Identifying Systematically Important Financial Institutions

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Abstract: The advent of the recent financial crisis has signalled the importance of having a total picture of the overall financial system instead of earlier focus by academicians and policy makers on individual banks. This new approach is termed as the Macro-prudential perspective and tries to understand the interconnectedness of financial institutions as well the effect of pro-cyclicality (the tendency for problems to be hidden during boom and exposed during crisis) to the financial system and the overall economy. Such totalitarian approach needs an effective system to identify those financial institutions with the capacity to distract the operations of financial markets or with the ability to breakdown the entire financial system. This paper is aimed at analysing related literatures that try to provide a workable framework on identifying such institutions. It covers tools and techniques employed by academicians as well as policy makers, in identifying SIFI.

Keywords: Systemic risk, financial crisis, Systematically Important Financial Institutions, capital adequacy, bank regulations, interconnectedness, and countercyclical measures.

I. INTRODUCTION

The current international financial crisis of 2007-09 has shown the importance of interconnected and complex financial institutions is far reaching, in the sense that their failure could endanger the stability of the entire financial system. In other words, it made clear that we should not only focus on 'too big to fail' organizations, we need also to understand firms that are 'too systemic to fail' (Bongini and Nieri, 2014). These organizations called Systematically Important Financial Institutions (SIFI) roles have been found at both ends (the good and the bad) of the economy. In the positive side, they provide economies of scale, diversification (in terms of area coverage and risk), controlling the effects of crisis (e.g. acquiring banks in bankruptcy), and as a tool in international payments. On the negative side, their bail out cost (due to their role in the disrupting the entire economy) is an imaginable when they fall or go bankruptcy. Policy makers are these expected to find ways through which their positive effect to the economy be maintained and their negatives aspects is managed. One way of achieving such a huge task to device a mechanism by which such institutions could be identified and regulated. The existing system, which adheres only to identifying the problems related to specific banks and solving

them (micro-prudential tools) fail to serve such a purpose. Given this fact, academicians and policy makers have been devising various macro-prudential tools to achieve this objective.

There are different ways of classifying the various lines of papers proposed on identifying SIFIs. In this paper the classification proposed by Bongini and Nieri (2014) would be adopted. Their classification focuses on the data that is being used for measuring the relevance of the financial institutions to be considered as SIFI. Accordingly, there are two, academicians and policy makers. Academicians tend to look for a frequently available data such as stock price to analyse and identify those institutions. Policy makers on the other hand had been focusing more on historical data. The academic papers could further be divided on the basis of what approach they utilize in measuring the institutions relevance, in to contribution and participation papers. Contribution papers focus, which could be either CoVaR (non-additive) or Shapley value (additive) measure the contribution of each and every financial institution to a possible financial crisis. On the other hand, the participation papers focus on how much of the financial crisis the institutions share. The policy makers part will focus on Basel Committee on Bank Supervision (BCBS) and Dodd-Frank Act.
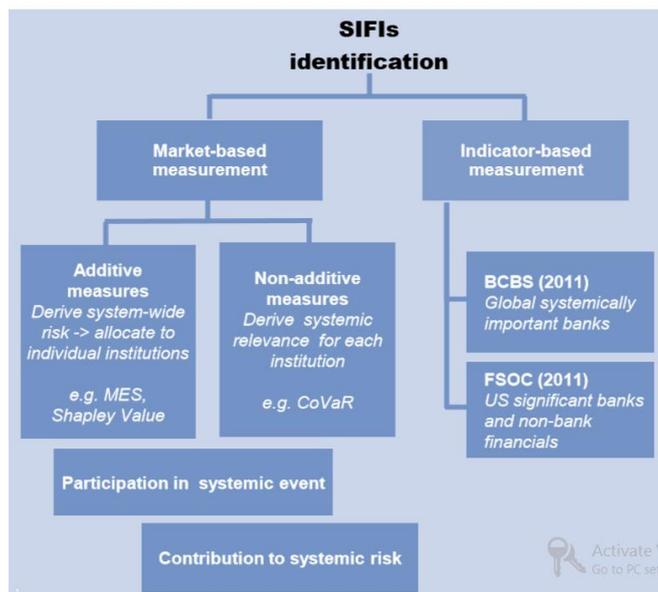
Source: Deutsche Bank Research, 2011
Figure 1: Identification of SIFIs

This paper will try to examine the various literatures on identifying SIFI. From now on, the paper will continue as follows. The second section deals with developing a theoretical framework on the various academic literatures for identifying SIFI. The third section will focus on methodologies adopted by policy makers. The fourth section will deal with the various empirical evidences of the applicability of the various methods for identifying SIFI documented across geographical areas and financial institutions. The last section will summarize and conclude the paper.

A. DEFINITION

In order to properly define and understand Systematically Important Financial Institutions (SIFI), it is advisable to have a better idea of the interrelationship between systemic risk and systemic importance. Systemic risk is a vague subject who does not have generally accepted definition. Hansen (2012) points out that the definitions of systemic risk ranges from simple credit shortage triggered by liquidity concerns of a bank, to a other complex susceptibility of a financial system to an explained shocks, or a bankruptcy of a major institution in the financial system. IMF (2009) definition of systemic risk focuses on impairments of a parcel or the entire financial system, which have potential to expose the system to the risk of disruption to financial services, which could hamper the functioning of the economy. The G-10 Report on Financial Sector Consolidation (2001) define systemic risk to be a negative occurrence with potential to destroy the confidence displayed in financial systems, and leading to a greater risk of disturbing the economy. On the other hand, IMF (2009) defines systemic importance of financial institution as if an exit or being under critical situation of a firm have the potential to create and lead to a system-wide contagion directly by counterparty transactions or indirectly through fire sale or other means, then the firm is SIFI.

One way to look at SIFI is from the positive contributions the institutions have that and deals with facts that their existence is detrimental to the economy. The other side claim the negative aspect of such institutions from their ability to disturb and destroy the financial system and the economy. Walter (2012) claims that, those economists who approach the SIFI from their destroying ability, suggest policies that guarantee their existence because; their bankruptcy would have a devastating effect to the economy and financial system. Regardless of how it is looked at identification of SIFI is part of Macro-prudential regulation. Macro-prudential regulation aims at mitigating the systemic risk or a risk with potential to disrupt the financial system in its entirety, which contrasts with the risk related to specific bank (macro-prudential regulation).

B. ECONOMIC EFFECTS OF SIFI

Problems of one bank could have a tendency to be transmitted to other banks, and then to other part of the economy and even the world in the form of contagion. Though the effect of contagion could originate from small or large financial institutions, large firms pose unique problems and more potential for such events. Organizations could be systemic either because they are large enough that they have dealing with a lot of other organizations or small firms who are the clone of each other that a loss in one could cause the demise of the whole. Problem in large firms could create contagion because of the counter party risk they pose for a long list of dealing they have leading a failure of their counterparty for third parties. It can also lead to fire sale in markets by disturbing the market prices. It is put forward that some institutions are not large rather too connected to fail, not because of their size rather because they control the flow of activities in some markets.

In order to create stability in the financial system and prevent financial crisis leading events the first recognizing the existence of large interconnected organizations is important. IMF claims that the key market segments be it securitization, derivatives, stocks, repo and soon are dominated by few large organizations, and the other firms would not have the capacity to take over if any of these fails. Considering the interconnectedness nature of these firms, it can lead in to contagion and serious economic problem. From the perspective of moral hazard (the tendency of large firms to think they are too big to fail and act carelessly), bailing out such intuitions is not fair and acceptable. Because they are consuming the taxpayers money for their reckless actions. Moreover bailing out is an inefficient move, because government must reward the better use of resource and punish otherwise. On the other hand bailing out of such big organization might be necessary for the financial stability of the economy. Therefore, in order to handle this situation a proper identification of SIFI is important, so to regulate them and prevent the bailout costs.

II. ACADEMIA

Most academicians address the identification of SIFI either through analysis of market-based data e.g. Huang et al (2009), and other use the market-based plus some additional

association with historical data e.g Adrian and Brunnermeier (2011). In this part, the focus will be on the various academic papers, which propose a tool for such an analysis. Most academicians unlike policy makers prefer market data to balance sheet data. Market-based analysis uses probability of default by institutions prepared by market participants that are available on a high frequency basis such as daily, weekly and soon. The main reason policy makers tend to ignore the market based due to its strict assumption of market efficiency including in stress times (which is not true most of the time).

They put forward two justifications for this action. First is that the tendency of to be updated regularly and timely. This allows a proper analysis and more frequent data, which enables the understanding of the changes in the financial system. But balance sheet data on the other hand are available less regularly, maximum three times in a year, so it doesn't allow a proper analysis. Second, their forward-looking approach as they indicate a frequent and continuous change on the market. They can show as the market anticipation through the changes in the asset price movement. It is easier to make predictions of the future based on daily and regular data than a quarterly data. The main discussion will focus on the two classifications of academic studies, contribution and participation approach. If we base our analysis on the approaches adopted on identifying SIFI, we can classify the academic studies to contribution and participation approach. The difference between the two approaches is presented in the exhibit 1 and its detailed explanations are provided in the next sections.

	Contribution to systemic risk	**Participation in systemic event**
Concept	Marginal distress of the system, conditional on the institution failing	Expected participation of the bank in a systemic event; losses to the bank creditors
Risk indicators	— Intersystem liabilities — Liquidity and maturity mismatch — Transparency and resolvability	— Asset correlations — Leverage — Risk bearing capacity
Policy objectives	— Contain systemic impact upon failure — Avoid moral hazard	— Ensure survivorship in systemic event

Source: Deutsche Bank Research, 2011
Exhibit 1: The difference between contribution and participation approach

A. CONTRIBUTION APPROACH

The contribution approach of SIFI identification starts from the assumption that a financial institution fails, and then goes in to assessing the potential for financial crisis resulting from this failure or the disturbances to the entire financial system stemming from this financial institutions' failure. The idea behind contribution approach is that when an institution fails, those institutions that have contractual agreement with it, will not receive their receivables, and if it is a very huge amount, it can make them to default on their own creditors leading to contagion. Another way it can affect the market is also by creating a situation of fire sale. Therefore, to understand the contribution a financial system to the financial system, it requires a proper analysis and study of the institutions' liabilities, and its potential of initiating sales fire and other impact on the credit market.

The default risk premium paid by to insurance companies to cover them failure to pay their debts ignores the potential of failure these institutions system wide. When institution that are big or highly interconnected fails to meet its contract, it can create a spill-over effect through its counter party risk, the increased uncertainty it exposes the financial system and other externalities. So, the exist of such organizations from the market (due to bankruptcy) is definite to cause a major disturbance to the financial system stability and the whole economy. In order to avoid such disturbances government might be forced to bailout such organizations, and this bail-out probability have its own problems as it creates the tendency by the institutions to take more risk and expose themselves to more chances of failure in order to earn abnormal profits. This situation can result to two critical situations that might expedite or worse lead to financial crisis. One is that it tilts the competition towards those big organizations, as the small institutions that have no potential to cause such disturbances will not be bailed out during failure, and it reduces fair competition. Another result of this situation is the moral hazard, as mentioned above the believe of the big institutions on the government bail-out can motivate them to take more risk and thus lead to further future crisis and problem. In this paper two prominent contribution approach models will be discussed.

a. CONDITIONAL VALUE AT RISK (CoVaR)

Proposed by Adrian and Brunnermeier (2011), Conditional Value at Risk (CoVar), is the first SIFIs measure discussed in this paper. In this methodology, the contribution of each financial institution is measured using ΔCoVar, which is the difference between CoVar and the VaR. On this respect, CoVar refers the value at risk of the financial system when the specific firm under study hits its worst loss (i.e. it VaR) while other institutions are normal. VaR on the other hand refers to the value at risk of the entire financial system during the normal time of all financial institutions and none of them is in worse condition. The difference between the CoVar and VaR, which is the ΔCoVar therefore shows to what extent the specific institutions is affecting the financial system and in other words its contribution to crisis. If the ΔCoVar with respect to a specific institution is very high then it can be categorized as SIFI.

There are two pluses of using this approach. First, the approach does not show only the exposure of a single financial institution to risk, rather it also measures its contribution to the overall financial system risk. So, it enables the achievement of an overall financial system stability objective such as macro-prudential policy. An institution, which is found to contribute a lot to destabilizing the financial system then, can be controlled by regulations aimed at it. Secondly, this approach clearly shows the contagion effects that are seen during bankruptcy of the financial institutions involved. It clearly shows the interrelationship between institutions.
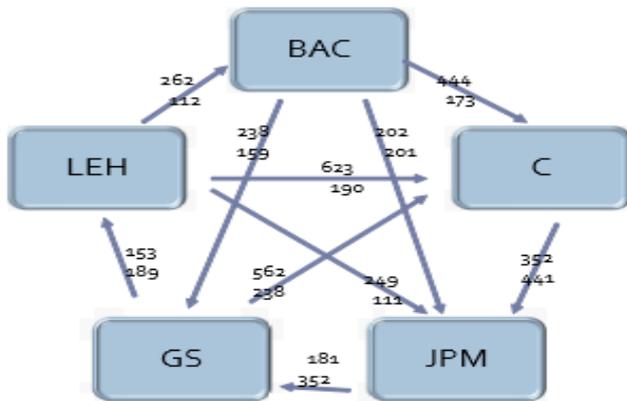
Source: Adrian and Brunnermeier, 2011. There are top and down numbers. The top number reflects when the in the organization in origin of the indicator is in problem, and the bottom reflects the opposite.

Figure 2: CoVaR network structure example

THE GENERAL MODEL

The section will provide a detailed analysis of the CoVaR methodology. The model starts from identification of the components. CoVaR, which is denoted as CoVaRps|a, measures what would the consequences to the whole system if the specific institution (a) has hit its VaR. That is, the p-quantile of the probability distribution is given as:

$$P(X^s \leq CoVaR_p^{S|C(X^a)} | C(X^a)) = p \qquad (1)$$

ΔCoVaR, is measures the difference between the CoVaR (if the institutions hits the VaR) and VaR (when the institutions are at normal), and is the measure of the organizations contribution to the overall financial system risk. i.e.

$$\Delta CoVaRps|a = CoVaR\ ps|Xa = VaRpa - CoVaR\ ps|Xa = Mediani \qquad (2)$$

Any SIFI identification tools' success is measured by its ability to help in the macro-prudential regulation, by assessing interconnectedness as well as pro-cyclicality. The model of ΔCoVaRqj|i achieves these two, interconnectedness using analysis of direct and indirect contagion effect and for pro-cyclicality using its ability to measure the build-up of risk that can ultimately realize in crisis.

THE ECONOMETRIC MODEL

CoVaR utilizes market data to determine the importance of institutions, and then combine it with balance sheet data to forecast the future contribution of the institutions. The study therefore focuses on the $VaR_p^{s|a}$ and $\Delta CoVaR_p^{s|a}$ on the rate at which financial asset grow. ME_p^a refers to the financial institution a's total equity market value and LEV_t^a refers to the total assets to book value ratio. Then, the asset value growth, X_t^{a} is calculated by

$$X_t^a = \frac{ME_{ti} \cdot LEV_{ta} - ME_{t-1i} \cdot LEV_{t-1a}}{ME_{t-1a} \cdot LEV_{t-1a}} = \frac{A_{ti} - A_{t-1i}}{A_{t-1i}} \qquad (3)$$

The CoVaR is given by

$$CoVaR_p^{system|X^a} = VaR_p^a: \quad = \quad CoVaR_p^{system|VaR_p^a} = \alpha_p^a + \beta_p^a VaR_p^a \qquad (4)$$

ΔCoVaR is given by

$$\Delta CoVaR_p^{system|i} = \beta_p^a (VaR_p^a - VaR_{50\%}^a) \qquad (5)$$

If time varying state variables are considered then the model changes to:

The CoVaR is given by

$$CoVaR_t^a(p) = \alpha^{system|a} + \beta^{system|a} VaR_t^a(p) + \gamma^{system|a} M_{t-1} \qquad (6)$$

ΔCoVaR is given by

$$\Delta CoVaR_t^a(p) = \beta^{system|a}(VaR_t^a(p) - VaR_t^a(50\%)) \qquad (7)$$

a. SHAPLEY VALUE

The second category of contribution approach is the paper by Drehmann and Tarashev (2011) and others, which tries to measure the contribution of each institutions using game theory. Shapley is a methodology of allocation of reward for a group of people who combine their forces to achieve a common goal. The same idea is tried to be utilized in finance to understand the contribution of each financial institutions by considering them all as player who are working together to bring the common goal which is financial stability. The same way reward is allocated to the players in Shapley methodology, the risk is divided to the institutions in the system. The part of the total risk that attributed to each institution are represented by the Shapley values. The Shapley value could be used as proxy for the systemic importance of each institution in the system. The arithmetic average of the contribution of single institution to the whole system is run to obtain the values. These arithmetic averages can be used to create sub groups in the system analysing the marginal contributions of the institutions involved.

The use of Shapley values as a systemic risk entails that each and every institution using its interactions, business dealing and other activities contributes to the overall risk of the financial system and thus the values are meant to attribute the exact contribution. This methodology explains how much risk is the institution generating to the system or subsystem it is assigned to. The Shapley value of any institution say a is the average risk it contributes given its weight in the overall system. So if company a has a larger weight in the system, its contributions to the risk have significant effect and it is considered as SIFI. This way the institutions in the system can be divided to SIFI as per their values.

THE MODEL

The Shapley value of bank a is calculated on the basis of its weight and the measures of risk indicated by θ. The generic model for finding the shapely value(SV) is given by

$$SV_a(N) = \frac{1}{n} \sum_{n_s=1}^{n} \frac{1}{c(n_s)} \sum_{\substack{N^{sys} \supset a \\ |N^{sys}| = n_s}} (\theta(N^{sys}) - \theta(N^{sys} - (a))) \qquad (8)$$

In this expression, $N^{sys} \supset a$ are all the financial system $N^{sys} \subseteq N$ containing banking a, $|N^{sys}|$ stands for the total banks in the system.

One main difference between the CoVaR is the additively. In CoVaR the sum of risks contributed by all the institutions is not one. Implying the effect of the crisis in bank a to bank b is different from the effect of crisis in bank b to a. But Shapley value is additive, implying the sum of all the risks contributed by the financial institutions is one. Meaning the risk contributed to a by crisis of bank a is the same as the risk

contributed by the crisis of b to bank a. accordingly the model is:

$$SV_a(N) - Sa_i(N-b) = SV_b(N) - SV_b(N-a) \text{ for all i, k} \in N \quad (9)$$

B. PARTICIPATION APPROACH

The participation approach starts from the advent of a massive shock leading to an imaginable loses, such as financial crisis, then it divide this loss to all financial institutions in the system. The institutions who are sharing majority of this loses are then considered as the SIFI. In order to measure the amount of losses each bank or financial institutions shares in the shock is usually measured by the amount of loses the institution would be a reason for the loses of non-bank creditors. In other word the participation approach tries to measure the share of the financial institution in the systemic event. If the institutions shares a tremendous amount it means its survival will matter a lot to the regulation body because if it is out of the picture it can lead to unprecedented loses to the whole economy.

a. SYSTEMATIC EXPECTED SHORTFALL

Huang & et al. (2009, 2010) and other authors (Acharya, 2009; Acharya et al., 2010; Brownlees and Engle, 2010) use the Systematic expected shortfall to identify SIFI. Systematic expected shortfall tries to identify what happens to the whole system when the observed loses surpass the value at risk amount of the economy. The same as Shapley method, it follows additively, that is the total amount of expected shortfall is one meaning it is additive in nature. This approach can be used either using existing crisis or generating simulation for developing such a situation. The implementation of the system depends on the assumption that a huge shock has happened that lead the value at risk of the whole system to be compromised. It is used to device a mechanism for measuring the systemic risk during crisis and how exposed the overall financial system is to this systemic risk identified.

THE MODEL

Testing of Shortfall requires the development of risk neutral PD which indicate the degree of exposure. Following Huang et al (2010), risk-neutral PD from the observed CDS spread ($s_{i,t}$)

$$PD_{a,t} = \frac{a_t s_{i,t}}{a_t LGD_{i,t} + b_t s_{i,t}} \quad (10)$$

Where $a_t \equiv \int_t^{t+T} e^{-rt} dt$ and $b_t = \int_t^{t+T} t e^{-rt} dt$, LGD is the loss-given default and r is the risk free rate.

After identifying the PD's, asset return need to be forecasted for running a stress test. Following Huang & et al. (2010) the asset return is obtained by:

$$\rho_{t,t+n} = c + k_1 p_{t-n,t} + \sum_{a=1}^{l} K_{2a} . \rho_{t-a, t-a+1} + \eta X_t + v_t \quad (11)$$

Where ρ is correlation of average returns from time t to t + n. X includes a list of financial market variables.

MODEL ESTIMATIONS

After obtaining the asset return correlation then it is easy to make the estimation either on the basis of historical data or simulation. The model estimations contain two parts:

$$X_t = c + \sum_{a=1}^{p} b_a . X_{t-a} + \varepsilon_t \quad (12)$$

$$PD_t = c_{2a} + a_t . PD_{a,t-1} + \gamma X_t + \mu_{at} \quad (13)$$

The first equation (12) measure the macro factors such as credit risk exposure (expressed by X in the model). The second equation (13) indicates the risk measure (PD – probability of default) in response the changes in the market.

III. POLICY MAKERS

As discussed in the analysis of academic papers it was pointed out that they prefer more market based data and follow market-based methodologies. Authorities on the other hand show preference for balance sheet data. Because crisis are an infrequent events so usual tilted market data might not serve the purpose. Regulators can use the market data as a cross reference for their result obtained using indicator base methodologies. Policy makers have some explanations for their preference. One explanation is that the universal applicability of the methods. They set general guideline and allow users to make specific use. Therefore, it provides robustness. Their transparency and the allowance for easy monitoring and tracing of SIFI, also adds another important benefit and dimension. However, their inability to differentiate between the contribution and participation of institutions in the risk remains a black point on its books.

The indictor based approach looks for reliable indicators riskiness from the balance data most of the time. The indicators provide a reference point where the actual performance are compered to. So, indicator based system requires benchmarking. A benchmark is an ideal state against which the performance can be checked. The benchmark against which indicators are measured is revised from time to time to allow smooth comparison, update on the importance of the indicators. In this section two important mechanisms devised after the advent of the 2007-2009 crisis will presented.

A. BASEL COMMITTEE ON BANK SUPERVISION (BCBS)

Basel Committee on Bank Supervision (BCBS) is a system that provides a form for matters related to the supervision of banks. As a response to the financial crisis in July 2009 devised a 5 point indicator based methodology for identifying SIFI (Bongini and Nieri, 2014). The draft was devised in 2012 as well as 2013. This section of the paper will discuss the various indicators proposed in the latest version. Initial the methodology was drafted for identifying SIFI, but now can be utilized even to identify non-financial institutions which with potential of causing systemic risk.

Category (and weighting)	Individual indicator	Indicator weighting
Cross-jurisdictional activity (20%)	Cross-jurisdictional claims	10%
	Cross-jurisdictional liabilities	10%
Size (20%)	Total exposures as defined for use in the Basel III leverage ratio	20%
Interconnectedness (20%)	Intra-financial system assets	6.67%
	Intra-financial system liabilities	6.67%
	Securities outstanding	6.67%
Substitutability/financial institution infrastructure (20%)	Assets under custody	6.67%
	Payments activity	6.67%
	Underwritten transactions in debt and equity markets	6.67%
Complexity (20%)	Notional amount of over-the-counter (OTC) derivatives	6.67%
	Level 3 assets	6.67%
	Trading and available-for-sale securities	6.67%

Source: BCBS, 2013

Exhibit 2: Indicator-based measurement approach

Exhibit 2 provides the indicators along with the various weights assigned to them. The detailed explanations of these indicators and their implications will follow next.

a. SIZE

The size of a firm is positively related to both contributions as well participation of the organization in the systemic risk. In that case the insolvency of a big institutions could result the disturbance of the whole system, through its larger interaction and activity globally. This negative effect is pronounced because there will not be an institution which is capable of filling the vacancy placed by the big institution. Using size as a measure of systemic importance is therefore intuitive and valid. The two commonly measure of size are capitalization level or total assets. BCBS advices the use of total exposure of the firm to risk as measured by Basel III leverage ratio, which includes both on and off balance sheet assets. Making proper adjustments to the accounting difference between countries can help in coming up with the same system globally allowing comparability. The size measured in relative terms, where each institution is set in certain group and peer comparison is made the groups created.

b. INTERCONNECTEDNESS

Though size of a firm is important, it is not the only determinant factor for systemic importance, For example, a medium sized institution with highly interconnected network of dealings and relationship could impact the system as much (if not bigger) as one large institution with average network. So the collapse of such medium-sized organization with an interconnected set of dealing can be very dangerous to the system as a whole. Considering this fact interconnectedness, which is measured using three indicators, i.e. asset outstanding within the financial system, liabilities outstanding within the system and outstanding securities in the system is another important indicator. It is measured by size of intra financial assets, liabilities and securities. The size of intra financial assets in the system reflects the participation approach of measurement. It helps us to know to what extent the institution is exposed in case of financial crisis and systemic events. The larger the intra financial asset the more exposed the institution, and therefore would indicate a higher participation in the system. The intra financial liabilities indicate and can be a tool to measure the institutions contribution to systemic risk. The

higher the intra financial liability of an institution the higher the institution contributes to financial disturbances in the system.

c. SUBSTITUTABILITY

Another hard to measure but a good indicator of systemic importance of a financial institution is substitutability. If it is easier to replace a financial institution, who is facing a huge problem is easier, then, it is having a lesser systemic importance. If an institutions provides they can only perform a specialized service or product that is, then their bankruptcy would have a huge influence because it creates a hole in the system that cannot be filled by the available firms. The BCBS proposes three ways of measuring the substitutability indicator, assets under custody, cleared and settled payments value, and transactions underwritten in equity and debts market. In order to obtain a better understanding of the substitutability of institutions, the regulatory body is expected to properly identify in which market the institution is highly involved, and what is the market share of the institution in this market. The way the institution delivers it services is also very important aspect in determination, because a simple system can easily be replaced, but a sophisticated system can't be easily replaced.

d. COMPLEXITY

The way the institutions are, structured and their parts function, as well the type of assets held and managed can be a useful indicator for determining the systemic importance of an institution. As per BCBS, the complexity of an institution is measured through its value of the over the counter trade (notional value) derivatives, asset for which market value can't be observed (level 3 markets), and asset available for trading and sales. The intuition behind the use of complexity is that, if an institution contains complex assets, its failure makes the sale of these assets very difficult, minimizing the amount of cash available for its creditors, this further can lead to a fire sale or contagion relationship. Therefore, we can consider complexity as a direct measure of the handling of the sales of an institution in case of failure as it tries to cover the major aspects the company assets and their value in the market. A proper analysis and understanding of complexity might help in segregating the assets and liabilities that are systemically relevant these their loss is fundamental could be identified and proper actions could be taken for them. Even though an excessive complexity of institutions is not supported, some level of complexity is required for an institutions development and the market growth.

e. CROSS-JURISDICTIONAL ACTIVITY

How global is the activities performed by an institution? The extents to which the activities a business extend affect its systemic importance. If the institution has a greater global presence, and fails, it would be very difficult to make coordinate its resolution activities and it can lead to contagion through spill over. The global coverage is measured through cross-borders liabilities (liabilities denominated in currencies

other than the companies origin country) and claims (income denominated in currencies other than the companies origin country) of organizations. The intuition behind the use global reach as importance indicator is that those financial institutions that are active in foreign countries have more tendencies to affect the global financial stability than the institutions that are limited to the home country. Some economists think this not a good measure, because if the regulators started limiting the operation of the global firms, then it can contribute to their failure by providing advantage that is more favourable to the local firms. Over all these 5 measures are used to identify SIFI as per the regulators.

B. DODD-FRANK ACT

The Basel Committee and the FSB has indicated that the five indicators mentioned above are not only used for financial institutions but also for other non-bank institutions. This being said the focus was mostly on banks. However, in US the regulation (Dodd-Frank Act) on the other hand the focus was more on non-banking financial institutions and other companies. Bongini and Nieri (2014) point out two important reasons; they already have a criteria for categorizing SIFI, and shadow banking was the reason behind the mortgage crisis. In the first case, any retail bank or group of banks is categorized as SIFI, if its total asset exceeds 50 Billion Dollar, meaning size was used the main criteria in this case. In the second case, the role of the shadow banking which were not properly regulated under the existing financial system was very big in the latest financial crisis, so the authorities were eager to put these organizations under control. The focus of Dodd-Frank act was to identify and find all the institutions, which have huge contribution to the systemic risk and put strict controls and regulation to discourage them from taking riskier transactions and activities.

Dodd-Frank has provided the power to determine the identification of SIFI for non-banking financial institutions to the Financial Stability Oversight Council (FSOC). FSOC has the discretion to decide on the systemic importance of a noon-financial firm, considering that their dissolution could possess a threat to the financial stability of the American financial system. Though a detailed methodology for identification is under process, those institutions that comprise shadow banking (because they are not under direct regulation) such as money market funds, hedge funds, securities houses, finance department of large corporate houses are among the institutions under investigation for such purpose.

a. INSURANCE

In understanding the role of insurance companies in the contribution of systemic risk, various aspects need to be addressed. One such factor is their involvement in activities that can compromise the financial system. Considering, insurance companies low interaction and dealing with financial institutions, they have less direct counter party dealing, so it appears they have less influence on the systemic risk when it comes to interconnectedness. Their huge size and influence over the entire economy on the other hand put them under the scrutiny for their contribution to systemic risk.

Many financial as well as non-financial institutions depend on their services. Therefore, if the probability of failure is used as a criteria to decide the systemic importance of the insurance company, the might not seem that important, but if their failure is considered as a determining criteria then they fall under the SIFI criteria.

b. MARKET STRUCTURE

Market structures such as payment systems, clearinghouse systems, and other structures that are facilitating the financial activities to take place also fall under the investigation for their possible contribution to the systemic risk. They are responsible for forming a structure and infrastructure for movement of money (e.g. transfer), securities, collateral and other important activities. The exist of organizations providing such services from the system pose a huge problem to the financial system as a whole till another similar efficient system is in place to replace it. This influence put them under radar for their contribution to the systemic risk, and the probable in substitutability is an important criteria. Supervisory authorities require centralization of these market structures, such as central collateralisation is proposed by Dodd-Frank act.

IV. EMPIRICAL STUDIES

The various academic and indicator based proposed for identification SIFI were the focus empirical test and analysis by regulatory authorities and academicians over time. This section will focus on the various empirical studies validating the various theories of identifying SIFI.

A. EMPIRICAL STUDIES ON CoVaR

Adrian and Brunnermeier (2011) used their CoVaR methodology to study publicly traded financial institutions comprising commercial banks, security broker-dealers, insurance companies, and real estate companies. Their study covers period from 1986 to 2010, of market data on daily market equity data, which they obtain from CRSP. They find that a higher volatility, repo spread and lower market return to be the main indicators of a financial crisis, and any organization involved in an environment full of these market variable to be considered as SIFI. In their study they compared the VaR of each institution against the CoVaR which implies when the institution fails, and conclude that they are very different and authorities need to focus on the VaR of the companies which doesn't reflect the spill over effect, rather they need to focus and measure the CoVaR. By associating their CoVaR measure with balance sheet data, they claim they were able to predict the occurrence of the financial crisis in 2007. Using the combination of balance sheet data and their SIFI identification methodology, they find that organizations having higher leverage (more debt), more maturity mismatch and that are big in size, to contribute a lot to the systemic risk.

Other than Adrian and Brunnermeier (2011), other authors also tried to perform empirical test of the CoVaR, in this paper, some influential papers of such kind will be

discussed. Adams, Füss, and Gropp (2010) use sate based CoVaR to study the spillover of risks among a wide range of financial institutions. They have found signs of pro-cyclicality, as risk that were hidden during normal time (appear small), tend to be exposed during volatile time of crisis. They find investment banks, hedge funds to the main players in the transfer of crisis and shocks to other financial institutions acting as a conduit. This is one of the reasons for the interest of authorities on elimination of shadow banking. The last and important finding they pointed out is the convergence of various hedge fund styles during crisis.

Another important study of CoVaR is the analysis of CDs in Asia-Pacific banks performed by Wong and Fong (2010), which portrays the proper interconnectedness and spillover effects. How interconnected and the effect of various economies on each other plays an important role in understanding systemic importance of companies. Understanding the interconnectivity, between Asian pacific banks can provide a light on contemplating the effect of a failure by one company over the other and vice versa. Through their CoVaR analysis, they were able to show which banks in the system contribute more to financial crisis. They also were able to demonstrate the spill over of one bank over another bank during its stress, and vice versa. They were able to develop an aggregate potential impact showing which banks in the Asian Pacific have a prolonged influence over other institutions and these require a stricter control and surveillance by the supervising authorities. Their analysis provides detailed results on how the exposure to risk of one country might change when its neighbouring country is under crisis. This kind of analysis could be very beneficial to European union countries for example in determining whether to let Greece default on its debt or to provide another bail-out. They can analyse the spillover effect by testing the influence to the rest of Europe if Greece was to exit the union.

B. EMPIRICAL STUDIES USING SHAPLEY VALUE

In this section various empirical studies that have used game theory to identify SIFI will be discussed. Tarashev et al. (2009, 2010), has made an extensive usage of Shapley values in allocating risk to the firms in the financial system. Tarashev et al. (2009) develops a system identifying SIFI, by the usage of game theory, where all the player are involved in a cooperative game against the same opponent, i.e systemic risk. Using that system, they combine balance sheet values to see what the main forces behind shocks to the system. They have used the size of the firms, factors that have the potential to influence the whole system and other criteria to determine the contribution of firms towards the financial crisis. They point out that size not the only fact determining the riskiness of institutions, for example 100 small firms which are replica of each can have a futile effect on the system than one big organization. So the use usage of Shapley value could be used to identify such kind of firms in addition to the big once. In an attempt to provide a flexible system Tarashev et al. (2010) used probability of default and loss-given default as parameters for identifying SIFI. The have provided a simplified real world example to demonstrate how Shapley value could be adjusted to various parameters developed the authorities.

Liu and Staum (2010) have empirically used the Shapley method by using cost as a measure of risk contribution by firms. They developed a system for allocating cost to all the firms on the basis of their participation in the financial system. In their system, they have utilized both Shapley values as well as Aumann-Shapley value. The Shapley value is used for measures a significant change in the system that stems from the exit of firms. This way the important of the firm in the system can be observed from the Shapley value, at the global level. The Aumann-Shapley value is used to determine a partial change in the financial system that acts as a warning, according to them local in nature. They have developed model which enable authorities to track actions by participants that undermine the regulation put over them for their contribution to risk. Using Shapley values they were able to track action of merger or split aimed at minimizing their systemic risk and eluding authorities imposing restrictions on them for their systemic importance.

Drehmann and Tarashev (2011), using data of 20 MNC, they try to identify SIFI. Using Shapley method, they found that the level of contribution of a firm to the financial system depends on interconnectedness, which is reflects its participation of in the interbank network either in the form of lender or borrower. By utilizing various measures of Shapley value measurements, they show that different measures of systemic risk lead to different result, and in turn to different conclusions. Therefore, authorities must be careful in their use of such methodologies. Their paper doesn't show which model is superior over other rather it only provides a comparison of various approach towards utilizing the shapely values. Their methodology measures two aspects; one is the participation of the bank or its share in the crisis of the financial crisis, and the other aspect is its contribution toward the occurrence of one. They found out that if a firm acts more as a lender in the interbank system, its importance is related to the participation in the financial crisis, on the other hand if it is more of a borrower in the system it has more contribution to the financial shocks.

C. EMPIRICAL EVIDENCES OF SYSTEMIC EXPECTED SHORT FALL

Many authors who start from the participation approach has attempted to test their methodologies and have devised many tools focusing on short fall. Huang & et al. (2009, 2010) for showing the effectiveness of their methodology, they use it over 12 large US financial institutions over the time 2001 to 2008. By assuming that firms are considered in distress or insolvency risk if they would default in 15% of their liability, they run their analysis. Their systemic risk measure increases during the time between 2001 and 2002 reaching its maximum point in the second half of 2012, then it shows, a downward trend reaching its minimum value in early 2007. Then again, it shows an upward trend during the time close to the financial crisis. They claim that, their measure is able to show the level of risk exposure and if it can be employed properly it can be used an indicator for the occurrence of crisis.

a. MARGINAL EXPECTED SHORTFALL (MES)

Suggested by Acharya et al. (2010), and Brownlees and Engle (2012) Marginal Expected Shortfall (MES), follows the opposite direction of CoVaR and tries to find the consequences to returns of a financial institution when the entire financial system is in crisis. Acaharya et al. (2010), use the MES methodology for identifying SIFI, and show that their methodology can predict the buildup of risk towards the financial crisis, the organizations which have contributed more to that. Their methodology was also good enough to show large financial organizations equity valuations have decreased to the minimum level during the financial crisis. The system also enables the performance of stress testing using historical data or simulation. They were also able to demonstrate how the spreads of credit default swaps has increased to the time that led to the financial crisis. They propose that their system can be used to identify SIFI, and implement various regulatory restrictions such as development of tax system reflecting the MES of each firm.

The papers that propose MES focuses on the idea that each firm need to be responsible for the amount of risk it contributes to the overall system. Otherwise moral hazard will set in where firms which are contributing a lot to the risk but sharing the burden together with others, to even take more risks leading to further crisis. These paper pin point that, the regulatory body should use systemic risk measures such as MES to identify the contribution of risk by each firm and impose regulatory restrictions as per their contribution i.e. the firms contributing more get higher restriction. In order to achieve these objectives, regulatory bodies could perform stress tests regularly and can identify the contributions of each firm.

Brownlees and Engle (2012) have used the MES to identify SIFI. In their paper the authors attempted to define MES from the perspective of an investor holding equities of a financial system, and measure the maximum amount of loss the investor expects to loss when the entire system is under a shock or some kind of financial crisis pressure. The employ a time varying variable analyzed using TARCH and DCC, allowing flexibility on the amount of volatility in market. On the basis of MES obtained they rank all the financial institution on the basis of their contribution to the risk of the financial system. Those holding the first ranks are the once systemically important till a determined amount of MES. They also found out the MES demonstrate a continuous deterioration of the financial system capitalization during the time of crisis, proving the ability of the measure to effectively indicate the time building up to crisis.

b. COMPONENT EXPECTED SHORTFALL (CES)

Banulescu and Dumitrescu (2012) has proposed another Shortfall model called component expected shortfall (CES), which uses absolute value on the place of marginal to indicate the contribution of each institution to the systemic risk of the system. Their measure takes in to account the firms' size, and tries to contemplate what would happen to it, if the overall system is in shock. On the basis of this data it ranks all the financial institutions in the system, to indicate their systemic

importance. Using this methodology they found out that the methodology employed effectively ranked the institutions which are heavily affected in the financial crisis as riskier firms. They found out that their ranking is similar to other studies which have used a much complex and a sophisticated method, implying that their system provides an effective and simple methodology.

Using the methodology, they have found a general tendency of increase in the average CES, implying the contribution to risk during the crisis reaching the limit on the crisis time, and then followed by a gentle decline during the post crisis period. This implies their methodology have a better prediction capacity, which could be a very important tool for usage by regulators and supervisory bodies in expecting crisis and taking preventive actions. Another important finding of their paper is the difference between the types of financial institutions for their contribution to systemic risk and thus to financial crisis. As expected depositories and broker-dealers due to their less direct impact on the financial system, were found more susceptible to bringing a higher level of risk and lead to higher contribution towards shocks. Insurance, which have little interaction with the financial system on the other hand have a very small contribution to risk and financial crisis.

c. SYSTEMIC RISK MEASURE (SRISK)

Acharya et al. (2012), and Brownlees and Engle (2012) present SRISK as an extension of MES, by including in their analysis the amount the company owes and how large it is. Brownlees and Engle (2012) use this systemic risk measure from the perspective of an investor holding equities of a financial system, and measure the maximum amount of loss the investor expects to loss when the entire system is under a shock or some kind of financial crisis pressure. The have implemented these tactics to measure the risk of the financial institutions using SRISK in the time two year before the emergence of the crisis, and ranked the companies, accordingly out of the top ten firms in the ranking, 8 firm were serious troubled during the financial crisis, implying if such measures and ranking were made beforehand may be they would have been avoided.

D. IDENTIFIED SIFI'S BY BCBS

As it is explained in the theoretical part, after the 2007-2009 crises the BCBS which has taken responsibility for the identification of by setting indicator based mechanisms. In this part of the paper the process of analysis and the various organization that are identified as SIFI by BCBS will be discussed.

a. GLOBALLY SYSTEMICALLY IMPORTANT BANKS (G-SIBs)

In order to identify Globally Important Financial Institutions (G-SIBs), BCBS has devised an indicator based quantitative methodology in which all the scores are sorted out and out of them the G-SIBs are identified and sorted. There are five general categories, each contributing 20% to the

overall systemic importance. Some indicators have their own categories insider them and each category will have equal percentage contribution to the indicator. There is a threshold against which all the institutions will be compared, in any institutions' score surpasses that threshold, then the firm is categorized as G-SIBs. If any firm does not have enough score to pass the threshold and the national supervisors of the country believe that it should be there, then they can add their own additional criteria make sure the firm is listed as G-SIB. The latest list of the G-SIBs and G-SIIs which is last updated on November 2014 is given in the exhibit 3 below.

b. GLOBALLY SYSTEMICALLY IMPORTANT INSURERS (G-SIIS)

Following Dodd-Frank act, there is a list for insurer which is termed as G-SIIs. In order to develop the list on the place of the five indicators employed for G-SIBs there are two main indicators. The two factors which are having highest weighting factors are; the non-traditional business (type of activates not performed by a typical insurer such as deposit services) performed by the firm, which carries 45% and the interconnectedness (similar to the measure involved in identifying G-SIBs) carrying 40%. The intuition behind these two criteria is that, Insurance companies can take more risk when they are involved in areas which is not their priority taking a lot risk and endangering the stability of the system. The interaction of insurance companies among themselves and other financial institutions also plays important role in systemic importance. The main important difference in the process of identifying G-SIIs and G-SIBs is that, G-SIIs doesn't not have threshold against which their score is compared, therefore the list is developed on case to case bases by the national supervisory authority of each country. The list of insurer listed in the G-SIIs according their score and discretion of their national authorities are listed in exhibit 3 along with the list of G-SIBs list.

Bucket	G-SIBs (alphabetical order)	G-SIIs (Alphabetical order)
5 (3.5% buffer)	-	-
4 (2.5% buffer)	HSBC and JP Morgan Chase.	-
3 (2% buffer)	Barclays, BNP Paribas, Citigroup, and Deutsche Bank.	-
2 (1.5% buffer)	Bank of America, Credit Suisse, Goldman Sachs, Mitsubishi UFJ FG, Morgan Stanley, and Royal Bank of Scotland.	-
1(1% buffer)	Agricultural Bank of China, Bank of China, Bank of New York Mellon, BBVA, Groupe BPCE, Groupe Crédit Agricole, Industrial	Allianz SE, American International Group, Inc., Assicurazioni Generali S.p.A., Aviva plc, Axa
	and Commercial Bank of China Limited, ING Bank, Mizuho FG, Nordea, Santander, Société Générale, Standard Chartered, State Street, Sumitomo Mitsui FG, UBS, UniCredit Group, and Wells Fargo.	S.A., MetLife, Inc., Ping An Insurance (Group) Company of China, Ltd., Prudential Financial, Inc., and Prudential plc.

Source: Financial Stability Board (2014)
Exhibit 3: G-SIBs and G-SIIs list 2014 (alphabetical ranking)

c. GLOBAL SYSTEMICALLY IMPORTANT NON-BANK, NON-INSURER FINANCIAL INSTITUTIONS

The Financial Stability Board (FSB) and the International Organization of Securities Commissions (IOSCO) has proposed a methodology for identifying globally systemically important non-bank, non-insurer financial institutions (NBNI G-SIFIs) on March 4, 2015 (BIS, 2015). The methodology is aimed at providing proper guidelines in helping national authorities to identify firms that are not in the banks or insurer but have the potential to disturb the financial system and economy of the country. Therefore, at this stage the sole purpose is for a proper look by respective authorities and their suggestions for the development of updated and conclusive version.

c. DOMESTIC SYSTEMICALLY IMPORTANT BANKS (D-SIBs)

The BCBS has developed another methodology for identifying financial institutions, which have little impact over the global financial system, but with potential capacity to disrupt their local financial system. The list of such firms is called D-SIBs. The BCBS has left local authorities to use their own indicators in identifying D-SIBs for allowing them greater flexibility. Each country prepares its own list of D-SIBs, which it believes have the potential to disturb its own financial stability.

V. SUMMARY AND CONCLUSIONS

The authorities responsible for identifying SIFI are in the process of developing and designing, a reliable and well-functioning system. To that end, they have been updating and revising their indictor based approach from time to time. Considering the Macro-prudential approach to regulation is at its infantry stage, many academicians and policy makers are proposing a system, which could identify SIFIs in the way that can lead to financial stability of the system. Most of the proposed systems such as CoVaR, MES, CES, SRISK and soon, has provided a very detailed and intuitively acceptable arguments, but most of the time they lead to different ranking and different assumptions. Therefore, the search for a reliable and robust methodology of identifying SIFI is far from over. This paper provided a detailed review of analytical framework

of identifying systemically important financial institutions. All the methodologies discussed make their own assumptions and made undeniable contribution towards the understanding of systemically important financial institutions and their importance.

Scholars have preferred a market-based approach towards the identification of SIFIs, the supervisory authorities (FSB and BCBS) has opted for an indicator-based approach. CoVaR through its usage of balance sheet data to develop a forward looking risk measure and its ability to use non-additive method, has attracted national author are using it for identifying D-SIB. The authors of the methodologies discussed claim that their system could have predicted the financial crisis beforehand, those claims can only be answered in the event future crisis.

REFERENCES

[1] Acharya V., Engle, R. and Richardson, M. (2012). Capital Shortfall: A New Approach to Ranking and Regulating Systemic Risks. American Economic Review, 102(3), 59-64.

[2] Acharya V., Pedersen, L., Philippon, T. and Richardson, M. (2010). Measuring Systemic Risk. Working Paper, New-York University.

[3] Adams, Z., Füss, R. Gropp and R. (2010). Modeling Spillover Effects Among Financial Institutions: A State-Dependent Sensitivity Value-at-Risk (SDSVaR) Approach. EBS Working Paper.

[4] Adrian, T. & Brunnermeier, M. K. (2011). CoVaR. NBER Working Paper, No. 17454.

[5] Banulescu, G. D. and Dumitrescu, E. I. 2012. A Component Approach to Systemic Risk. Which are the Riskiest Financial Institutions of Them All? Proceedings of CREDIT 2012 Conference.

[6] Bongini, P. & Nieri, L. (2014). Identifying and regulating systemically important. Economic Notes: Banca Monte Dei Paschi di Siena SpA, 43, 39-62

[7] Brownlees, C. and Engle, R. (2012). Volatility, Correlation and Tails for Systemic Risk Measurement. Working Paper, New-York University.

[8] Drehmann, M. & Tarashev, N. (2011). Measuring the systemic importance of interconnected banks. BIS Working Paper, No. 34.

[9] Financial Stability Board (2015). Assessment Methodologies for Identifying Non-Bank Non-Insurer Global Systemically Important Financial Institutions. FSB and IOSCO.

[10] Financial Stability Board (FSB). 2014. Update of group of global systemically important banks (G-SIBs), 1 November 2012.

[11] Hansen, L. P. (2012). Challenges in Identifying and Measuring Systemic Risk. NBER Working Paper No. 18505.

[12] Huang, X., Zhou, H. & Zhu, H. (2009). A framework for assessing the systemic risk of major financial institutions. Journal of Banking and Finance, 33(11), 2036–49.

[13] Huang, X., Zhou, H. & Zhu, H. (2010). Assessing the systemic risk of a heterogeneous portfolio of banks during the recent financial crisis. BIS Working Paper, No. 296.

[14] IMF, BIS, FSB. (2009). Guidance to Assess the Systemic Importance of Financial Institutions, Markets and Instruments: Initial Considerations. Report to the G20 Finance Ministers and Governors. October 2009.

[15] Liu, M. and Staum. J. (2010). Systemic Risk Components in a Network Model of Contagion. Mimeo, Northwestern University.

[16] Tarashev, N., Borio, C. and Tsatsaronis, K. (2010). Attributing systemic risk to individual institutions. Methodology and policy implications. BIS Working paper, No. 308.

[17] Tarashev, N., Borio, C., Tsatsaronis, K. (2009). The Systemic Importance of Financial Institutions. BIS Quarterly Review, September, 75–87.

[18] Walter, I. (2012). Universal Banking and Financial Architecture. The Quarterly Review of Economics and Finance, 51, 114–22.

[19] Weistroffe, C. (2011). Identifying systemically important financial institutions (SIFIs). Deutsche Bank Research.

[20] Wong, A., and Fong, T. (2010). An Analysis of the Interconnectivity among the Asia-Pacific Economies. Hong Kong Monetary Authority Working Paper.