated test focusing, depending on their specific characteristics, on the banking, insurance and capital markets sectors, exposed to risks in commercial real estate.

### 3.4. USE OF THE DATA AND RELEVANT DATA COLLECTIONS

Stress tests are quantitative tests that are **conditional upon available data**. Their limitations often reflect the inability to access and use relevant data, or a lack of data. They relate, for example, to the capacity of the test to take into account the impact of use of derivatives and security financing transactions, and to provide in- depth analysis market liquidity (see CGFS (2015)).

<sup>155</sup> Following Brexit, FCA (2017) reviews the risks on open-ended funds invested in categories of very illiquid asset (real estate, landholding trusts, infrastructures, and financials such as unlisted assets).

**Proposed guidance to competent authorities (macroprudential, statistical, supervisory) aim to:**

The macro stress tests are intended to use, primarily, the data collections established after the financial crisis...

...in return they help to provide an understanding of how relevant these collections are, and make them more consistent...

...and to highlight certain limitations.

- **increase access to and use of available data, in particular by:**
  - **facilitating**, subject to a guarantee of confidentiality, **inter-institutional access** with a requisite level of granularity - especially in order to better anchor top-down tests in detailed empirical observation of supervisory data and increase the capacity of the bottom-up tests to account for market dynamics;
  - **increase capacity to use data**, particularly with the development of identifiers, standards (LEI, UPI, UTI, etc.) and detailed classifications (categories of agents; products). Such progress could enable the modelling of complete networks of **market counterparties**, covering, where needed, **exposures linked to derivatives, multi-layer secured financing transactions;**
  - **developing** the use of granular market data, particularly to account for **specific characteristics and properties** of traded assets (rating, etc.) and **market liquidity**.
- **periodically extend** (based on cost and opportunity studies) **relevant data collection**. With regard to investment funds, **UCITS data** and more generally on fund **liabilities** (subscriptions and gross redemptions; identification of end-unitholders; identification, from among redemptions, of reallocations to other types of fund; etc.) and assets on reinvestments in other funds, are insufficient in Europe. On these points, as on others (use of LMTs, etc.) it is sometimes possible, in the absence of regular data collection, to request data **from the supervised entities on an *ad hoc* basis**.

### 3.5. MACRO STRESS TESTS: GOVERNANCE DEVELOPMENT

Although they have a very suitable framework for implementing macro stress tests...

**Competent authorities** seem, in general, to have the powers and coordination mechanisms needed to conduct macro stress tests - including those needed to request information from supervised entities or coordinate international and national competent authorities across financial sectors (see initiatives by the French HCSF, the ESRB, the FSB, or the IMF). Based on general principles at an international level, a **more specific and unified European framework clarifies the terminology and reinforces the mechanism** on some points, harmonises different practices, and clarifies the issues for stakeholders.

**Proposals to international and European macroprudential authorities aim to:**

...the powers and coordination mechanisms of the authorities in this area could be more specific.

Regulatory use of macro stress tests in the capital markets sector (e.g. based on a required frequency) seems to be premature at this stage, however.

- **promote a more explicit governance framework** to ensure authorities' capacity to carry out macro stress tests that:
  - **encourage progress on methodologies** (bottom-up and top-down), are **inclusive** (considering all relevant initiatives) and **transparent** (based on a dialogue between competent authorities, and with stakeholders (industry, academic) on relevant specifications);
  - are **international**, to establish harmonised practices on general principles. In Europe, European Commission proposals, as part of the **review of the ESAs**, contribute appropriately to the integration of the macro stress tests in the ESAs' risk management processes, in particular those of ESMA;

- are **flexible**, so they can adapt to the diversity of relevant specifications and changes in methodology. At this stage, a set frequency for the tests evaluating market risks is not yet indicated; rather, it is better to conduct regular opportunity studies assessing alternative specifications, centred on the materiality of the risks;

- **integrate the macroprudential use of macro stress tests for risk management purposes in an incremental medium-term strategy.** Transposition of the macroprudential diagnostics (results of the macro stress tests) into the capital markets sector in terms of activation of potential tools (e.g. in the asset management field - leverage cap; macroprudential use of liquidity management tools; etc.) is still at an exploratory stage, and could potentially have undesired consequences. Factors affecting behaviours of market participants are still difficult to narrow down to simple quantitative assessments. Credibility of authorities therefore lies primarily in their ability to consider the relevant risk indicators within integrated macroprudential approaches.

### 3.6. OPPORTUNITIES FOR EFFECTIVE IMPLEMENTATION OF MACRO STRESS TESTS

Some macroprudential authorities have outlined the possibility that the low interest rate environment and the anticipation of low volatility of asset prices associated with high asset prices (compression of risk premia) results in financial market downturns, particularly in segments where investors seeking yield are exposed to certain corporate or sovereign bond risks. With regard to asset management, some vulnerabilities, for example *private equity* funds, could be assessed (see box 3). The systemic dimension of the risks would, however, probably be found in an intersectoral and international analysis.

**In this context, a bond liquidity stress test could be of benefit:**

- **if, within a well-delineated market segment** - i.e. whose vulnerabilities are specified by macroeconomic and structural market trends, an analysis of liquidity provision and demand factors, etc. - **it considered all market participants contributing to form market equilibria** - dealers and own-account traders, investment fund and institutional managers, banks, insurance companies;
- if it were based, in the first instance, on **bottom-up stress tests** whose credibility is rooted in precise risk indicators with respect to the specific vulnerabilities of the agents in scope, therefore on their ability to formulate, if applicable, effective risk management recommendations;
- if it were enhanced, **if possible based on quantitative specifications**, and ultimately by a qualitative **top-down approach** (see IMF FSAPs) to account for the limitations of the methodologies and data, aiming to assess the consistency of all the tests carried out in a macroprudential framework serving the needs of policy trade-offs, particularly between sectors and national jurisdictions.

Concrete tests could be envisaged.

Capitalising on bottom-up tests that target specific vulnerabilities would provide a useful and credible foundation for assessment of the direct effects of a shock in this context.

Even if exploratory, a top-down test would usefully contribute to an assessment of the impact of the market dynamics that cannot be captured elsewhere, particularly between different sectors and jurisdictions.

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## ACRONYMS

ABM	Agent-Based Models
ACPR	<i>Autorité du contrôle prudentiel et de résolution</i>
AEAPP	<i>Autorité européenne des assurances et des pensions professionnelles (EIOPA)</i>
AEMF	<i>Autorité européenne des marchés financiers (ESMA)</i>
AIFM	<i>Alternative Investments Funds Managers</i>
AMF	<i>Autorité des marchés financiers</i>
ANC	<i>Autorité des normes comptables</i>
BCBS	Basel Committee for Banking Supervision
BCE	<i>Banque centrale européenne (ECB)</i>
BHC	Bank Holding Company
BIS	<i>Bank for International Settlements (BRI)</i>
BRI	<i>Banque des règlements internationaux (BIS)</i>
CCP	<i>Central Counterparty Clearing</i>
CERS	<i>Comité européen du risque systémique (ESRB)</i>
CGFS	<i>Committee on the Global Financial System (BIS)</i>
C-NAV	<i>Constant net asset value</i>
CPMI	<i>Committee on Payments and Market Infrastructures</i>
CSF	<i>Conseil de stabilité financière (FSB)</i>
CSFF	<i>Commission de surveillance du secteur financier</i>
DB	<i>Defined Benefits (fund)</i>
DC	<i>Defined Contributions (fund)</i>
DFA	<i>Dodd-Frank Act</i>
DMM	<i>Designated market makers (NYSE)</i>
EBA	European Banking Authority
EBA	European Banking Authority
ECB	<i>European Central Bank (BCE)</i>
EIOPA	<i>European Insurance and Occupational Pensions Authority</i>
ELTIF	<i>European Long-Term Investment Fund</i>
EMIR	<i>European Market Infrastructures Regulation</i>
ESMA	<i>European Securities and Markets Authority (AEMF)</i>
ESRB	<i>European Systemic Risk Board (CERS)</i>
ETF	<i>Exchange-Traded Fund</i>
EU	<i>European Union (UE)</i>
EUSEF	<i>European Social Entrepreneurship Funds</i>
EuVECA	<i>European Venture Capital vehicles</i>
FCA	<i>Financial Conduct Authority</i>
FMI	<i>Fonds monétaire international (IMF)</i>
FSAP	<i>Financial Sector Assessment Program (IMF)</i>
FSB	<i>Financial Stability Board (CSF)</i>
HCSF	<i>Haut conseil de stabilité financière</i>
HFT	<i>High Frequency Trading</i>
HQLA	<i>High-Quality Liquid Assets</i>
IMF	<i>International Monetary Fund (FMI)</i>
IORP	<i>Institutions for Occupational Retirement Provision</i>
IOSCO	<i>International Organisation of Securities Commission (OICV)</i>
LBO	<i>Leveraged BuyOut</i>
LEI	<i>Legal Entity Identifier</i>
LMT	<i>Liquidity Management Tool</i>
MIF	<i>Markets in Financial Instruments Directive</i>
MiFID	<i>Markets in Financial Instruments Directive</i>
MMFR	<i>Money markets funds regulation</i>
NAV	<i>Net asset value</i>
NCA	<i>National Competent Authorities</i>
OICV	<i>Organisation internationale des commissions de valeurs (IOSCO)</i>
OPCI	<i>Organisme de placement collectif immobilier (French real estate mutual fund)</i>
OPCVM	<i>Organisme de placement collectif en valeurs mobilières (UCITS)</i>
OTC	<i>Over the counter</i>
RIAD	<i>Register of Institutions and Affiliates Database (ECB)</i>
SCR	<i>Solvency Capital Requirement</i>
SEC	<i>Securities and Exchange Commission</i>
SFTR	<i>Securities Financing Transaction Regulation</i>
SHSDB	<i>Securities Holdings Statistics Database</i>
UCITS	<i>European directive on undertakings for collective investment in transferable securities</i>
UE	<i>Union européenne (EU)</i>
UPI	<i>Unique Product Identifier</i>
UTI	<i>Unique Transaction Identifier</i>