Defining and measuring systematic risk

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Defining and Measuring Systemic Risk

With the planned implementation of the European Systematic Risk Board (ESRB) in 2010, European authorities are trying to identify and avoid future financial crises before they start. This board, under the lead of the European Central Bank (ECB) will have to deal with the macro-prudential supervision of the financial sector in Europe and is mandated to detect "systemic risks". However, the ECB does not have a clear concept of systemic risk itself and even in the academia there exists no generally accepted definition.

Moreover, in his speech at the CEPR/ESI 13th Annual Conference on 'Financial Supervision in an Uncertain World' on 25-26 September 2009 in Venice, ECB Executive Board Member Mr. Lorenzo Bini Smaghi pointed out that "firm-level data (...) have been recognized as essential for more accurate assessments of the potential impact of risks materializing. (...). It should include better data coverage of non-regulated financial sectors, as well as more granular information on key node-institutions in the financial system and on potential interlinkages between them."

Bini Smaghi (2009) first stressed the conceptual issues of systemic risk, after which he stressed the tasks of the ESRB being risk detection, risk assessment and ultimately issuing risk warnings. This briefing paper will be structured in the same way. First, the different definitions of systemic risk will be discussed, to be able to pinpoint the common components of systemic risk. Then, we will move to

risk detection and assessment, for which accurate indicators should be developed together with the gathering of appropriate data. Finally, this new way of defining and measuring systemic risk should be translated into new ESRB policy, taking into account that the indicators can and should be refined over time.

Defining Systemic Risk

The ESRB needs a clear concept of systemic risk to be able to measure it properly. There exist various definitions of systemic risk, which all share some common features. As Mr. Bini Smaghi also stressed, the definition introduced by the G10 provides a good starting point:

"[Systemic risk is] the risk that an event will trigger a loss of economic value or confidence in, and attendant increases in uncertainty about, a substantial portion of the financial system that is serious enough to quite probably have significant adverse effects on the real economy".

Important parts of this definition are the loss of confidence, increases in uncertainty, the fact that a substantial portion of the financial system is concerned and ultimately the significant adverse effects on the real economy. The last part warrants intervention by the ESRB >

[1] The author gratefully acknowledges the very helpful comments of Mr. Edin Mujagic, MSc and the excellent research assistance of Mr. Rob Nijskens, MSc.

in an early stage. This definition is also quite similar to that of the ECB, which is phrased in terms of financial stability (i.e. the absence of systemic risk):

"[Financial stability is a] condition in which the financial system – comprising of financial intermediaries, markets and market infrastructures – is capable of withstanding shocks and the unraveling of imbalances, thereby mitigating the likelihood of disruptions in the financial intermediation process which are severe enough to significantly impair the allocation of savings to profitable investment opportunities"

In this definition it is clear that the financial system is stable when it can withstand the shocks that are mentioned in the G10 definition of systemic risk, i.e. those shocks that cause impairment to economic activity through affecting the ability of the financial system to allocate funds. The definition coined by Adrian and Brunnermeier (2009) is quite concise:

"The risk that institutional distress spreads widely and distorts the supply of credit and capital to the real economy"

It is similar to that used by Acharya et al. (2009):

"[The risk] of widespread failures of financial institutions or freezing up of capital markets that can substantially reduce the supply of such intermediated capital to the real economy."

Hart and Zingales (2009) use an analogous definition, which also refers to the risk that the failure of one institution leads to a failure of other institutions in the system, having ultimate spillover effects on the real economy.

Borio and Drehmann (2008) have analyzed many definitions and concluded that they all have several elements in common, which are important to create a unifying understanding of systemic risk. All of them consider the whole financial system instead of individual institutions. Furthermore, they stress the risk of spillovers from the financial sector to the real economy and the costs in terms of welfare that are associated with these spillovers. Finally, most of them refer to the risk of financial instability, which is often more concrete and better measurable than financial stability.

Detecting and Assessing Systemic Risk

After having defined what is meant by systemic risk, it is imperative to design good measurement of this risk. This depends among others on sophisticated techniques that help in designing indicators that warn against a systemic crisis, and on the availability of detailed information as input for these indicators. Furthermore, the ESRB should take into account interlinkages between financial institutions; a factor that has been widely overlooked during the last years. However, let us first focus on how to measure systemic risk. We can divide the measurement of systemic risk into two components, which should complement each other. The first consists of detecting early warning indicators for asset bubbles and the second component refers to assessing the individual institutions' contribution to systemic risk. We will pick out the recent contributions to this literature.

Early Warning Indicators for Asset Bubbles

Borio and Drehmann (2009) improve upon earlier research by Borio and Lowe (2004) by constructing leading indicators for banking crises using both credit variables and asset prices. They argue that financial imbalances, which may lead to banking crises, manifest themselves when there is a coexistence of "unusually rapid cumulative growth in private sector credit and asset prices". This means asset price misalignments (usually a boom) exist in a financial system that has limited capacity to withstand the impending asset price reversal (bust). The indicators are measured as deviations of variables from their trends, issuing a signal when this gap exceeds a certain threshold. The authors construct indicators based on credit variables, equity prices and property prices (which is quite novel). They find that these joint indicators work quite well, also out of sample (i.e. in predicting the current crisis) according to standard measures such as the *noise-to-signal ratio*. Especially the indicators including all three categories (credit, equity and property) perform well. However, the authors stress that there are certain caveats. First, they confirm that the role of expert judgment is still quite large, as a complement to the signals the indicators provide. For policy purposes, they thus recommend a threshold range instead of specific points. Furthermore, the indicators could be improved in a few dimensions. One point is that cross-border exposures to asset price movements should be incorporated more systematically, preferably using data on individual institutions at the national level. Here lies an important improvement in terms of information provision, especially for national supervisors. Additionally, global measures of credit growth and asset price movements could be used (see below). Next, making the asset price series (especially property prices) more homogeneous across countries could greatly improve performance of the indicators in comparing countries. Furthermore, the authors stress that further asset price series, such as exchange rates and credit risk spreads, could be useful. Finally, the measures of leverage should be enhanced, especially concerning the leverage within the financial system that may indicate limited shock absorption capacity. This is also addressed in the second part of this section. Very recently, Alessi and Detken (2009) have performed a thorough exercise to improve the early warning indicators for harmful (costly) asset booms leading to systemic crises. They consider a host >

of financial and real variables (a total of 89), for 18 OECD countries as well as for a subgroup of 8 Euro Area countries. A main improvement of their method is that they determine the thresholds for indicators in real time, i.e. they dynamically update the optimal thresholds over time (as more crises have occurred). Another improvement is that they assess the usefulness of the many indicators using different criteria, which are determined by the weights that policy makers attach to type I *(missing crises*) and type II *(false alarm)* errors. In doing so, they confirm the usefulness results of Borio and Lowe and Borio and Drehmann and go even further in their assessment. Arguing that the usefulness of indicators for policy makers is determined by the relative preferences with respected to missing crises and providing false alarms, they set up a usefulness measure that depends on these relative preferences. They contend that central bankers on average have a stronger aversion to false alarms than to missing crises, especially because of credibility concerns. However, these preferences may also become more balanced when considering the severity of the recent financial crisis, which may explain the growing interest in early warning systems. The authors consider one indicator, the global private credit gap, that predicts 82% of the crises correctly and has a 32% share of false alarms as the best performing indicator when preferences are relatively balanced, for both the 18 country sample and the smaller Euro Area sample. It also has an average lead time for its first signal of 5.5 quarters before a crisis actually begins. Following Borio and Drehmann, the authors also construct joint indicators, which is a good way of reducing the noisiness of signals. However, they do not improve much upon the usefulness of individual indicators when using the preference weights. Furthermore, there is a large within-sample crosscountry variation in these indicators, which raises issues when using aggregated data coming from individual countries.

Finally, Alessi and Detken conclude that global financial variables perform best in predicting costly booms, where global credit slightly outperforms global money. However, the authors also stress that signals should be interpreted very carefully and should definitely not be considered as the only input to the policy maker's information set. Furthermore, the codependence among variables should be further explored, as well as other balance sheet items of financial intermediaries (especially concerning leverage). When potentially harmful asset booms that can lead to systemic crises are identified, we also need to single out the financial institutions (FIs) that constitute the highest risk for the system so regulatory action can be taken. Several financial experts have provided contributions to this literature on systemically relevant financial institutions.

Individual Institutions' Contribution to Systemic Risk

Acharya et al. (2009) adopt standard techniques that are used to manage risk within banks to consider the risk of the financial system as a whole. They begin by stressing that current regulation and measurement is aimed at limiting each institution's risk in isolation without paying enough attention to systemic risk. The authors specify a measure of *marginal expected shortfall* (MES) as used in Value at Risk (VaR) approaches applied by banks, which measures the loss in case returns go below a certain percentile of the distribution (i.e. 1% or 5% on the left side). This measure can be calculated for each individual group or trading desk within an institution, called MESi; it measures how each group's risk taking adds to the financial institution's overall risk. However, the authors argue that this measure can also be calculated for a financial institution as a whole, where the MESi measures the contribution of each FI to the risk of the complete financial system. Then, they define a measure of *systemic expected shortfall* (SES), which is related to the MES taking leverage and risk taking into account. It measures the effect of externalities from the banking sector to the real economy. These externalities take place when aggregate banking capital drops below a certain threshold (which can be optimally estimated) and thus certain institutions may fail; the externalities are also increasing in the size of the capital drop. The individual measure SESi increases when a particular bank has high leverage (also subject to a bankspecific threshold) and takes high risks, in which case this bank has a high contribution to systemic risk (and thus a high SESi). Finally, the authors estimate the SESi for several large institutions, and the results confirm that the institutions that contributed most to the crisis indeed had a large SESi. They conclude that the measurement SESi can be improved when regulators gather more specific data on FIs, which constitutes a task for national regulators.

One possible drawback of the above method is that it is difficult to determine when the systemically relevant institutions are likely to fail and cause spillovers to the real economy. Hart and Zingales (2009) use credit default swap (CDS)[2] prices (which are market based) as an indicator of default for systemic institutions and as a trigger for regulatory action. This mechanism bypasses credit rating agencies, whose incentives and efforts have become regarded as flawed recently. The authors argue that if we want to maintain a system of financial institutions that are too big to fail (LFIs) we need a mechanism that provides warnings when these instituti- >

[1] Ironically, CDS are seen as one of the causes of the current crisis. Hart and Zingales therefore state that "It would be only fitting if they were part of the solution".

ons may experience distress. They set up a system similar to that of margin calls, with CDS prices on the LFI's debt as a trigger mechanism. Credit default swaps are instruments that are standardized and frequently traded, so their prices are a good indicator for the likelihood that a large FI will default. Hart and Zingales then set up a system in which a sufficiently high CDS price will trigger regulatory investigation of the LFI. The regulator will in the end decide whether the institution is adequately capitalized (i.e. debt is not at risk) or not and, in the latter case, will take over the company. It will then recapitalize and sell it, wiping out existing creditors and imposing a haircut on creditors. This threat, as argued by the authors, can be used to make LFIs issue sufficient capital ex ante so they will never be faced with the abovementioned regulatory procedure. The (anticipated) behaviour of the CDS price will thus be an indicator for the solvency of systemically important institutions. The advantages of this method to measure systemic risk are that it uses data for individual institutions and is forward looking. However, the method is still relying mainly on market data and does not indicate which FIs are systemic. Adrian and Brunnermeier (2009), besides considering the contribution of one institution to the stability of the system, additionally take into account the abovementioned point about the systemic interconnectedness of institutions and the effects they have on each other. This issue of financial network effects has already been stressed in the early 2000's, among others by Allen and Gale (2000) and Kiyotaki and Moores (2002). It has indeed become clear that financial institutions, regulated and non-regulated, were much more interconnected than regulators have been able to assess during the last decade.

Therefore, Adrian and Brunnermeier propose a measure called CoVaRi, which is defined as the VaR of the whole financial system conditional on institution i being in distress. The difference between the CoVaRi and the unconditional VaR of the financial system, denoted as ΔCoVaR, denotes (as in Acharya et al. (2009)) the marginal contribution of a particular institution to the overall systemic risk. The authors argue that their measure has several advantages. First, it captures systemic risk per institution alongside the individual risk of this institution, opposite to current risk measures. The main conclusion here is that institutions may have a low VaR but a high CoVaR; something that is not captured in current regulation. Second, the CoVaR can also be used to gauge spillover effects from one institution to another: ΔCoVaRi|j denotes the increase in risk of institution i conditional on institution j already being in distress, or the effect that distress of institution j has on the risk of institution i. Finally, this measure can also be extended to expected shortfall (see above) so as to construct a Co-ES measure, which indicates the expected losses of the whole financial system when a systemic crisis occurs. The authors then delineate several methods to estimate CoVaR, including quintile regressions and panel data methods, which are dynamic enough to capture the changing nature of CoVaR. They then argue that their measure can be used as a basis for macro-prudential regulation by i.e. imposing systemic risk weighted capital charges.

The abovementioned measures of systemic risk contribution can complement each other: the methods of Acharya et al. and Adrian and Brunnermeier can be used to determine which institutions are possibly a threat to systemic stability (including their network effects), while the measure of Hart and Zingales can be employed to determine when this threat may materialize so regulators can take timely prudential action.

Policy Action

The abovementioned measures of systemic risk can provide early warnings for a systemic crisis. The first part of them focuses on aggregate systemic risk, indicated by asset booms, while the second part focuses on the contribution of individual financial institutions to the risk of the financial system as a whole. It must be stressed that both types of measures should be used in tandem, and that the previous section of this briefing paper is not exhaustive but only a characterization of the measures necessary to gauge systemic risk properly. For the newly to be established ESRB this means that it should take into account all these indicators (and more) in the establishment of its regulatory policy. These indicators can be used by the ESRB to set up macro-prudential regulation for the European financial system and, together with national supervisors, for establishing the prudential regulation of individual institutions that contribute to a great extent to systemic instability. It is important to base new regulatory policy on a broad set of systemic risk measures, and evaluate their performance over time. It should be noted that it is an extremely difficult task. Too large a set of systemic risk measures will not solve anything but rather keep the confusion in place. For example, some of the indicators could send warning signals while others may not. It then comes to the question of interpretation and thus subjectivity, the very think that must be avoided as much as possible. Too narrow a set of systemic risk indicators entails the danger that warning signals could not be picked up early enough. Therefore, the ESRB should approach this as a signal extraction problem, which can be solved by Bayesian updating until a compact set of useful indicators remains. This set, with appropriate weights on each indicator, can serve as a basis for European macro-prudential regulation.

The complicating factor according to Eijffinger and Mujagic (2009) is that the policy instruments of the ECB and ESRB must be independent of each other. The (interbank) money markets interest rates cannot be used for both price >

stability and financial stability, as the outlook for price stability could warrant higher interest rates, while ensuring financial stability might require a lower interest rate. Finding new instruments that are effective, easy to use, and independent of the interest-rate instrument seems to be an impossible task. And yet there is a solution. Central banks should give the *growth of (broad) money supply* more prominence in their monetary policy strategies. The ECB with its often criticized monetary pillar may have a head start. Important central banks, such as the Bank of England and the United States Federal Reserve, kept their key interest rates too low for too long leading to a long period of double-digit growth in money supply. The ECB was more cautious. To be sure, the fall of the risk premium on financial markets, the development of all kinds of exotic derivatives, and these derivatives' subsequent misuse sowed the seeds for this crisis, but those factors could not have caused the crisis without the plentiful rainfall that allowed those seeds to grow.

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